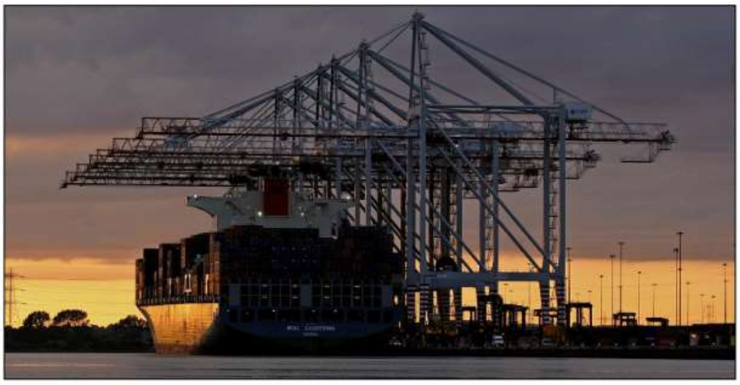
"DRAFT ENVIRONMENTAL IMPACT ASSESSMENT REPORT"
FOR
DEVELOPMENT OF A GREENFIELD PORT AT VADHAVAN, DISTRICT –PALGHAR, MAHARASHTRA

(Project Area: 17,471 Ha out of which 16,906Ha is port limit & 571Ha outside port limit**;** Water front area: 15363.5Ha; Reclamation area: 1448Ha; Berth area: 63.5Ha; Reclamation quantity: 200Mcum with marine borrow pit located offshore of Daman coast at 50km from port**)**

Terms of Reference (ToR) obtained by MoEF&CC vide no. 10-52/2020-IA.III dated 7th October, 2020 and Additional ToR obtained dated 2nd June, 2023.

STUDY PERIOD: MARCH TO MAY 2021
Monitoring done by M/s Excellent Enviro Laboratory & Research Center (Air & Noise); M/s. Envirocare labs Pvt. Ltd. (Soil & Water)
(NABL approved & MoEF&CC recognized firm)

(Project or Activity Category 'A' Schedule- 7e – Ports & Harbors ≥ 5 million TPA of cargo handling capacity, As per EIA Notification, 2006 and amendments thereof)



PROPOSED BY
JAWAHARLAL NEHRU PORT AUTHORITY AND MAHARASHTRA MERITIME BOARD

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABBREVIATIONS

AHPPL	:	Adani-Hajira Port Pvt. Ltd
AP	:	Air Pollution
AQ	:	Air Quality
BDL	:	Below Detection Limit
BOD	:	Biochemical Oxygen Demand
BMC	:	Brihanmumbai Municipal Corporation
CaCO3	:	Calcium Carbonate (Hardness)
CapEx	:	Capital expenditures
CER	:	Corporate Environment Responsibility
Cl	:	Chlorine
CO	:	Carbon Monoxide
COD	:	Chemical Oxygen Demand
COP	:	coefficient of performance
C&D waste	:	Construction and Demolition waste
CPCB	:	Central Pollution Control Board
CRZ	:	Coastal Regulation Zone
CWPRS	:	Central Water and Power Research Centre
CZMP	:	Coastal Zone Management Plan
dB(A)	:	A-weighted decibels
DFC	:	Dedicated Freight Corridor
DG	:	Diesel Generator
DMP	:	Disaster Management Plan
DMIC	:	Delhi–Mumbai Industrial Corridor Project
DPR	:	Detailed Project Report
EAC	:	Expert Appraisal Committee
EB	:	Ecology and Bio-diversity
ECBC	:	Energy Conservation Building Code
E. coli	:	*Escherichia coli*
EC	:	Environmental Clearance
EIA	:	Environmental Impact Assessment
EMP	:	Environment Management Plan
EP Act	:	Environment Protection Act
ETP	:	Effluent Treatment Plant
FGD	:	Focus group discussion

FMCG	:	fast moving consumer goods
FMCD	:	fast moving consumer durables
FSI	:	Floor space index
GDP	:	Gross domestic product
GMB	:	Gujarat Maritime Board
GSR	:	General Statutory Rules
GW	:	Ground water
HFL	:	High Flood Line
HPBD	:	High Performance Building Design
ICDS	:	Integrated Child Development Scheme
ILP	:	Integrated Logistics Parks
IMD	:	India Meteorological Department
ISO	:	International Organization for Standardization
JNPA	:	Jawaharlal Nehru Port Authority
kg/ha	:	Kilogram per Hectare
KLD	:	Kilo Liters per day
KVA	:	kilovolt-ampere
LFD	:	Low flow fixtures
LNG	:	Liquefied natural gas
LPG	:	Liquefied petroleum gas
LU	:	Land Use
LULC	:	Land Use and Land Cover
Leq	:	Equivalent Continuous Sound Level.
LFL	:	Low Flood Line
MbPA	:	Mumbai Port Authority
meq/100 gm	:	milliequivalents (meq) exchangeable cations per 100 g
Mg/l	:	Milligram per Litre
MIDC	:	Maharashtra Industrial Development Corporation
MoEF & CC	:	Ministry of Environment & Forests & Climate Change
MoST	:	Ministry of Surface Transport
MMB	:	Maharashtra Maritime Board
MMR	:	Mumbai Metropolitan Region
MMTPA	:	Million Metric Tonnes Per Annum
MOU	:	Memorandum of Understanding
MPCB	:	Maharashtra Pollution Control Board

MSEDCL	:	Maharashtra State Electricity Distribution Company Limited
NABET	:	National Accreditation Board for Education and Training
NGO	:	Non-Governmental Organisation
NOC	:	No Objection Certificate
NOx	:	Oxides of Nitrogen
NV	:	Noise and Vibration
OWC	:	Organic Waste Convertor
pH	:	power of hydrogen
PM	:	Particulate Matter
PP	:	Project Proponent
PPP	:	Public - Private – Partnership
PPE	:	Personal protective equipment
PUC	:	Pollution under Control
3PL	:	Third party logistics
QCI	:	Quality Control Inspection
RIL	:	Reliance Industries Limited
RG	:	Recreational Ground
RH	:	Risk and Hazard
RHDHV	:	Royal HaskoningDHV
RoRo	:	Roll-on/roll-off
RSPM	:	Respirable suspended particulate matter
RWH	:	Rain Water Harvesting
SE	:	Socio Economic
SEAC	:	State Environmental Appraisal Committee
SEIAA	:	State Environmental Impact Assessment Authority
SC	:	Soil Conservation
SHW	:	Solid and Hazardous Waste Management
SH30	:	State Highway 30
SOI	:	Survey of India
SOP's	:	Standard Operating Procedure
SO_2	:	Sulphur Dioxide
SPCB	:	State Pollution Control Board
SPM	:	Suspended Particulate Matter
STP	:	Sewage Treatment Plant
SW	:	Surface Water

TEU	**:**	Twenty-foot equivalent units
TKN	**:**	Total Kjeldahl Nitrogen
TOR	**:**	Terms of Reference
TSS	**:**	Total Suspended Solid
TEU	**:**	Twenty-foot Equivalent Unit
VRF	**:**	Variable Refrigerant Volume
WP	**:**	Water Pollution
w.r.t.	**:**	With respect to
WCIP	**:**	West Coast of India Pilot
ZSI	**:**	Zoological Survey of India

LIST OF ANNEXURES

Preamble

The purpose of this Environmental Impact Assessment Study is to obtain Environment Clearance (including CRZ Clearance) for development of Green Field Port at Vadhavan. The port will be constructed majorly 6.5 Kms away from the sea shore and for support activities small part of space between inter-tidal zone (land between low tide and high tide) in low lying land will be reclaimed from sea for the basic infra for foreshore development and connectivity to fore shore Port and operational area. This project is a **"Greenfield"** project and it is proposed to construct in such a way that, it will have minimal impact to the environment, fishery activities, mangroves and locals.

The proposed development of port at Vadhavan will have-

- ✓ **NO MANGROVES DESTRUCTION** as the port layout is planned in such a manner that mangroves will be unaffected.
- ✓ **NO SEA COAST EROSION**
- ✓ **NO LAND ACQUISITION FOR PORT** as the land acquisition is only required for rail and road which is 571 ha of which about 30% of which is forest land and government land.

The proposed development plays a significant role in strengthening connectivity along the Maharashtra coastline and enhancement in economy of Maharashtra.

This project will have substantial positive impact on socio-economic profile of Vadhavan, in and around Dahanu, both in terms of overall employment and skill development of local workforce. The socio-economic scenario in the region will certainly change with positive impact on the existing regional socio-economic pattern. There will be change in employment pattern with local residents will be given preference for jobs opportunities and/or self-employment. The probable augmentation in infrastructure resources such as transport, Communication, health facilities & other basic facilities will also help in increase in living standards of local population.

CHAPTER 1 INTRODUCTION

INTRODUCTION

Environment plays a vital role in overall development of the country. Recognizing the importance of environmental protection and sustainable development, the Ministry of Environment and Forest, Government of India had formulated policies and procedures governing the industrial and other developmental activities to prevent indiscriminate exploitation of natural resources and to promote integration of environmental concern in developmental projects.

The Ministry of Environment & Forest has made prior environmental clearance (EC) for certain developmental projects mandatory through its notification issued on 14th September 2006 and as amended on 1st December 2009. The Office Memorandum of MoEF, dated 3rd Nov 2009 on new policy on expansion of existing ports and initiation of new projects along the coastline is to be followed for development of ports and harbors. The categorization of the developmental projects /activities is specified in the EIA Notification 2006 and its amendment.

GENERAL INFORMATION ON PORT AND HARBOR SECTOR

Ports and harbors are the gateways of maritime trade as also inland transport. Need to enhance the standard of living calls for continual growth in the economy and calls for rapid industrialization and commensurate development of all the associated sectors of the country as a whole. In as much as maritime transport is economical and the only means to transport larger volumes of cargo across oceans, ports and harbors are, therefore, called upon to handle larger volumes of cargo throughputs of both raw material as well as products. Thus, demand for handling bigger size ships and deploy state of the art cargo handling systems many a time require augmentation/ expansion of facilities at existing ports and development of new ports and harbors. However, port development and operational activities may create a wide range of impact on the environment through activities like dredging, reclamation, construction work, development of utilities and services, discharges from ships and waterfront industries, cargo operations and other port related activities. The potential adverse effects of port development encompass water pollution, contamination of bottom sediments, damage to marine ecology and fisheries, beach erosion/ accretion, current pattern changes, waste disposal, oil leakage and spillage, emission of hazard- ous gases, air pollution, noise pollution, flood light effect and other socio-cultural impact. The preparation of EIA report and implementation of EMP are essential to effectively address this adverse effect.

Major Sources of Environmental Impact in Respect of Port and Harbor Projects

Major sources of the adverse effects on account of development of port and harbor projects can be categorized into the following types:

- Location of port
- Construction, dredging and reclamation
- Port operation, including ship traffic and discharges
- Cargo handling, storage and transport

The anticipated environmental Impact and Mitigation Measures is elaborated in Chapter 5.

ENVIRONMENTAL CLEARANCE PROCESS

The participants of the EIA process and their function are given in Table 1

Table 1-Participants in an EIA

Participants	Description & Function
Project Proponent	Government or private organization or whoever proposes project development.
Environmental consultant	The person(s), agency or company responsible for conducting the EIA
Public-Citizens and media	Special interest groups such as the NGO's, environmental agencies, labor unions form the public participation group who have a role in identifying specific environmental concerns
Reviewer	Agency responsible for reviewing the environmental impact summery report such as the Impact Assessment Agency
Other agencies of Government	National and State Government agencies that will directly or indirectly or indirectly have an interest or responsibility in the EIA process
Expert advisors	They may be Government and private experts with special knowledge of the either the project activity or the EIA process.
Decision-maker	Designated official/agency

Flow-chart depicting these stages in obtaining the prior environmental clearance for Port and harbor projects is presented in following figure

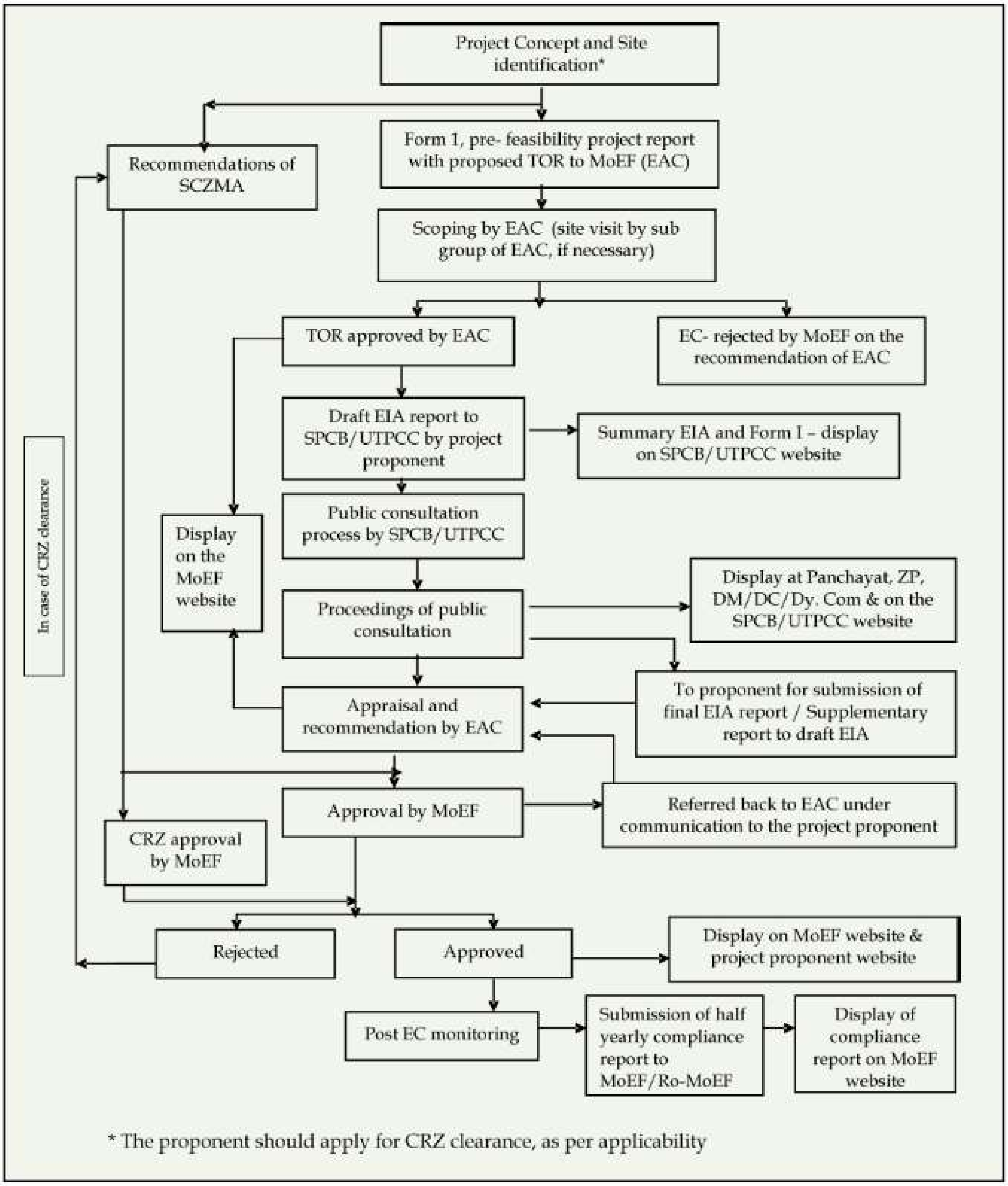


Figure 1 Prior Environmental Clearance Process for Category -A projects

GENERIC STRUCTURE OF ENVIRONMENTAL IMPACT ASSESSMENT DOCUMENT

Structure of EIA Report

The report is structured as per Appendix III of EIA Notification, 2006 and also EIA guidance manual for Ports and Harbour, February 2010, released by the MoEF.

Chapter 1: Introduction

Chapter 2: Project Description

Chapter 3: Analysis of Alternatives (Locations or layouts or technologies)

Chapter 4: Description of Environment

Chapter 5: Anticipated Environmental Impact and Mitigation Measures

Chapter 6: Environmental Monitoring Programme

Chapter 7: Additional Studies

Chapter 8: Project Benefits

Chapter 9: Environmental Cost Benefit Analysis

Chapter 10: Environmental Management Plan

Chapter 11: Summary and Conclusions

Chapter 12: Disclosure of Consultants Engaged

VALIDITY OF ENVIRONMENTAL CLEARANCE

The prior environmental clearance granted for ports and harbors sector is valid for a period of ten years, as per the notification vide S.O. 1807(E) dated 12th April, 2022. The regulatory authority concerned may extend this validity period by a maximum period of one year, provided the application is made in the laid down proforma to the regulatory authority by the applicant within the validity of period of the existing Environmental Clearance.

ABOUT THE PROJECT PROPONENT

Jawaharlal Nehru Port Authority, is the largest container port in India located east of Mumbai in Maharashtra. The port on the Arabian Sea is accessed via Thane Creek. This port is also the terminal of Western Dedicated Freight Corridor proposed by Indian Railways.

Jawaharlal Nehru Port is administered by the Jawaharlal Nehru Port Authority, Major port under Ministry of Ports, Shipping and waterways Government of India. The port was developed to relieve pressure on Mumbai Port, then the pre-eminent port of India.

The Jawaharlal Nehru Port Authority (JNPA) at Navi Mumbai is a premier container handling Port in India accounting for around 50% of the total containerized cargo volume, across the major ports of India. Commissioned on 26th May 1989, in less than three decades of its operations, JNPA has transformed from a bulk cargo terminal to the premier container port in the country. Ranked 26th among the top 100 Container Ports in the world, JNPA is connected to over 200 ports in the world.

Major exports from Jawaharlal Nehru Port are textiles, sporting goods, carpets, textile machinery, boneless meat, chemicals and pharmaceuticals. The main imports are chemicals, machinery, plastics, electrical machinery, vegetable oils and aluminium and other non-ferrous metals. The port handles cargo traffic mostly originating from or destined for Maharashtra, Madhya Pradesh, Gujarat, Karnataka, as well as most of North India.

As part of Sagarmala Programme, more than 574 projects (Cost: Rs. 6.01 Lacs Cr.) have been identified for implementation, during 2015-2035, across the areas of port modernization & new port development, port connectivity enhancement, port-linked industrialization and coastal community development. To fill the demand gap, 2 new major ports are planned which will bring in significant capacity expansion. The locations of these new ports are deliberated after detailed origin-destination study of cargo commodities and there are mainly three levers that propel the need for building new ports: New port locations have been identified based on the cargo flow for key commodities and the projected traffic: Greenfield ports are proposed to be developed at

- Vadhavan (Maharashtra)
- Paradip Outer Harbour (Odhisha)

BRIEF DESCRIPTION OF THE PROJECT

The proposed port is located at near Dahanu, abutting northern boundary of Palghar district of Maharashtra at co-ordinates Latitude 19^{0}55.8’N and Longitude 72°39.6’E. Port site has natural and strategic advantages. The site is about 150 km north of Mumbai and about 150 km west Nashik and about 180 km south of Surat respectively.

Port (s) constitutes an infrastructure and supply chain for trade and economy of the country. At present there are four main container handling ports on the west coast of India namely Mundra, Pipavav, Hazira (all private ports) in Gujarat & JNPA in Maharashtra. The combined total share of these Ports is 69-70% of the total container volume of the country. These four ports serve the large hinterland of Punjab, Himachal Pradesh, Jammu & Kashmir, Haryana, Delhi, Rajasthan, Uttaranchal, Uttar Pradesh, west

Madhya Pradesh, apart from their immediate hinterland in Gujarat and Maharashtra. Remaining 30% of Indian container market share is distributed amongst ports on the east coast (27%) and South West ports (3%). It may also be noted that 58% of India's international seaborne trade is handled through the West coast ports and 42% from the east coast ports thereby indicating that landlocked states in North West India mostly use ports on the west coast of the country for their imports and exports. It is also a fact that west coast ports serve the maximum hinterland in terms of population, geographical area and economic activities.

Jawaharlal Nehru Port Authority (JNPA) is the major container port in India serving as a gateway port patronised by all major container shipping lines operating in international seaborne trade. However, JNPA has exhausted its potential to expand further due to geographical and natural limitations and therefore, additional cargo will have to be served by other ports which too are likely to exhaust their container cargo handling capacity considering India's container cargo projections in the context of growing international trade coupled with positive economic growth. Further, vessel size has been increasing due to growing international trade and benefits of economy of scale. It is thus obvious that the country needs a new container handling port with deeper draft to thwart the impending situation of demand supply mismatch due to full capacity utilization of JNPA and other ports in India. There is an impending need for establishment of Port with deep draft of 18-20 metres, capable of berthing large vessels, such as container vessels carrying 16,000 TEUs to 24,000 TEUs. Considering the nation's projected demand of international trade, detailed research studies were carried out for identifying the sites for construction of a Major Port where large vessels can berth round the year and the international seaborne trade can be carried out. Consequently, proposed port site at Vadhavan in Dahanu taluka of Palghar district was identified which has unique natural features for construction of a modern all weather port. The proposed site has 18 metres draft naturally available in the port and 20 metres navigational channel also naturally available which drastically minimises capital and maintenance dredging.

Further, the world container sea borne business is dominated by China as it stepped up infrastructure investment since 1980s. The Chinese container ports have displayed spectacular growth and today China has 7 ports out of top 10 container ports in the world with Shanghai Port being number one, handling container volume of 47.3 million TEUs in year 2022. The three remaining slots in the top ten container ports are taken by Singapore (2), Busan (Korea) (6) and Rotterrdam (10). (Source: Lloyd's List Maritime Intelligence). The position of JN Port, the leading container port in India is 28th with 6.06 million (2022) TEUs. Even after the completion of 4th terminal at JN Port, it will still be only able to become the 17th largest container ports in the world.

The analysis also shows that development of Vadhavan port site opens an opportunity for India to break into the countries with top 10 container ports in the world. Looking at the demand for additional container capacity of 15 million TEUs in year 2035, which increases to 23.2 million TEUs in year 2040, the proposed Vadhavan port site can be developed to achieve this goal with a capacity of 24 million TEUs. The port layout of Vadhavan port prepared in consultation with CWPRS can accommodate adequate number of berths to create this capacity.

Moreover, there is growing trend towards containerisation of cargo world over and India has substantial general cargo volume which has potential for containerisation. Since the capacities created in the four ports on the western coast will be fully utilised, there will be no adverse impact on existing container handling ports on the west coast. Hence, no shifting of cargo from existing ports is necessary for the new port because there will be excess cargo than the capacities available in the four west coast ports. More importantly, it is necessary to start development of a new modern deep draft port now so that in year 2026-27 the country is able to meet projected demand of international trade and maintain a robust supply side.

Vadhavan can also be positioned as a hub port in the Arabian Sea catering to the container traffic of east coast of Africa, India's west coast, and countries in the Persian Gulf reversing the present picture. Deep draft, access to large hinterland of west and north west India, good evacuation possibility by rail and road network, one km. long container terminals with large container yards and landlord port development model are likely to attract major private operators to open their container terminals in Vadhavan port and call their container vessels of 16,000-24,000 TEUs capacity and then aggregate/distribute their containers from Vadhavan port, given advantages of economies of scale and thrust by the container shipping lines to reduce operating costs to remain competitive.

The Jawaharlal Nehru Port Authority (JNPA) at Navi Mumbai is India's No. 1 container port across all major ports in India. JNPA occupies a prominent place among the most modern ports in India and is ranked 26th among the top 100 container Ports in the world, JNPA is connected to over 200 ports in the world. In last three decades, JNPA systematically evolved its operational efficiency and improved its handling capacity to transform itself into a Port at par with global standards.

JNPA has been assigned the responsibility to develop Vadhavan port as a major port on landlord port development model. Port site has natural and strategic advantages to become a mega port and has prospect of achieving throughput of 300 million Tonnes.

PROPOSED VADHAVAN PORT INFRASTRUCTURE

Vadhavan Port is planned to be developed by JNPA (Jawaharlal Nehru Port Authority) and MMB (Maharashtra Maritime Board) as Joint Venture Project with equity share of 74% & 26% respectively. The port will be developed in two phases. The proposed port is to be developed on landlord model with the port terminals to be developed on PPP basis. In this model, basic infrastructure of the port necessitating upfront investment such as, breakwater, rail and road linkages, power, water lines and common infrastructure and services will be developed by the port/ SPV whereas all cargo handling infrastructure will be developed and operated by the agencies which are awarded concessions through global tender in an open and transparent manner by the port.

The Phase 1 development of port is envisioned to have the following components:

JNPA (Landlord)

Inside Port

- Breakwater of total length 10.14 km main breakwater
- Dredging 6.98 M cum in phase-1 and 21.5Mcum in phase
- Port craft/ Tug berth of 200 m.
- Total Reclamation area inside the port 1448 ha. with 116 2 ha. in Phase 1
- Road inside the port 32 km
- DFC rail yard 227.5 ha.
- Buildings with area of 23,500 m^2
- Pavement inside port.

Outside Port

- Land acquisition 571 ha. For road and rail connectivity
- External road connectivity of 33.4 km with 120m wide corridor
- Rail linkage area length 12 km 60 m wide corridor
- Water pipeline from Surya river which is about 22 km from port site
- Power line from Boisar power station 20 km from port

Concessionaire (Operator)

- Container terminals including storage yard, equipment, terminal pavements, drainage, utilities networks etc., with total berth length of 9000 m (4 terminals in Phase-1 and 5 terminals in Phase 2 each of 1000 m length) capable of handling vessels of 24,000 TEU and above with 24,000 TEU design container vessels.
- Multipurpose berths of 1000 m (4 berths each of 250 m) including equipment, storage yard/ shed
- 1 Ro Ro berth of 250 m including storage and onshore facilities
- 4 Liquid cargo terminals including pipelines and tank farm

NEED FOR VADHAVAN PORT

The ports on the North-West (Gujarat and Maharashtra) region of India handles around 54% of overall port traffic and 65% of container traffic. Development of state-of-the-art deep draft port is essential for India’s economic growth and maintain logistics competitiveness. The existing Major port JNPA has draft restriction and evacuation issues due to growth of large city around it. Deendayal port has draft and capacity limitations. The other 2 container ports on the North -West India APMT and Adani Hazira has their own limitations for expansion. The time involved in conceptualisation to commissioning of a large state of the art ports could range between 5 years to 10 years. Hence, there is a need to start developing large port in North-West India before existing ports run out of capacity.

India needs state-of-the-art large container ports that is closer to international mainline shipping routes. JNPA ports, presently, is the most preferred port by mainline operators due to its nearness to the shipping route.

The location of proposed Vadhavan port is most suitable for creation of large gateway port that would complement existing ports of India. Vadhavan due to its location advantage will be able to cater to large land mass of India, catering to nearly 50% of the country's population that reside in northern, central and western stretches of the country. Logistically, Vadhavan is closer to most of the cargo destination locations. Vadhavan would have competitive advantage over other ports due to its ability to berth larger ships and its closeness to Gujarat, Rajasthan, Northern and Central India. Transit time and cost for rail traffic to Vadhavan port is expected to be lower with direct connectivity to DFC. The other container ports of South Gujarat and Saurashtra will be connected to DFC using feeder network resulting in delays at interchange points. The logistics cost savings due to infrastructure and connectivity advantage by Vadhavan Port is likely to provide higher traffic gains for Vadhavan compared to other competing ports in the hinterland.

The other alternative locations for development of new and futuristic ports have their limitations. Location on the South of JNPA is away from cargo centres of northern hinterland. A port developed south of JNPA would further increase the inland distance. Coastal area to the south of JNPA has Western Ghats running parallel to the coast. Negotiating these ghats to access waterfront by road or rail would be very expensive and cumbersome, restricting seamless cargo movement to/from the ports in the region. As such, Vadhavan provides best alternative for faster and cost-effective inland evacuation. These warrants need for a new container port near north Maharashtra and South Gujarat, Vadhavan is the only suitable alternative available presently.

Vadhavan port is planned at location with deep draft. This would remove recurring dredging cost and draft limitation obstructing growth of JNPA. Some of the salient features of Vadhavan is as follows.

- Futuristic Container Terminals with deep draft to cater largest container vessels available even on the design board;
- Proximity to hinterland clusters including upcoming Dedicated Freight Corridor (DFC) and DMIC corridor resulting in lower inland evacuation cost to the hinterland;
- The port is developed at a location of deep draft that would provide channel availability without recurring dredging. This would reduce maintenance cost of port, impacting favourable tariffs for container handling

- This will have state of art cargo handling system with minimal environmental impact.

The landlord-based development model of Vadhavan from beginning is likely to attract global container terminal operators. A combination of transparency due to government initiation and deep draft would increase attractiveness of Vadhavan port for developers compared to other ports in the region. Larger shipping lines intend to own and operate container ports and container terminals. Several such instances are available in India. Hence, forging a partnership with the shipping line by the port developer is likely to increase commercial attractiveness of the port.

PROJECT SITE

The location map showing the Vadhavan Port with all its infrastructure facilities is given in Chapter 2. Apart from Port the main facility, the other project components include dredging and reclamation offshore Marine borough pits located within 40-50 Kms on northside of port, quarry for extraction of rock for construction of break water and civil construction, Road and rail connectivity, ancillary facilities such as storage yards, container terminals, development of back up area for storage and warehousing, functional buildings in the port area.

PROJECT STATUS

Detailed Project Report (DPR) has been prepared for the proposed Vadhavan port and is attached as **Annexure -1**. Studies conducted for the proposed port have established that there will be no need of land acquisition for development of the port and hence there will be no displacement of local people and consequent rehabilitation & resettlement. The port will be constructed majorly 6.5 Kms away from the sea shore and for support activities small part of space between inter-tidal zone (land between low tide and high tide) in low lying land will be reclaimed from sea for the basic infra for foreshore development and connectivity to fore shore Port and operational area. Only for rail and road linkage approx. 571 hectares land (consisting of private, tribal and government land) will need to be acquired in a strip of 120 metres throughout the length of 33.4 kms. for connecting to the National Highway 8 (Mumbai Delhi) and rail line at a distance of 12 kms from the port for which 60 metres strip will be required. This alignment has been made to avoid disruption of human habitation and drinking water sources. Moreover, all the mangroves near shore in an area of 98 hectares will be fully protected thus conserving existing ecology with innovative port design and minimal environment impact due to port development which would also be tackled by enforcement of an environment management plan.

Socio- economic study of villages falling within radius of 10 kms of the proposed port and rail and road alignment have also been conducted to ascertain their living standards and village infrastructure so as to make effective intervention for improving their condition. JNPA has organised health camps in these villages. Village level meetings have been held to spread information about the port project and seek the support of the local community. The area is predominantly tribals and survey has revealed that they survive at subsistence level economy. The port project is expected to improve their economic condition by generating employment opportunities and offering better value for their produce. The report is attached as **Annexure – 12** for Dahanu region and for Daman region, the study has been conducted by CMFRI

Accordingly, after approval of the cabinet proposal for setting up a major Port at Vadhavan, with due concurrence of the Ministry of Environment, Forest & Climate Control (MOEF&CC), on 19th February 2020, the MoPSW issued a Notification under Section 3(8) read with Section 5(2) of the Indian Ports Act, 1908 and Section 2(q) of the Major Ports Act, 1963, *inter alia*, declaring the port proposed to be set up at Vadhavan as a 'Major' port ("**said Project**"), with immediate effect. Pursuant to the exchange of various communications between the MoEF&CC, the Central Pollution Control Board ("**CPCB**") and the MoPSW, on **08.06.2020**, the MoPSW, *inter alia*, called upon JNPA to "*…take further necessary action for development of Major Port at Vadhavan accordingly*." On **20th July 2020**, JNPA submitted an online proposal to the MoEF&CC, *inter alia*, seeking Terms of Reference ("**TOR**") to obtain an Environment Clearance Certificate ("**EC**") for the "Development of Greenfield Port at Vadhavan, District Palghar, Maharashtra", as mandated by the Notification 14th September 2006 published by the MoEF&CC ("**EIA Notification**"), and the subsequent amendments thereto.

After duly considering the aforesaid proposal and the detailed presentation made by JNPA, the Expert Appraisal Committee for Infrastructure, CRZ and other miscellaneous projects ("**EAC**") in it's 241st Meeting, *inter alia*, recommended the grant of TOR in respect of the said Project on **25th - 26th August 2020**, respectively. Accordingly, on **7th October 2020**, the MoEF&CC approved the TOR for the said Project and for preparation of an EIA/ EMP report including condition to obtain NOC from Dahanu Taluka Environment Protection Authority (DTEPA), a monitoring body constituted by MoEF on 20th June, 1991. As per ToR all the studies were completed and submitted to DTEPA.

JNPA through the amendment proposal applied to the MoEF&CC, *inter alia*, seeking amendment in TOR for the change in recalamtion quantity from 86.88Mcum to 200Mcum. Also, as per revised CWPRS layout, the location of the port was changed from onshore to offshore port. Considering the substantial amount of recalamation requirement, it was decided to extract the fill material through marine borrow pit as against the earth filling borrowed from land location and in view of ecological sensitivity of the region, the change of location is proposed to borrow material from Offshore. The locations of offshore are in the northern side of Vadhavan port location where sandy bed is available. The marine borrow pit is identified in the offshore of the Daman coast about 50 km from the port site at a depth varying from 20 m to 25 m.

Accordingly, EAC after deliberation in its 324th meeting held on 19-21st April 2023, *inter alia,* recommended the proposal for amendment in ToR vide No. 10-52/2020-IA.III (Proposal no. IA/MH/NCP/295375/2022) dated 2nd June, 2023.

The Dahanu Taluka Environment Protection Authority (DTEPA) has granted JNPA permission to establish and develop the Vadhavan port in the Dahanu Taluka on 31st July 2023, based on draft EIA report submitted to them.

The project development is on a landlord model.

CONNECTIVITY ASPECT – RAIL AND ROAD CONNECTIVITY

For any port project, the road and rail connectivity are absolutely essential for the cargo as well as for the vehicular movement. Therefore, the road and rail connectivity discussed in this report are not separate and it is an integral part of the Vadhavan Port project. Although both the Indian Railways line and National Highways are running very close proximity to the proposed Vadhavan Port project site, these are to be connected for the road and rail movement of containers as well as other cargos from/to the proposed port terminal. Road and rail connectivity will bring lot of flexibility to the port infrastructure to complement local economic activities. The new port including the road and rail infrastructure can act as a catalyst for regional development and providing opportunities for the local population. This is the only candidate project location in India with deep natural water; minimal maintenance dredging and all other important criteria are favourable to develop a deep draft container PORT that can allow access to the largest vessels. Further, for the first time in India, a port project is being developed with a well-planned Multipurpose, RORO, liquid and Liquid terminals which will also necessitate an excellent rail and road connectivity.

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT

The development of the proposed Vadhavan Port including road-rail connectivity may result in land and seaside environmental changes through increased traffic and development. Therefore, adequate environmental mitigation and management measures are essential for the project. The specific objectives of the Environmental Impact Assessment (EIA) process are:

- ✓ To establish the environmental baseline in the study area and to identify any significant environmental aspects
- ✓ To assess the project impacts and provide for measures to address the adverse impacts by the provision of the requisite avoidance, mitigation and compensation measures
- ✓ To integrate the environmental issues including genuine stake holder concerns in the project planning and design

- ✓ To develop appropriate management plans for implementing, monitoring and reporting of the environmental mitigation and enhancement measures suggested during all stages of project cycle.

The EIA study has been carried out based on the amended/ additional ToR dated 2nd June 2023 (A copy of the letter is enclosed as **Annexure 2a** for reference) and earlier approved ToR dated 07-10-2020 (A copy of the letter is enclosed as **Annexure 2** for reference) covering both terrestrial and marine environments.

OBJECTIVE OF ESIA FOR ROAD/RAIL CONNECTIVITY STUDY

The objective of ESIA for Road/Rail connectivity is to carry out an ESIA/Environmental Management Plan (EMP) for the proposed road and rail connectivity to Vadhavan Port and to obtain EC from statutory authorities. The ESIA and EMP will enable the effective application of all country laws to minimise, mitigate and to avoid project environmental impacts thereby ensure, enhance and optimise the targeted overall project benefits. In addition the project has to take all valid stake holder concerns to address them suitably.

It may be noted that the road/rail ESIA will be merged to the Port EIA to represent the overall Port infrastructure EIA (i.e. Port EIA + Road rail connectivity ESIA = overall Port infrastructure EIA). This overall EIA will be submitted to the Maharastra State Pollution Control Board (MPCB) as the draft EIA to carry out public hearing. Later, a Draft EIA will be updated with all inputs including those from the public hearing to prepare a Final Draft EIA for Vadhavan Port. The Final Draft EIA will be used for obtaining other State and Central clearances.

SCOPE OF THE STUDY

The scope of EIA study includes:

- ✓ Assessment of Baseline Environmental Conditions for terrestrial environment within the study area based on field studies and review of literature
- ✓ Identification and Prediction of significant impacts due to proposed expansion on various environmental and social attributes
- ✓ Environmental Impact Evaluation
- ✓ Preparation of EMP
- ✓ Approach and Methodology

Since this is part of Port project and the road and rail being very private in nature (This is not an NH, SH, MDR or even for that matter a rural road /Rail which connects villages) for the port project, the MOEF / ASCI manual on highways does not apply to this project. This is further discussed in the later part of the project.

Project Influenced Area (PIA)/ General Study Area

As per the norms laid out by MoEF an area within 10 km radius with the Vadhavan Port site as a centre has been earmarked for the study as the *general study area*. Nevertheless, this study as a special case considered the *core study area* is the acquired project Road/Rail site with two-kilometre radius from the centre of the Port site.

Palghar district is the only PIA district and Vadhavan and Dhahanu and Palghar are the PIA talukas.

In addition to the 10 km radius general study area, a 15 km radius study area that had been scanned and used during the Form 1 & ToR stage for mapping ecologically or environmentally sensitive areas and features in the vicinity of the project.

The road alignment starts from Varor (Vadhavan port) and ends at NH-08 (Tawa junction) between coordinates 19°55'10.41"N, 72°40'34.28"E and 19°52'47.68"N, 72°56'40.50"E. The length of the new road is about 33.40 Km. The proposed Rail alignment runs along to road alignment for initial 12 Km or so. Road route map is as shown in figure below:

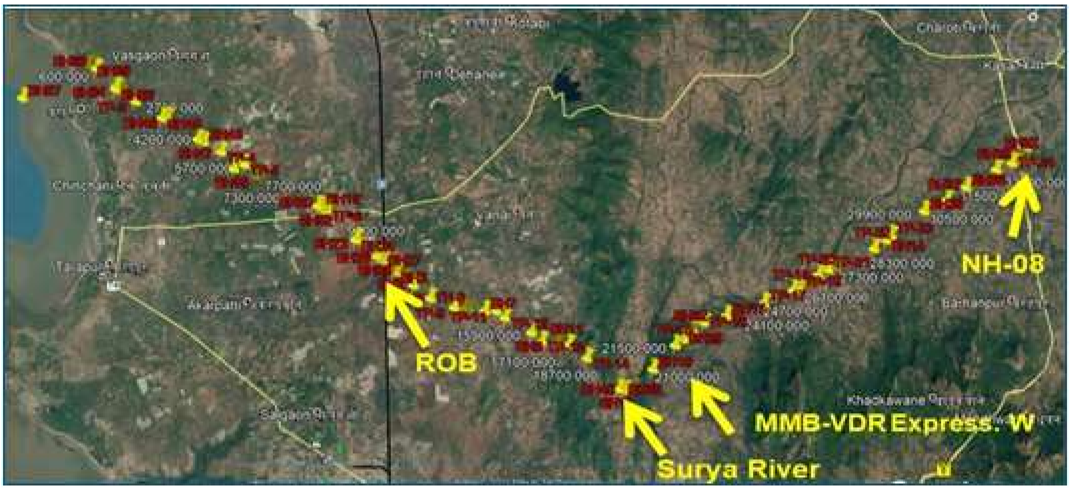


Figure 2 General study area map

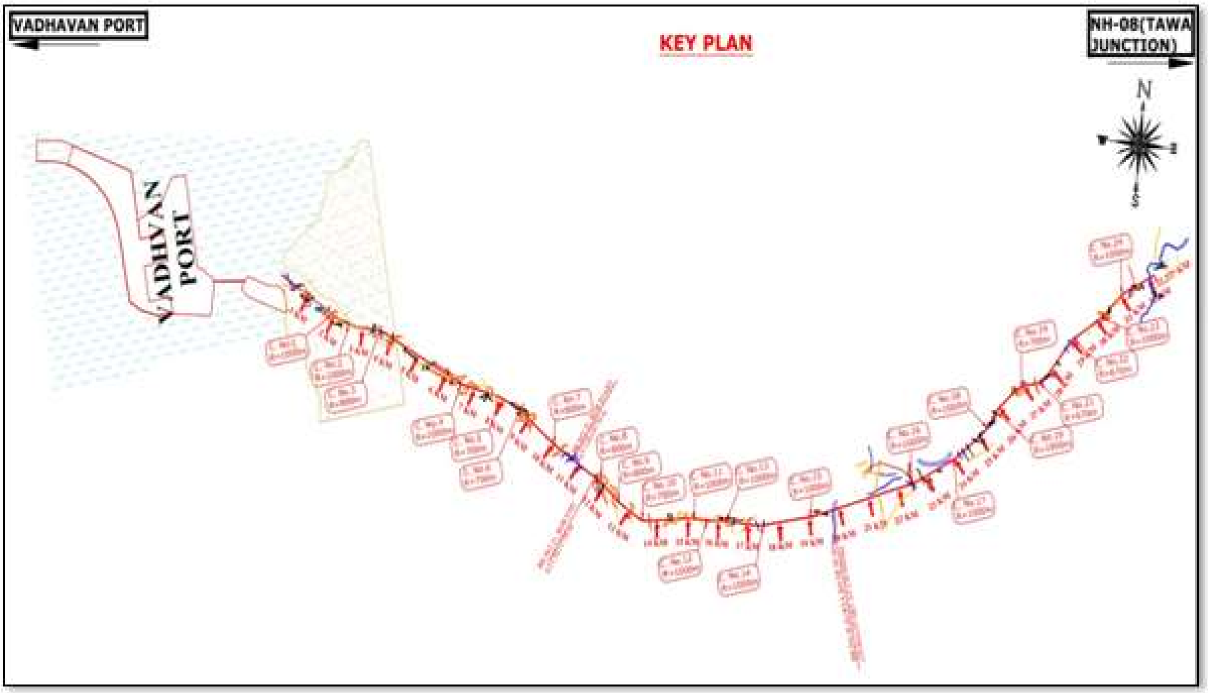


Figure 3 Road Connectivity

The baseline terrestrial environmental surveys were carried out for one month, i.e. during March - May, 2021 for the road and rail connectivity alone. Site specific hourly meteorological data was generated during the study period. Ambient air quality monitoring at the identified monitoring locations in the study area was carried out during the study period with twice a week frequency. Hourly noise levels were recorded once identified monitoring locations during the study period. Inland water quality (surface and groundwater) and soil quality sampling was carried once during the study period at the identified sampling locations in the study area.

METHODOLOGY

The ESIA for the proposed road rail connectivity to port has been carried out both for construction as well as operational phases. In each phase, the anticipated impacts due to the proposed project on terrestrial and social components have been addressed. The methodology adopted for the study is discussed. This ESIA has addressed both the Earth domain and Earth Surface domain in its entirety.

The earth domain include vertically down the surface of the earth with all its resources– Topography, Groundwater & surface water resource in quantity and quality, Geology, Hydrogeology, tectonics and seismicity.

The earth surface domain include vertically up the surface of the earth - Land use, Air, Noise, Agriculture, Socio economics, Road/Rail etc.

ANALYSIS OF ALTERNATIVES

The detailed analysis of selection of port layout for the proposed Vadhavan port has been described in the chapter for three scenarios.

To ensure sustainable development under the given conditions, the analysis of alternatives considered for rail and road layout selection has been discussed in detail and presented in the Chapter 3. In this, there were several options for the start location or take-off point and also for the end location or terminal at the Vadhavan Port site.

BASELINE ENVIRONMENTAL CONDITIONS

The baseline environmental status of the study area was established by carrying out the field surveys covering terrestrial environmental components. In addition, authenticated secondary data was also collected, reviewed and presented.

Terrestrial Environment: The baseline environmental data for terrestrial environment was collected within the study area for following attributes.

a) Meteorology
b) Ambient Air Quality (PM_{10}, $PM_{2.5}$, SO_2, NO_X and CO)
c) Noise
d) Water Quality
e) Soil
f) Ecology
g) Land use and Land Cover Mapping
h) Topography

The baseline terrestrial environmental conditions are described in **Chapter 4**.

Socio-Economic Aspects:

In addition to the primary surveys and stake holder consultations on the Project affected area for land acquisition, data on population, literacy, occupation, amenities, and medical facilities was collected from District Administration. As a part of this study, a Social Impact Assessment (SIA) is also being carried out for both Rail and Road connectivity.

Further a Resettlement Action Plan (RAP) is also being prepared based on the land acquisition act and resettlement provisions there in. The documents for this will be prepared separately and the summary of this will be provided in the ESIA report.

ANTICIPATED ENVIRONMENTAL IMPACTS AND AVOIDANCE/ MITIGATION MEASURES

The environmental and social impacts which are likely to arise due to the proposed road and rail connectivity (as an integral part of port project) project during the construction as well as operational phases have been studied in detail with respect to the facilities being proposed. Further, the impacts have been assessed taking into consideration the existing baseline status of the terrestrial environment. The mitigation measures are proposed to minimise/avoid each of the likely impacts. These are presented in **Chapter 5**.

ENVIRONMENTAL MONITORING PROGRAMME

Post project environmental monitoring programme has been formulated for road and rail connectivity (as an integral part of the port project) and presented in the **Chapter 6** of this report. The environmental monitoring programme covers the technical and network design of monitoring, as well as the effectiveness of mitigation measures (including measurement methodologies, frequency, location, etc., and detailed budget & procurement schedules).

ADDITIONAL STUDIES FOR ROAD/RAIL CONNECTIVITY

a) ***Stakeholder and Community Consultation*:** Unlike other projects this project has consulted all stakeholders both institutional as well as community stakeholders. Details of such stakeholder/community engagements have been compiled and provided in a section in **Chapter 7**. Most of such interactions have been video recorded for the best interest of the project implementation.

b) ***Rehabilitation and Resettlement Action Plan:*** The guidelines are prepared for addressing the issues limited to this project for resettlement and rehabilitation of the PAPs. The policy has been developed based on the National Highways Act 1956 and The Right to Fair Compensation and Transparency in LA RR Act, 2013 and accordingly recommendations have been proposed in **Chapter 7**.

c) ***Risk Assessment (RA) and Disaster Management Plan (DMP):*** This part will be included in the combined ESIA report to be prepared later by merging the ESIA for Road and Rail and Port EIA.

PROJECT BENEFITS

The project benefits in terms of improvements in the physical infrastructures and social infrastructure, employment potential and other tangible benefits are presented in **Chapter 8**.

ENVIRONMENTAL MANAGEMENT PLAN (EMP)

An EMP was prepared based on the mitigation measures for the impacts during construction and operational phases and necessary environmental monitoring programme proposed. The institutional mechanism responsible for the implementation of the mitigation measures and Green Belt development is presented in **Chapter 9**.

APPLICABLE LEGAL AND POLICY FRAMEWORK

Government of India (GoI) Requirements

Prior to the implementation of the project Port as a whole it needs to get environmental clearances from various regulatory bodies like State level and National level agencies. The most important government departments and institutions responsible for environment protection and management in India are:

i) Ministry of Environment & Forests and Climate Change (MoEF& CC)
ii) Central Pollution Control Board (CPCB)
iii) State Pollution Control Board (SPCB)
iv) Local bodies – Corporations, Municipalities, Gram Panchayats

The EIA for the Vadhavan Port has been carried out conforming to the requirements of September 14, 2006 Notification issued by MoEF & CC, Government of India (GoI).

The relevant important acts, rules and notifications for environmental protection in India are provided in the **Table 2**

Table 2 ***Important Acts & Rules for Environmental Protection in India***

Legal Requirement	Compliance/Application
The Environment (Protection) Act, 1986 and subsequent amendments	An Act to provide for the protection and improvement of environment and the prevention of hazards to human beings, other living creatures, plants and property
Dhahanu EZA Notification 1991, and subsequent amendments	Notification for Ecological Fragile Area (EZA) 1991
Forest (Conservation) Act, 1980, and The Indian Forest Act, 1927 and subsequent amendments	Act to provide for the conservation of forests and all related aspects of Development
Wildlife (Protection Act), 1972	Act to provide the protection of wildlife
The Air (Prevention & Control of Pollution) Act, 1981 and subsequent amendments	An Act to provide for the prevention, control and abatement of air pollution, include the preservation of the quality of air and control of air pollution; relates to the issue of the Air Consent (CFO) for the Stack and DG set emissions that are likely to be installed in the project site
The Water (Prevention & Control of Pollution) Act, 1974 and subsequent amendments	An Act to provide for the prevention and control of water pollution and the maintaining or restoring of wholesomeness of water, for the establishment, relates to the issue of the Water Consent (CFO) for the water requirement for the day

Legal Requirement	Compliance/Application
	to day project operations and daily unit wise waste generation
The Public Liability Insurance Act, 1991	An Act to provide for public liability – insurance for the purpose of providing immediate relief to the persons affected – in terms of responsibility and finances
Biological Diversity Act, 2002	Aimed at conservation of biological resources and associated knowledge as well as facilitating access to them in a sustainable manner and through a just process
Environmental Impact Assessment Notification-2006 and subsequent amendments thereof	Imposing certain restrictions and prohibitions on new projects or activities, or on the expansion or modernization of existing projects or activities based on their potential environmental impacts, being undertaken in any part of India, unless prior environmental clearance has been accorded in accordance with the objectives of National Environment Policy
Coastal Regulation Zone Notification, 2019	An act to empower the State and the central government authorities to take measures for protecting and improving the quality of the coastal environment and preventing, abating and controlling environmental pollution in the coastal areas of India
The Noise Pollution (Control & Regulation) Rules, 2000 and subsequent amendments thereof	Deciding the levels of noise at various areas or zones defined as industrial, residential, commercial and silence zone during day and night times
Solid Waste Management rule, 2016 and subsequent amendments thereof	This is applicable to port project related traffic movement. Details will be provided in the combined document.
The Hazardous Wastes (Management and Handling) Rules, 2016 and subsequent amendments thereof	Although no such cargo is included as of now, this is applicable to port project related traffic movement. Details will be provided in the combined document.
Ancient Monuments and Archaeological site & Remains act, 1958	Act to provide conservation of cultural and historical remains found in India
Land Acquisition Act, 1894 & 1989	Set out rule for acquisition of land by Government. This being a core Social impacts GoI is now formulating a new Land acquisition replacing an Act that is older than 1947, the independent India
National Resettlement and Rehabilitation Policy, 2003	All social issues related to land acquisition, resettlement and rehabilitation

TERMS OF REFERENCE (TOR)

MoEF&CC have granted Terms of Reference in the minutes of 241st Meeting of EAC held on 25th and 26th August 2020 for EIA studies for development of proposed Vadhavan Port. After detailed deliberations on the proposal, the Committee recommended for grant of Terms of

Reference as specified by the Ministry as Standard ToR on 7th October 2020 for the said project/activity and accordingly, all the studies as per the ToR have been completed.

JNPA applied for amendment in ToR for change of location from onshore to offshore port along with increment in reclamation quantity from 86.88M cum to 200M cum. The marine borrow pit for reclamation requirement was identified in the offshore the Daman coast about 50km from the port site. MoEF&CC granted amendment to TOR in its 324th meeting held on 19-21st April 2023, vide No. 10-52/2020-IA.III (Proposal no. IA/MH/NCP/295375/2022) dated 2nd June, 2023.

The Dahanu Taluka Environment Protection Authority (DTEPA) has granted JNPA permission to establish and develop the Vadhavan port in the Dahanu Taluka on 31st July 2023.

EAC has also recommended the following TOR in addition to Standard ToR for preparation of EIA-EMP report:

Table 3 Compliance of specific ToR conditions as per amended ToR dated 02.06.2023

SN	**Amended ToR Specific Condition**	**Compliance**
i.	Justification for the site suitability and viability of the project location shall be submitted	The justification is explained in Chapter 3 of EIA report.
ii	The PP has to conduct the studies as per revised configuration for the EIA/EMP studies	JNPA have revised the Detailed Project Report (DPR) prepared by RHDHV as per the revised layout. **Report enclosed as Annexure – 1** JNPA has also carried out “Dispersion of silt during dredging from marine Burrow pit for reclamation by Department of Ocean Engineering, Indian institute of technology Madras, Chennai (October 2022)” **Report enclosed as Annexure – 9** JNPA has also carried out revised study of “Impact of Breakwaters and Transport Carrier on the Erosion/ Accretion for the Vadhavan Port’ by National Centre for Coastal research (NCCR) and Indian National Centre for Ocean Information Services (INCOIS), Ministry of Earth Sciences. **Report enclosed as Annexure – 10**
iii	Traffic assessment studies for the increase of the traffic due to port related activities on	Traffic Impact assessment study has been carried out by IIT Mumbai (May 2021). <u>Some of the broad observations from the study are</u>:

<table>
<tr><th>SN</th><th>Amended ToR Specific Condition</th><th>Compliance</th></tr>
<tr><td></td><td>NH-8/ Vadodara Expressway shall be conducted.</td><td>The existing road network is sufficient to carry the present level of traffic. However, many parts of the network are under distress condition affecting the speed and capacity.
The road widths are not uniform. Narrow road widths for small stretches affecting the travel speed and capacity.
In future, the study network will require capacity additions by widening the existing roads. The simulation showed reduced speeds and increased queue lengths at some key
locations. Provision must be made for sufficient fund construction and land for widening. The proposed 8-lane connector for port-bound truck traffic is good enough for more than 15 years (until 2038) as per the port TEU handling estimates. The estimated freight demand beyond 2040 may create congestion.
With the implementation of the proposed improvements at different stages, the road network can be maintained at a low congestion level for more than 20 years.
Detailed Traffic Impact Assessment study attached as <u>Annexure No. 8.</u></td></tr>
<tr><td>iv</td><td>JNPA has identified a burrow pit at around 50-65kms into sea from the proposed Vadhavan port for obtaining sand for creating reclaimed land at the proposed Vadhavan Port. The marine sand will be dredgedusing Trailing Suction Hopper Dredger (TSHD) and the sand will be transported and dumped at the reclamation location. This has involved the mining in the marine in this regard Comments/ permission shall be obtained from the Ministry of Earth Sciences.</td><td>JNPA has obtained Letter From Ministry Of Earth Sciences, Government of India dated 25th May, 2023
Letter enclosed as Annexure - 16</td></tr>
<tr><td>v</td><td>A detailed and additional biodiversity study for the borrow pit region covering monsoon and winter season (considering the sand flats are active breeding areas for fishes and other sand</td><td>Biodiversity study for the proposed Borrow pit region in arabian sea with Reference to development of vadhavan port, palghar, maharashtra is carried out by Zoological Survey of India (October 2023).
Report enclosed as Annexure-11

Recommendation made in the report are as follows;</td></tr>
</table>

SN	**Amended ToR Specific Condition**	**Compliance**
	burrowing fauna) should be undertaken by Zoological Survey of India.	On the thorough scrutiny of the project facilities, baseline data collected on the faunal diversity of the proposed burrow pit in the Arabian Sea off Daman coast, and also, positively considering the envisaged benefits of the proposed project (The Vadhavan has a natural draft of ~20 m and has Port has potential to be among the Top 10 Container Ports in the World. The Vadhavan Port will add container capacity of 15 Million to ~23.2 Million TEUs. It will reduce logistic cost and provide hinterland connectivity through Mumbai Delhi western railway line at a distance of 12 km and Natioanl Road Grid NH-48 is about ~33.6 km), Marine Borrow Pit for Sand Mining from the proposed site off Daman in the Arabian Sea are recommended in view of the following reasons; 1. The proposed activity is the only environmentally feasible proposal as huge amount of sand required for reclamation location offshore in Dahanu within protected bunds and use of sea sand is most environmentally sustainable. 2. The proposal is for making burrow pit in Arabian sea for dredging/ sand mining for the development of the port, the environmental impact is presumed to be temporary in nature and naturally be restored and marine creatures will adopt to the location as soon as the dredging and mining activities are completed. 3. There is no significant nesting / breeding grounds for any endemic or threatened marine species including turtles, dolphins, pelagic or shorebird and fishes etc. reported and or observed in the proposed project areas. 4. The assessment of the present study revealed out the environmental impact through the proposed project that could be recorded and which can be managed sustainably to restore the pristine ecosystem though proper conservatory measures. 5. It is suggested that second year of operational phase of the project, baseline data on the status of faunal communities may be collected which will be helpful to assess the environment in the project site. 6. A state-of-art research Institutes/ laboratory should be developed in the proposed project area with the consultation with expert scientists to monitor the ecosystem with greater emphasis on breeding grounds for fishes and shellfishes, their health and population status. 7. Suggested mitigation measures should be followed rigorously in order to safeguard the marine life as well as their feeding, breeding and migratory path and future survival.

SN	Amended ToR Specific Condition	Compliance
		8. The suggested environmental management plans may be strictly followed. JNPA will follow all th recommendation made in the ZSI report.
vi	A comprehensive and dedicated socio-economic studies to be conducted with specific focus on fisherman community both in Daman and Dahanu region considering large scale sand mining that may have an impact on active fishing grounds. Such fishing grounds to be documented by Central Marine Fisheries Research Institute (CMFRI) or similar competent nationally reputed institute with expertise in fisheries. Details regarding the impact, mitigation and R&R for fisherman community be envisaged.	Impact study of proposed Vadhavan Port on Coastal Fisheries is conducted by M/s. Central Marine Fisheries Research Institute in Dahanu region (**Report enclosed as Annexure-12)** Impact Assessment of Proposed Sand Mining on the Marine Fisheries and Fisher Community of Daman Union Territory is carried out by CMFRI (**Report enclosed as Annexure-13)** Recommendations by ICAR-Central Marine Fisheries Research Institute, Mumbai Regional Station, ICAR-CMFRI are as below; • The offshore sand borrow method is the most environmentally acceptable method of obtaining the required fill material. The site is selected with a view to achieving the smallest and least persistent environmental impact as possible. The method of dredging, the area of dredging and times of the dredging operations have all been selected with this in view. • Impact of removal of 1 m of bed is not expected to create a significant physical impact, the maximum possible impact will be from the temporary raising of the turbidity levels during dredging operations. The loss of productivity in the dredged area will be temporary. The distance and depth at which dredging takes place will ensure that this activity will in no way have an impact on coastal stability. • As the marine borrow pit location far away from the coastal region approximately 50 - 60km with high tidal range and associated strong currents, the concentration of the sediment plume gets weakened immediately during the dredging activity. • Fishermen affected during the operation period of dredging need to be compensated against the non-accessibility of fishing ground by the fishers. • Guidelines for Management of Marine Sediment Extraction may be followed strictly to prevent any harmful effect on fisheries and their dependent community. • Proposed mitigatory measures should be followed stringently in order to prevent the impact of dredging

SN	Amended ToR Specific Condition	Compliance
		activity on productivity and fisheries of proposed sand mining area. • Sea bed at site is completely flat and does not contain any reefs or habitats such as seagrass bed, coral reef etc. as evinced by the detailed bathymetric survey. Socio-Economic Study for Dahanu region is conducted by Southern Enviro Engineers Pvt. Ltd., Hyderabad (**Report enclosed as Annexure – 14** Conclusions and Recommendation of the report are as follows; Most of the fisher population seems to be congregated in Dhakti-Dahanu village (21.0%) followed by Dahanu (9.3%), Chinchani (8.7%), Ghivali (8.7%), Gungwada (8.6%), Dhumket (7.5%). The remaining 7,525 fisher population (36.2%) resides in the remaining 10 villages. The fishers who spend at least 90% of the fishing time (excluding closed season) in a year for the source of income in were considered as "Full-time fishers" whereas fishers those who spend less than 90% of the fishing time in a calendar year were considered as "Part time fishers". The study by CMFRI revealed that 3,537 (17%) of the total Fisher population is involved in actual fishing activities. Among them 1,734 fishers (49.0%) are engaged full time and the remaining 1,803 fishers (51.0%) have part-time involvement in fishery related activities. A total of 7,580 fishers are engaged in fishing associated activities.
vii	The mining also proposed after 12 nautical mines around 50-65kms into sea. Ministry shall obtained the comments from CRZ division in this regard.	Application to MCZMA is yet to be done. The remarks of CRZ Committee shall be obtained appropriately.
viii	Public Hearing shall be conducted at Dahanu districts and Daman Districts	Public Hearing shall duly be conducted in both Daman as well as Dahanu districts.
ix	NO LNG and LPG Terminal shall be allowed in the proposal at this time.	JNPA duly noted and no LNG and LPG terminal shall be proposed.
x	Two seasons additional baseline data shall be collected by Zoological Survey of India covering monsoon and winter season with specific focus on offshore marine mammals movement and fish aggregation sites if any with	Biodiversity study for the proposed Borrow pit region in arabian sea with Reference to development of vadhavan port, palghar, maharashtra is carried out by Zoological Survey of India. (**Report enclosed as Annexure-11)**

SN	Amended ToR Specific Condition	Compliance
	special focus on offshore and mining areas and port reclamation areas.	
xi	Impact of breakwaters and transport carriageway on the erosion/ accretion to be evaluated by National Center for Coastal Research	JNPA has carried out study of "Impact of Breakwaters and Transport Carrier on the Erosion/ Accretion for the Vadhavan Port' by National Centre for Coastal research (NCCR) and Indian National Centre for Ocean Information Services (INCOIS), Ministry of Earth Sciences. **Report enclosed as Annexure –10** The existing reports on wave tranquillity, hydrodynamics, shoreline change assessment, and shoreline morphology study were analyzed and shoreline change analysis was carried out by NCCR. The following were the outcomes of the study: 1. The maximum significant wave height in the port basin is 1.0m in the Final Master Plan Layout as compared to 2.5 m height offshore. Due to the presence of offshore breakwater, blockage of sediments along the coast is not anticipated. However, there could be a possibility of the formation of a salient behind the proposed port, which needs to be monitored. 2. The Tidal Hydrodynamic and Siltation study finalized the Master Plan Layout for favorable operation and maneuvering conditions with minimum effect on the morphology. The maximum current strengths at container terminals are within 0.15 m/s and flow approaches at an angle varying between 4° and 7° along oil berths and Other Liquid terminals. These hydrodynamic conditions allow the bypassing of sediments towards the North of the port area. 3. The shoreline morphology study reveals that a net transport of about 0.07 Mm3 is transported just North of the proposed port area. Although Northerly transport is not fully hindered, maintenance dredging of the port can be utilized for nourishment in the North of the port. A minimum of 0.15 Mm3 of sand shall be used for nourishment of the North which will be dredged from the port basin as a part of maintenance dredging. 4. The littoral drift and shoreline evolution comparing the original shoreline and proposed port indicates an insignificant effect on the adjacent shoreline. 5. The shoreline change analysis by NCCR suggests that a stretch of 2.4 km of the study area is in a moderate to high erosion state for long-term analysis. The construction of the port breakwater is likely to reduce erosion in the south.

Table 4 Compliance of specific ToR conditions as per ToR dated 07.10.2020

SN	Specific Condition	Compliance
i)	Environmental cost benefit analysis to be carried out and submitted in EIA/ EMP report.	• The development is envisaged to play a significant role in strengthening connectivity along the Maharashtra coastline. • Enhancement in economy of Maharashtra. • Substantial positive impact on socio-economic profile of Vadhavan, in Particular, and Dahanu, in general, both in terms of overall employment and skill development of local workforce. • Direct as well as indirect employment potential is envisaged. • Augmentation in infrastructure resources such as transport, Communication, health facilities & other basic facilities The details on Project benefits are given in Chapter 9 of EIA **Project Cost:** INR 76,220 Crores **Budget Environmental Management Plan-** Construction Phase: Port Area Capital cost: 302 Lakhs O & M Cost per Annum: 197.35 Lakhs **Operation Phase for Port Area** Capital cost: 443 Lakhs O & M Cost per Annum: 404.5 Lakhs **Operation phase Rail-Road**: Capital cost: 222.12 Lakhs O & M Cost per Annum: 73.17 Lakhs **Operation Phase – Residential Area** Capital cost: 212 Lakhs O & M Cost per Annum: 55 Lakhs **Offshore monitoring cost: 500 Lakhs** As per the MOEFCC Memorandum dated 1st May, 2018 JNPA has proposed an amount of Rs. 190 Crores under Corporate Environment Responsibility (CER).
ii)	Submit a copy of layout superimposed on the HTL/LTL map demarcated by an authorized agency on 1:4000 scale	A layout superimposed on HTL/LTL map has been prepared by Institute of Remote Sensing, Anna University, Chennai, based on CRZ Notification 2019 The proposed details viz Approach Trestle, Breakwater, Navigational Area, Offshore Reclamation Area, Sheltered Area within Vadhavan Port Limits lies in CRZ-IVA and Reclamation Area near Shore lies in CRZ-IB, CRZ-III (200m to 500m from HTL), CRZ-III (No Development Zone), CRZ-IVA and outside CRZ areas as per approved CZMP.

SN	**Specific Condition**	**Compliance**
		The reclamation area near shore in within Vadhavan Port Limits lies in CRZ-IB, CRZ-III (200m to 500m from HTL), CRZ-III (No Development Zone), CRZ-IVA, and outside CRZ areas as per approved. The remaining Area within Vadhavan Port Limits lies in CRZ-IA, CRZ-IA (50m Mangrove Buffer Zone), CRZ-IB, CRZ-III (No Development Zone), and CRZ-IVA areas as per approved CZMP. The proposed Road and Rail Alignment for the port connectivity lies in CRZ-IB, CRZ-III (200m to 500m from HTL), CRZ-III (No Development Zone) and Outside CRZ areas as per approved CZMP. **Copy of the IRS report enclosed as Annexure – 3**
iii)	Recommendation of the Maharashtra CZMA.	Application to MCZMA is yet to be done. Once MCZMA recommends the project we will upload the same to MoEF&CC.
iv)	No POL Jetty is envisaged view eco sensitive location	POL jetty is not envisaged in the notified eco-sensitive location.
v)	NoC to be obtained from Dahanu Taluka Environment Protection Authority (DTEPA) as applicable.	The Dahanu Taluka Environment Protection Authority (DTEPA) has granted JNPA permission to establish and develop the Vadhavan port in the Dahanu Taluka on 31st July 2023. **(Copy of permission is enclosed as Annexure - 15)**
vi)	Submit superimposing of latest CZMP as per CRZ (2011) on the CRZ map.	A layout superimposed on HTL/LTL map has been prepared by Institute of Remote Sensing, Anna University, Chennai, based on CRZ Notification 2019 **Copy of the IRS report enclosed as Annexure – 3**
vii)	Submit a complete set of documents required as per para 4.2 (i) of CRZ Notification, 2011	JNPA will submit the same after MCZMA application.
viii)	Hydrodynamics study on impact of dredging on flow characteristics	Mathematical Model Studies to assess the impact of proposed capital dredging on tidal hydrodynamics of nearby area of proposed port at Vadhvan is carried out by CWPRS (T. R. 5970 – Nov 2021). **Detailed Hydrodynamic report is attached as Annexure 4**
ix)	Flooding and related impact on creek and control area during the cyclonic storm should be studied	Mathematical Model Studies to assess the impact of Proposed Port Development at Vadhavan on Flooding in Dahanu Creek and Nearby Control area under Cyclonic Conditions is carried out by CWPRS (T. R. 6173 - Oct 2023) enclosed as **annexure 5**

SN	Specific Condition	Compliance
x)	The EIA would give a detailed analysis of the Impacts of storage and handling and the management plan including hazard mitigation measures of each cargo type along with the proposed compliance to the Hazardous Chemicals Storage rules	The details of storage of all types of cargo, hazardous chemicals will be decided and finalize by the concessionaire after work is awarded by JNPA. During construction phase hazardous waste such as lubricating oil from vehicles, empty paint, Oil & grease filter form surface runoff, sludge containing oil, empty paint cans etc. will be generated. During operation phase Empty barrels/containers/liners contaminated with hazardous chemicals /wastes, contaminated cotton rags or other cleaning materials, Oil contained material form oil spill cleaning etc. will be generated Safe and environmentally sound management of hazardous and other wastes shall be provided. Hazardous wastes generated shall be sent or sold to an authorized actual user or shall be disposed of in an authorized disposal facility. Hazardous and other wastes shall be transported from port to an authorized actual user or to an authorized disposal facility in accordance with the provisions of Hazardous and Other Wastes (Management and Trans boundary Movement) Rules, 2016 and subsequent amendments thereof DMP for Natural and manmade hazards has been carried out and included in section 7.2 of Chapter 7 of EIA report.
xi)	Study the impact of dredging and dumping on marine ecology and draw up a management plan through the NIO/NIOT or any other institute specializing in marine ecology.	Marine biodiversity management plan for the proposed greenfield port at Vadhavan, Palghar district, Maharashtra is conducted by NIO (SSP 3374 – Jan 2022). Based on the studies the following has been concluded. **Impact of dredging and dumping on marine ecology** Dredging and disposal of dredged material can lead to a temporary decrease in water transparency, increased concentrations of suspended matter, and increased rates of sedimentation. In the case of contaminated sediment or sediments with high contents of organic matter, dredging and resuspension may also lead to effects on water quality by the release of contaminants leads to increase in nutrients concentration and reduced dissolved oxygen in the water column Dredged material may come into suspension in the water column because of many activities like, disturbance of the substratum, during transport to the surface, overflow from barges or leakage of pipelines, during transport between dredging and disposal sites, and during disposal of dredged material Turbidity changes induced by dredging will result in adverse environmental effects when the turbidity generated is significantly larger than the natural variation of turbidity and sedimentation rates in the area. Turbidity created by

SN	Specific Condition	Compliance
		dredging will cause clogging and smothering effects on filter-feeding organisms such as mussels, oysters, bivalves etc **Mitigating measures for reducing the impact of dredging activities** • Methods like tidal dredging, physical barriers, environmental dredging techniques and so forth, which may be used to mitigate effects of dredging on sensitive organisms and on ecosystems. In hydraulic dredging techniques, the dredging rate can be adapted by increasing the amount of water pumped up relative to the amount of sediment that is dredged, which can help to reduce the extent of turbidity plumes. Examples of other environmentally less damaging dredging equipment include encapsulated bucket lines for bucket chain dredgers, closed clamshells for grab dredgers, auger dredgers, disc cutters, scoop dredgers and sweep dredgers. • Adoption of sub-suction dredging, which allows for lowering of the seafloor by extracting sediment from deeper layers without disturbing the top layer is also a good option for dredging in the berth pocket and turning circle. Mitigating measures applied in other cases include confined land-disposal, turbidity modelling (plume prediction), turbidity thresholds, minimizing duration of dredging, seasonal restrictions, limiting over-dredge quantities, establishment of no-spud zones, use of silt screens, prohibiting dredging near the Shankodar (19°56'44.78"N, 72°38'14.60"E) which is having a comparatively high biodiversity in the study area, stopping dredging when turbidity thresholds are exceeded. Protection of an environmentally very sensitive area like Sankodhar with silt screens may in some cases be viable, but only if the physical conditions of the site (esp. waves and currents) allow their effective use. **NIO Report attached as per Annexure 6**
xii)	Ship Navigation studies for entrance channel and turning circle should be conducted for prevention of navigation hazards.	2D Desktop Navigation Simulation Study has been carried out by DHI/ Force (March 2022) and attached as **Annexure 7** From the study, following recommendations were made, The vessel approach speed to the berth should be consistent with existing pilotage practice.

SN	**Specific Condition**	**Compliance**
		During vessel's arrival, it is recommended that all tugs to be made fast soonest possible after vessel enters and in the shelter of the breakwater. Consider using at least two 65ton bollard pull ASD tugs and two 100ton bollard pull ASD tugs capacity during the berthing and un-berthing of large vessel. Recommend that constant vigilance be exercised in controlling the vessel's bow during manoeuvering near the entrance of approach channel due to strong cross tidal current of between 2.5 to 3.2 knots during maximum flood and ebb. Vessel set and drift must be closely monitored. A channel transit speed of between 9 to 10 knots at the entrance of the approach channel during study proofs to be sufficient to keep vessel's heading with manageable angle of drift. Although there were sufficient resources in terms of vessel's ability to apply early counter helm and use of engine power, it is recommended that non-piloted vessel be made aware to exercise vigilance during vessel approach in maximum flood, as the vessel will experience a starboard sheer/swing caused by flood current at stern of vessel as the vessel's bow enter sheltered waters at breakwater. Although the 750m wide approach channel is sufficiently wide for a two-way vessel traffic, consider such be allowed during lesser current speed or during slack tide for large vessels or with piloted vessels. Considering the March 2022 navigation study report uses a maximum wind speed of 15 knots, consider suspending berthing and un-berthing operations when wind speed exceeds 15 knots or when the risk is deemed to be high. It is recommended to limit the operable wind speed and tidal current to low initially during the handling of large vessel with deep draft and large windage area. This restriction can possibly be relaxed when routine and experience has been acquired. It is recommended that other traffic movement be restricted or controlled in the port basin area while a vessel is conducting a berthing or un-berthing manoeuver in the area. As good seamanship practice, it is recommended that pilot check with Master that the vessel's anchor to be ready for emergency use at all time during manoeuvering.

SN	Specific Condition	Compliance
		That further simulation runs be conducted by the pilots of the port on a Full Mission Ship Simulator to further evaluate the conditions of safe operation and to establish the preliminary pilotage guidelines.
xiii)	Traffic forecast and congestion studies at roads connecting arterial roads to be conducted. Detail traffic density study to be conducted since lot of container movements are expected in & out of the proposed port	Traffic Impact assessment study has been carried out by IIT Mumbai (May 2021) <u>Some of the broad observations from the study are</u>: • The existing road network is sufficient to carry the present level of traffic. However, many parts of the network are under distress condition affecting the speed and capacity. • The road widths are not uniform. Narrow road widths for small stretches affecting the travel speed and capacity. • In future, the study network will require capacity additions by widening the existing roads. The simulation showed reduced speeds and increased queue lengths at some key • locations. Provision must be made for sufficient fund construction and land for widening. The proposed 8-lane connector for port-bound truck traffic is good enough for more than 15 years (until 2038) as per the port TEU handling estimates. The estimated freight demand beyond 2040 may create congestion. • With the implementation of the proposed improvements at different stages, the road network can be maintained at a low congestion level for more than 20 years. Detailed Traffic Impact Assessment study attached as **<u>Annexure No. 8</u>**
xiv)	Impact of port on shoreline changes and sea bed morphology to be conducted and mitigation measures for shore protection to drawn based on above studies	Shoreline changes and sebed morphology studies was conducted by National Centre for Coastal research (NCCR) and Indian National Centre for Ocean Information Services (INCOIS), Ministry of Earth Sciences. **Report enclosed as Annexure –10** The existing reports on wave tranquillity, hydrodynamics, shoreline change assessment, and shoreline morphology study were analyzed and shoreline change analysis was carried out by NCCR. The following were the outcomes of the study: 1. The maximum significant wave height in the port basin is 1.0m in the Final Master Plan Layout as compared to 2.5 m height offshore. Due to the presence of offshore breakwater, blockage of sediments along the coast is not anticipated. However, there could be a possibility of the formation of a salient behind the proposed port, which needs to be monitored.

SN	Specific Condition	Compliance
		2. The Tidal Hydrodynamic and Siltation study finalized the Master Plan Layout for favorable operation and maneuvering conditions with minimum effect on the morphology. The maximum current strengths at container terminals are within 0.15 m/s and flow approaches at an angle varying between 4° and 7° along oil berths and Other Liquid terminals. These hydrodynamic conditions allow the bypassing of sediments towards the North of the port area. 3. The shoreline morphology study reveals that a net transport of about 0.07 Mm3 is transported just North of the proposed port area. Although Northerly transport is not fully hindered, maintenance dredging of the port can be utilized for nourishment in the North of the port. A minimum of 0.15 Mm3 of sand shall be used for nourishment of the North which will be dredged from the port basin as a part of maintenance dredging. 4. The littoral drift and shoreline evolution comparing the original shoreline and proposed port indicates an insignificant effect on the adjacent shoreline. 5. The shoreline change analysis by NCCR suggests that a stretch of 2.4 km of the study area is in a moderate to high erosion state for long-term analysis. The construction of the port breakwater is likely to reduce erosion in the south.
xv)	Details of Emission, effluents, solid waste and hazardous waste generation and their management in the existing and proposed facilities	The details of Emission, effluents, solid waste and hazardous waste generation and their management in the existing and proposed facilities covered in Chapter 5 of EIA report
xvi)	Requirement of water, power, with source of supply, status of approval, water balance diagram, man-power requirement (regular and contract).	**Water requirement** Daily water demand for the Phase 1 development is estimated to be around 6.8 MLD (million litres per day) and for the master plan phase, the anticipated demand is at 13.3 MLD. Out of this the potable water demand for port usage is 1.8 MLD in Phase 1 and 2.8 MLD in master plan phase, with the balance being the demand for raw water and supply to port township. A static storage of raw water of 1-day storage is provided for the port while half a day storage is provided for the township. Details have been provided in Chapter 2 of EIA report **Power requirement –** The required electrical system for the project will consist of: a. The incoming electrical supply at 80 MVa level. b. 220/33 kV substations containing transformers, switchboards, control equipment, etc. to supply the

SN	Specific Condition	Compliance
		electrical power to various parts of the site at the required voltage levels of 11kV or 6.6 kV & 0.415 kV. c. Control and Monitoring systems. Two locations of the nearest 220 kV source from PGCIL line/Tarapur Boisar power station are identified to be provided by MSETCL, which are 20km away from port. Details have been provided in Chapter 2 of EIA report Status of approval: JNPA has applied to respective gov. departments for supply of water, power. Man-power requirement: Regular- 2040 nos, Contract- 6000 nos.
xvii)	Permission from CGWA in case of groundwater use being proposed for the project	No groundwater extraction/use is envisaged in the project
xviii)	Wastewater Management Plan.	The sewerage system is limited to the areas wherever office buildings, canteens, and other operational buildings are constructed. For the isolated buildings where the quantity is negligible, it is proposed to setup STPs for disposal. STP of 5000KLD with Sequential Batch Reactor (SBR) Technology is proposed to be installed for phase 1. For master plan, adequate capacity of STP shall be provided. During monsoon months, the sludge will be stored separately in a storage structure with adequate capacity. The treated water will be recirculated for gardening and non-drinking purposes. The sludge from the treatment plant will be processed and converted into Biomass used as manure. The ships will not be allowed to discharge their sewage in the port complex. As per MARPOL convention, the ships are now required to have STP on board. Refer Chapter 2 of EIA report.
xix)	Details of Environmental Monitoring Plan.	Environmental Monitoring Plan is given in chapter 6 of EIA report.
xx)	To prepare a detailed biodiversity impact assessment report and	A detailed biodiversity impact assessment report and management plan has been carried out by NIO (SSP 3374 – Jan 2022).

SN	Specific Condition	Compliance
	management plan through reputed institute such as NIO, NIOT or university having specialized skills on marine, brackish water ecology and biodiversity with focus on winter season. The report shall study the impact of the activity on the intertidal biotopes, corals and coral communities if present, molluscs, sea grasses, sea weeds, sub tidal habitats, fishes, cetaceans and other marine and aquatic micro, macro and mega flora and fauna including benthos, plankton, turtles, birds etc. as also the productivity.. The data collection and impact assessment shall be as per standard survey methods.	**Impact on Biodiversity**: Decrease in primary productivity, Decrease in zooplankton biomass, Benthic biota loss, Noise related issues, Impact on marine mammals, Mangrove conservation **Mitigation measures proposed** Adoption of a sustainable dredge management plan, Disposal of dredged material in approved dumping ground , Ensure dumping of excess/unusable dredge the material would be uniform ,Implementation of oil spill control SOPs , Slop tanks on barges and boats for collection of liquid, solid and hazardous waste , Adoption of environmental friendly dredgers and technologies for dredging and construction , Minimise the spill on the marine environment , Adoption of scientific methods such as containment system to retain the solid inside the reclamation area. Application of temporal and geographic closures, Bubble curtains and jackets around noisemaking equipment , Acoustic decoupling of equipment , Vessel speed limit and restrictions , Installing silt curtains around sensitive areas , Good mangroves patches were present aroundthe proposed port project site , Avoid any disturbance to this nearby mangrove vegetation , Strict adhering of the marine environment and biodiversity monitoring plans under the environmental monitoring programme **The report is attached as <u>Annexure 6.</u>**
xxi)	Impact of undersea noise on cetaceans needs to be studied through the reputed institutes like NIO	The study of impact of undersea noise on cetaceans has been carried out by NIO. The possible impacts are as follows- **<u>Port development activities</u>:** During the study period no any cetacean observed in the study area. Various developmental activities during the construction and operational phase of the proposed port at Vadhavan can cause an impact on the local cetacean diversity, distribution and its behavior. **Dredging activities:** Marine mammals, particularly cetaceans, are acoustically reliant animals that utilize sound for detecting prey, navigating, and communicating. Reported effects include temporary threshold shift (TTS) or permanent threshold shift (PTS), the latter being considered as auditory injury. Other effects include acoustic masking, which could cause animals to alter the duration, frequency, or sound level of acoustic signals. Masking of important sounds can theoretically impact reproductive success of individual whales, and in turn affect populations • Behavioral changes due to noise exposure can happen at large distances from the source, and may be costly biologically, as they could affect energy

SN	Specific Condition	Compliance
		expenditure, or limit the amount of time spent feeding or resting. It has been hypothesized that noise impacts have the potential to induce stress. Stress could reduce the foraging efficiency of marine mammals or increase their susceptibility to disease and the effects of toxins. Reactions of marine mammals to dredging sound are expected to depend on types of dredgers used and its state of operation, on the local sound propagation conditions, and the receiver characteristics with regard to the sensitivity and bandwidth of hearing. Sound levels that marine mammals are exposed to usually are below suspected injury thresholds or PTS however, TTS cannot be ruled out if marine mammals are exposed to noise for prolonged periods. • During operations of dredging and dumping, an increase in suspended solids concentration is expected. This increase may potentially influence humpback dolphins' prey, and affect the dolphins indirectly by the loss of food supply due to disturbance of the seafloor and increased sedimentation. Moreover, during dredging operations, contaminants such as heavy metals and organochlorines settled on the seabed may be stirred up and redistributed into the water column. This potential contaminant release by resuspension of environmental contaminants may increase their bioaccumulation in dolphins and porpoises through the intake of prey items in the vicinity of the work area. The potential contaminant release should be examined through hazard to health risk assessment
xxii)	The concentrations of Petroleum Hydrocarbons in seawater at low tide and high tide conditions should be presented at proposed SPM site.	➢ The concentrations of PHc off Vadhavan waters varied between 2.5 and 5.7 µg/L, averaged at 3.8 µg/L. ➢ The limits of PHc decrease from nearshore to the offshore, varying between 3.3 µg/L and 2.4 µg/L, respectively indicated in the figure above. ➢ The levels of PHc found during this study are much lower compared to the adjacent estuarine and creek environment of Mumbai ➢ NO SPM are envisaged
xxiii)	A certificate from the competent authority for discharging treated effluent/ untreated effluents into the Public sewer/ disposal/ drainage systems along with the final disposal point.	We will obtain Consent to Establish and Consent to Operate for this project

SN	Specific Condition	Compliance
xxiv)	A certificate of adequacy of available power from the agency supplying power to the project along with the load allowed for the project.	A Certificate of adequacy of availability of power supply will be obtained from MSEDCL.
xxv)	A certificate from the competent authority handling municipal solid wastes, indicating the existing civic capacities of handling and their adequacy to cater to the M.S.W. generated from project	JNPA will follow all the existing regulations and guideline for above point
xxvi)	An assessment of the cumulative impact of all development and increased inhabitation being carried out or proposed to be carried out by the project or other agencies in the core area, shall be made for traffic densities and parking capabilities in a 05 Kms radius from the site. A detailed traffic management and a traffic decongestion plan drawn up through an organisation of repute and specializing in Transport Planning shall be submitted with the EIA	Study has been carried out by IIT Mumbai and the Detailed Traffic Impact Assessment study attached as **Annexure No. 8.**
xxvii	Disaster Management Plan for the project	The details of storage of all types of cargo, hazardous chemicals will be decided and finalise by the concessionaire after work is awarded by JNPA The details of Risk Assessment and Disaster Management Plan is mentioned in Chapter 8 of EIA report
xxvii	Details and status of court case pending against the project, if any.	CIVIL APPEAL NO(S). 5718-5719/2021 in the Hon'ble Supreme Court. Jawaharlal Nehru Port Authority Appellant(S) Versus National Fishworkers Forum & Ors. Respondent(S). Hon'ble Bombay Court case writ petition 9473 of 2023.

<table>
<tr><th>SN</th><th>Specific Condition</th><th>Compliance</th></tr>
<tr><td>xxix)</td><td>Public hearing to be conducted and issues raised and commitments made by the project proponent on the same should be included in EIA/EMP Report in the form of tabular chart with financial budget for complying with the commitments made</td><td>Public Hearing will be conducted as per the procedure laid down in EIA Notification 2006.</td></tr>
<tr><td>xxx)</td><td>Plan for Corporate Environment Responsibility (CER) as specified under Ministry's Office Memorandum vide F.No. 22-65/2017-IA.III dated 1st May, 2018 shall be prepared and submitted along with EIA Report</td><td>As per the MOEFCC Memorandum dated 1st May, 2018 JNPA has proposed an amount of Rs. 190 Crores (0.25% of the project cost i.e. Rs. 76,220 Crores) under Corporate Environment Responsibility (CER). As per direction of MOEF&CC the Proposed Corporate Environmental Responsibility (CER) activities as follows-
<table>
<tr><th>Sr. No.</th><th>Proposed activities</th><th>Fund allocation in Crs.</th></tr>
<tr><td>1</td><td>Education and skill development</td><td>58</td></tr>
<tr><td>2</td><td>Health</td><td>35</td></tr>
<tr><td>3</td><td>Drinking Water Supply, Sanitation</td><td>27</td></tr>
<tr><td>4</td><td>Roads</td><td>25</td></tr>
<tr><td>5</td><td>Cross Drains</td><td>5</td></tr>
<tr><td>6</td><td>Electrification including Solar Power</td><td>10</td></tr>
<tr><td>7</td><td>Solid Waste Management Facility</td><td>10</td></tr>
<tr><td>8</td><td>Rain Water Harvesting</td><td>5</td></tr>
<tr><td>9</td><td>Avenue Plantation</td><td>5</td></tr>
<tr><td>10</td><td>Plantation in Community Area</td><td>10</td></tr>
<tr><td></td><td>Total</td><td>190</td></tr>
</table>
However the final CER fundings will be subject to final outcome of the public consultation and as decided by EAC of the central or State level comittees and the same will be incorporated as prescribed in final EIA report.</td></tr>
<tr><td>xxxi)</td><td>A tabular chart with index for point-wise compliance of above ToRs</td><td>Tabulated above</td></tr>
</table>

CHAPTER 2 PROJECT DESCRIPTION

2.1 Introduction

2.1.1 Identification of Project

India has an approximately 7500 km long peninsular coastline and is located close to major shipping routes linking East Asia, Europe and the Middle East. India therefore has the potential to significantly grow its maritime trade with other countries and as its economy grows, necessity of developing ports for international trade will also grow. Presently, there are 12 Major Ports and 200 Non-Major ports in India. The Major Ports are all Federal Government owned and handled around 54% of India's maritime trade in 2019-20. The cumulative traffic handled by Indian Ports in 2019-20 were about 1,310 MT of which Major Ports contributed 704.9 MT and Non-Major Ports (minor and intermediate ports) handled 604.8 MT. Major Ports are ports developed by act of Parliament with Ministry of Shipping, Government of India ownership. Non-major ports include ports owned by State Government, Private Ports, Captive Ports setup for specific cargo by large industries, etc. Though there are 200 non-major ports, the number of functional ports with more than 2 MT of annual traffic are 26 only.

The country's ports sector has witnessed strong growth over the past decade with total traffic handled by it increasing from 360 MT in FY01 to 1,310 MT in FY20. The traffic-handling capacity of major ports increased at a CAGR of 7.3% during 2012–2017 to reach 945 MT. During the same year, traffic handled at non-major ports grew at 8.6% year on year, largely due to the 12.4% year on year growth of Gujarat Maritime Board (GMB) ports.

The 12 major ports carry about 54% of the total port traffic of the country. The share of non-major ports in cargo traffic has increased from 7% in 1990 to the current levels of 46%. Large cities have grown around Major ports restricting its expansion, limiting cargo evacuation to hinterland. There exist inefficiencies at major ports. The non-major ports (especially private ports) are developed away from cities with modern infrastructure. The operational efficiencies of these non-major ports have gradually taken away incremental cargo of Major ports and with development of minor ports by the respective states.

As part of Sagarmala Programme, more than 574 projects (Cost: Rs. 6.01 Lacs Cr.) have been identified for implementation, during 2015-2035, across the areas of port modernization & new port development, port connectivity enhancement, port-linked industrialization and coastal community development. To fill the demand gap, 2 new major ports are planned which will bring in significant capacity expansion. The locations of these new ports are deliberated after detailed origin-destination study of cargo commodities and there are mainly three levers that propel the need for building new ports: New port locations have been identified based on the cargo flow for key commodities and the projected traffic: Greenfield ports are proposed to be developed at

- Vadhavan (Maharashtra)
- Paradip Outer Harbour (Odhisha)

There has been an impressive growth of about 9% per annum in container traffic during the five years ending 2015-20. The container trade went up to 17.3 million twenty-foot equivalent units (TEU) by 2020 from 11.5 million TEU in 2015, 8.0 million TEU in 2010, 4.5 million TEU in 2005 and 2.1 million TEU in 2000. India's container traffic has grown by 8 times in last 20 years. There is certainly a need for new and state of the art container port to sustain high trade growth. Vadhavan would provide good alternative for same.

Maharashtra with a coastline of 720 km stretching along the Arabian sea has two major ports. Mumbai and JNPAwhich cater to the hinterland of Maharashtra, North Karnataka, Telengana, Gujarat and secondary hinterland of NCR, Punjab, Rajasthan and Uttar Pradesh. JNPAwas developed as a satellite port of Mumbai port and has coped well in becoming the largest container port of the country. The development of Phase 2 of 4th container terminal is underway and after its full development there is little space for further expansion. Apart from that due to the presence of bed rock at or very close the existing bed level, JNPA cannot be deepened further economically to handle the future generation of mega container ships drawing draft of 16 m or more. There is a need for a large draft port that will cater to the spill over traffic from JNPA port once its expanded capacity of 10 million TEUs is fully utilized.

With the projected demand for containers to go up, it is necessary to locate a new mega port site which can cater to increased requirement of capacity and could be developed to handle the future deep draft ships. Considering the above it has been decided to develop Vadhavan port as a satellite port for JNPA and for this purpose the present report has been prepared to assess its environmental impact.

2.1.2 Project Vision

The vision of JNPA is to develop a state-of-art Port which shall be in lines with the International Port Terminal. The port will be developed on landlord model in two phases. In this model, basic infrastructure of the port necessitating upfront investment such as, breakwater, rail and road linkages, power, water lines and common infrastructure and services will be developed by the port/ SPV whereas all cargo handling infrastructure will be developed and operated by the agencies which are awarded the concessions.

2.2 Brief Description of Nature, Size, Location of the Project

The natural water depth available at proposed Vadhavan port is more than any competing Indian port and more or equal than competing international ports. It will be able to capture the increasing trend of larger container vessels which none of the existing Indian ports can service, due to which majority of containers destined or generated from India are being transhipped or double-handled from competing international ports, resulting in higher import/export cost. Vadhavan port will further enhance India's ability to handle containerised cargo while establishing a strong supply chain network in Maharashtra.

The port limit proposed as the original port limits notified in the G.O. 690, dated 19.02.2020. The port limits for the proposed Vadhavan port are as shown in the following figure.

The proposed project site is located in west coast of India at Vadhavan of Dahanu taluka in Palghar district, Maharashtra.

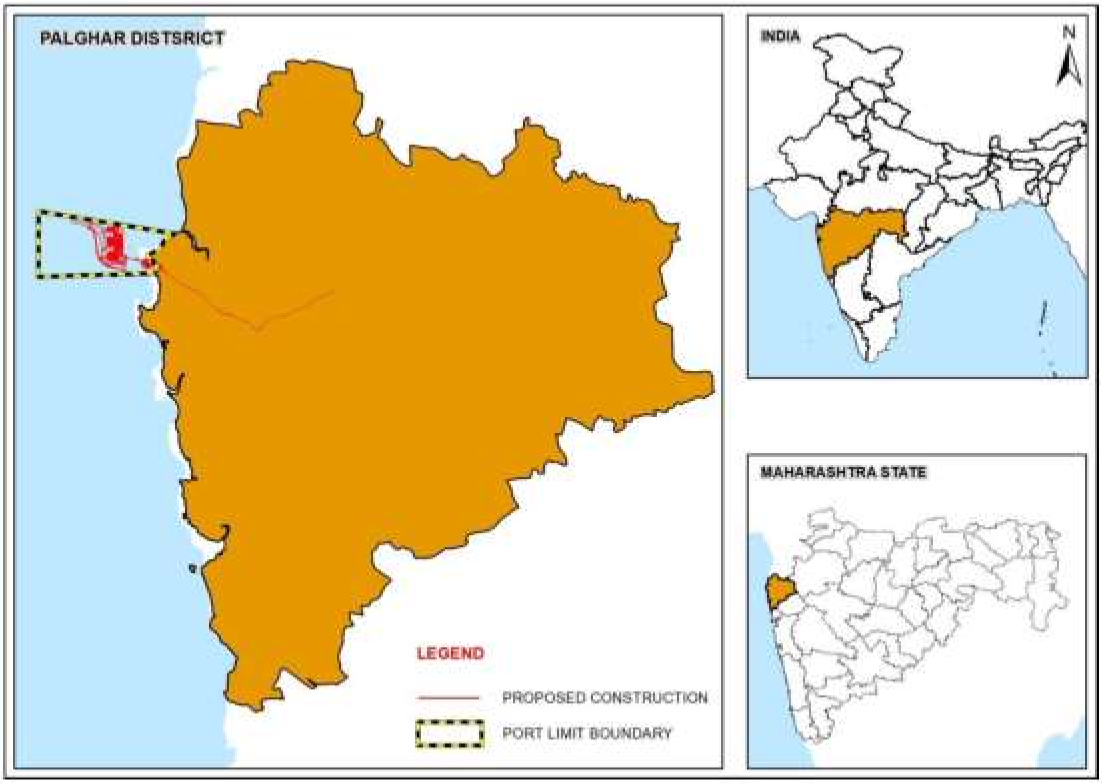


Figure 4 Location of project site

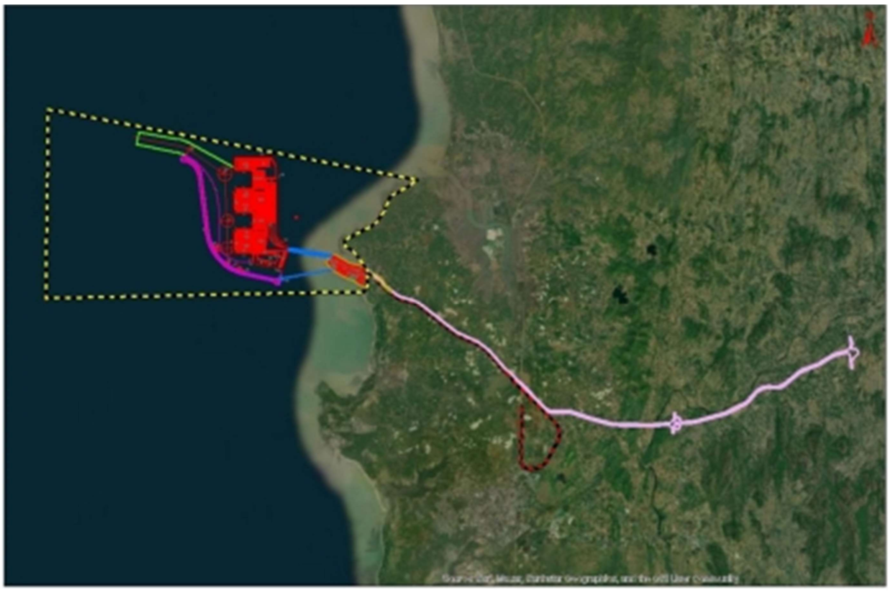


Figure 4b Satellite Imagery of the project site

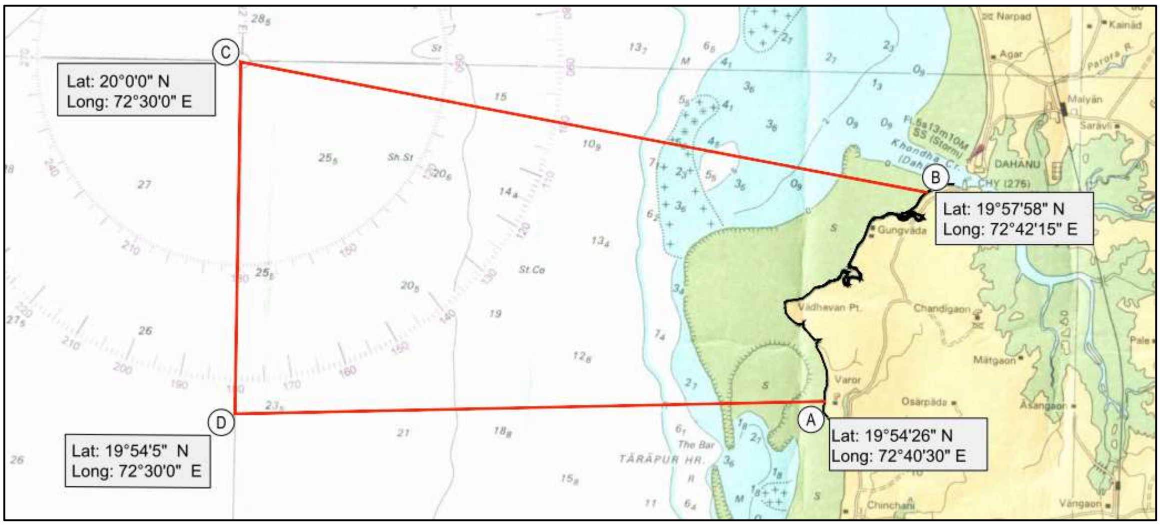


Figure 5 Vadhavan port Limit

The coordinates of proposed port limit are given in Table below;

Table 4 Coordinates of port limit boundary

Sl.No	Description	Label	Latitude	Longitude
1	Port Limit Boundary	A	19° 54' 26.000" N	72° 40' 30.000" E
		B	19° 57' 58.000" N	72° 42' 15.000" E
		C	20° 00' 00.000" N	72° 30' 00.000" E
		D	19° 54' 05.000" N	72° 30' 00.000" E
2	Proposed Offshore Reclamation Area	E	19° 58' 35.251" N	72° 36' 9.782" E
		F	19° 58' 36.270" N	72° 37' 25.479" E
		G	19° 55' 49.894" N	72° 37' 59.505" E
		H	19° 55' 5.493" N	72° 37' 48.259" E
		I	19° 55' 34.438" N	72° 36' 14.318" E
3	Proposed Navigational Area	J	19° 59' 21.027" N	72° 33' 0.839" E
		K	19° 58' 16.038" N	72° 36' 10.073" E
		L	19° 58' 37.112" N	72° 34' 33.636" E
		M	19° 58' 56.801" N	72° 32' 56.348" E

4	Proposed Sheltered Area	H	19° 55' 5.493" N	72° 37' 48.259" E
		L	19° 58' 37.112" N	72° 34' 33.636" E
5	Proposed Breakwater	N	19° 58' 32.043" N	72° 34' 24.504" E
		O	19° 54' 39.465" N	72° 37' 44.855" E
6	Proposed Approach Trestle	P	19° 54' 47.066" N	72° 37' 36.439" E
		Q	19° 55' 7.070" N	72° 39' 28.022" E
		R	19° 55' 42.908" N	72° 37' 59.609" E
		S	19° 55' 34.167" N	72° 39' 26.793" E
7	Proposed Reclamation Area near Shore	T	19° 55' 36.372" N	72° 39' 28.412" E
		U	19° 54' 26.761" N	72° 41' 27.532" E
		V	19° 54' 33.333" N	72° 40' 35.538" E
		W	19° 55' 22.603" N	72° 39' 15.493" E
8	Proposed Road	X	19° 55' 10.498" N	72° 40' 34.359" E
		Y	19° 50' 26.500" N	72° 50' 51.597" E
		Z	19° 52' 45.587" N	72° 56' 53.906" E
9	Proposed Railway Line	AA	19° 55' 8.191" N	72° 40' 32.196" E
		AB	19° 50' 56.385" N	72° 45' 47.335" E

The major site-specific advantages of the proposed site are:

- A natural water depth of around 20.0 m below CD is available at 10 km from Vadhavan point and 15 m contour is available at a distance of 6 km which will allow safe voyage and mooring for the new generation vessels.
- Land required for port is about 1448 ha. is planned to be developed through reclamation and eliminates the scope of land acquisition and rehabilitation, thus, avoiding the R&R issues.
- Breakwater of total length 10,140 m.
- As deep-water depth is available at 6 to 10 km from the shore, new generation vessels calling for deep draft can be planned without/ minimal cost on dredging.
- Connectivity to NH-48 (Mumbai-Delhi), Vadodara-Mumbai Expressway, existing Indian railways link and DFC (Dedicated Freight Corridor) is available at short distances for providing connectivity to cargo destinations centre in hinterland.
- The Road and Rail Connectivity can be availed through un-habituated areas which do not call for rehabilitation and resettlement.

Following are some of the features of location advantage of Vadhavan Port.

➢ Futuristic Container Terminals with deep draft to cater largest container vessels available even on the design board.

- Proximity to hinterland clusters including upcoming Dedicated Freight Corridor (DFC) and DMIC corridor resulting in lower inland evacuation cost to the hinterland.
- The port is developed at a location of deep draft that would provide channel availability withoutrecurring dredging. This would reduce maintenance cost of port, impacting favourable tariffs forcontainer handling.

2.3 Project Proponent

Vadhavan Port is planned to be developed by JNPA (Jawaharlal Nehru Port Authority) and MMB (Maharashtra Maritime Board) as Joint Venture Project with equity share of 74% & 26% respectively. The port will be developed in two phases. The proposed port is to be developed on landlord model with the port terminals to be developed on PPP basis. In this model, basic infrastructure of the port necessitating upfront investment such as, breakwater, rail and road linkages, power, water lines and common infrastructure and services will be developed by the port/ SPV whereas all cargo handling infrastructure will be developed and operated by the agencies which are awarded concessions through global tender in an open and transparent manner by the port.

2.4 Need and advantages of Vadhavan Port

Existing ports have strong customer base, infrastructure, connectivity and logistics services along with long years of experiences. However, over the period of time, some of the ports have reached their capacity and due to expansion constraint, the congestion at port has caused serious concern especially ports like JNPAand MbPA. Competitors are facing following 5 major restrictions for capacity expansion.

- Unavailability of waterfront to create new Jetties/Terminals (JNPA, AHPPL-partially)
- Located further away from the route considered unproductive for shipping lines to divert (Kandla, Dahej)
- Heavy siltation/tidal issues rendering expansion of infrastructure extremely high (Hazira, Dahej)
- Legal & Regulatory issues embedded in the 30 years' concession agreement restricting expansion of private ports till the time they are sure of extension of Concession Agreement (Mundra and Pipavav)
- Limited availability of waterfront suitable for construction of Container port on the Coast of Maharashtra and Gujarat (discussed in detail in section Need for Vadhavan).

Because of capacity constrains the cargo of these ports is routed to other ports available in immediate hinterland. Vadhavan is nearest to MbPA and JNPA as compared to ports of Gujarat. Vadhavan have huge advantage due to its proximity to JNPA and MbPA making it easier to attract spill over traffic. Vadhavan would have competitive edge over these major ports also due to the ability to berth large ships and closeness to northern hinterland. The logistics cost savings due to infrastructure and connectivity advantage to Vadhavan is likely to provide higher traffic gains for Vadhavan compared to competitors. Vadhavan would be able to attract incremental increase in traffic over the years is then distributed as per the facilities and capacity constraints at different ports. Vadhavan having the highest potential with modern facilities, deep draft and no capacity constraints in the initial years is expected to gain a larger share in the traffic. Also, there is no other container port planned in near future in the hinterland by respective state government. Possibility of any new port in competitive location is very limited. It has been assumed that Vadhavan will be the new large container port in Maharashtra catering to NCR region.

2.5 Development Modalities

Vadhavan port will be developed as an all-weather port for handling primarily the containers including other cargoes such as multipurpose, Ro-Ro, liquid bulk. Various terminals would be developed to cater these respective cargoes.

The port would be developed based on Public-Private Partnership (PPP) model devised by Government of India. The authority would invite private developers for further development of infrastructure. The responsibilities of private developers would include;

- Development of respective Jetties.
- Installation of all material handling equipment.
- Creation of respective backup and other storage facilities.
- Other infrastructure exclusively for use of PPP developer.

The container terminal of Vadhavan is likely to attract global container terminal operators. A combination of transparency due to government initiation and deep draft would increase attractiveness of Vadhavan port for developers compared to other ports in the region. Larger shipping lines intend to own and operate container ports and container terminals. Several such instances are available in India. Hence, forging a partnership with the shipping line by the port developer is likely to increase commercial attractiveness of the port.

The Phase 1 development of port is envisioned to have the following components:

JNPA (Landlord)

Inside Port

- Breakwater of total length 10.14 km
- Dredging 6.98 M cum in Phase-1 and 21.5 Mcum in Phase-2
- Port craft/ Tug berth of 200 m (1 berth with berthing face of 100m on each side).
- Total Reclamation area inside the port 1448 ha. of 257 M cum with 1162 ha. in Phase 1
- Road inside the port 32 km
- DFC rail yard 227.5 ha.
- Buildings with area of 23,500 m^2
- Pavement inside port.

Outside Port

- Land acquisition 571 ha. For road and rail connectivity
- External road connectivity of 33.4 km with 120m wide corridor
- Rail linkage area length 12 km 40 m wide corridor
- Water pipeline from Surya River which is 22km from port site.
- Power line from PGCIL line/Tarapur Boisar power station 20 km from port

Concessionaire (Operator)

- Container terminals including storage yard, equipment, terminal pavements, drainage, utilities networks etc., with total berth length of 9000 m (4 terminals in Phase-1 and 5 terminals in Phase 2 each of 1000 m length) capable of handling vessels of 24,000 TEU and above with 24,000 TEU design container vessels.
- Multipurpose berths of 1000 m (4 berths each of 250 m) including equipment, storage yard/ shed
- 1 Ro Ro berth of 250 m including storage and onshore facilities
- 4 Liquid cargo terminals including pipelines and tank farm

The port is designed primarily to cater container business. Other berths are being developed to utilise the waterfront facility given the Greenfield development.

2.6 Projections

Vadhavan is envisaged to be a container and clean cargo port. Container traffic is likely to dominate ports business. The infrastructure and equipment for container handling are specialised and can rarely be used for handling other commodities. Multiple methods of traffic analysis and projection for Vadhavan has been undertaken. Following are broad methods used in traffic projections of Vadhavan.

- Commodity wise detailed projection of containerised cargo of North and West India region
- Country comparison
- Extrapolation of historic trade
- Co-relation with GDP growth

The container projection arrived using above methods for India is distributed in the region. Market share for Vadhavan is arrived based on the capacity constraints at existing ports in North and West India region (Gujarat and Maharashtra).

Table 5 Vadhavan Port's Container Traffic Projections (mn TEUs)

India Traffic	2020	2025	2030	2035	2040	2045	2050
Pessimistic	0.0	0.7	4.0	7.7	12.2	14.8	19.3
Realistic	0.0	0.9	6.5	14.1	23.2	31.3	39.4
Optimistic	0.0	1.0	7.4	16.5	29.4	43.0	57.5

Table 6 Other Principal Commodities Traffic Projection for Vadhavan Port (mn T)

Commodities	FY21	FY25	FY30	FY35	FY40	FY45	FY50
Edible Oil	0.0	0.4	1.0	1.1	1.2	1.3	1.4
Chemical	0.0	0.6	0.9	1.0	1.1	1.2	1.3
Liquid Bulk	0.0	2.7	3.1	3.8	4.2	4.7	5.2
Fertilizer	0.0	0.9	1.0	1.2	1.2	1.3	1.4
General cargo	0.0	1.5	2.4	3.5	4.6	5.9	7.2
Coastal Cargo	0.0	1.0	1.7	2.4	3.2	4.1	5.0
Other Liquids	0.0	0.0	2.3	4.5	4.5	4.5	4.5
Total	**0.0**	**7.1**	**12.3**	**17.5**	**20.1**	**23.1**	**26.1**
Ro-Ro ('000 Vehicles)	0.0	20.9	49.5	76.8	169.0	195.9	227.1

2.7 Cargo Evacuation

Cargo evaluation for Vadhavan Port is based on Traffic Projections, Evacuation pattern at competing ports, Availability of first/last mile connectivity and Development in transportation sector (Rail, Road, Pipeline). Seamless evacuation of container and cargo to the hinterland is essential for success of Vadhavan Port. The capacity of port is minimum of the capacity of berth, capacity of storage and capacity of cargo evacuation to the hinterland. Hence, inland evacuation capacity has to be augmented in line with the capacity of port. Any gap in the inland evacuation capacity is likely to force shift of cargo projected to be handled at Vadhavan Port to other competing port. Commissioning of Western Dedicated Freight Corridor (W-DFC) is likely to benefit Vadhavan. It would help reduce logistics cost of evacuating containers from existing mode namely Indian Railways and Roadways. It would also help enhance otherwise restricted capacity of containers on Indian Railway and road.

The container movement distribution has been categorised in 3 geographical regions

- NCR and Other Northern Stages (presence of DFC)
- Gujarat (Mostly South Gujarat, Central Gujarat, etc.)
- Immediate Hinterland of Maharashtra, MP and Central India

Following table summarises total container movement in the hinterland using various modes of transportation. It is estimated that about 13.5 million TEU containers will moving using road, 4.8 million TEU using Indian Railways and 6 million TEU using DFC in Fy-40. The share will increase to about 22.4 million TEU containers will moving using road, 5.3 million TEU using Indian Railways and 13.5 million TEU using DFC in Fy-50

Table 7 Container volumes distribution to various OD pairs (mn TEUs)

Mode	Fy-21	Fy-25	Fy-30	Fy-35	Fy-40	Fy-45	Fy-50
Total	**0.0**	**0.9**	**6.5**	**14.1**	**23.2**	**31.3**	**39.4**
Road	0.0	0.7	4.4	9.3	15.3	20.2	25.4
Rail (IR)	0.0	0.3	0.1	0.3	0.5	0.7	0.9
Rail (DFC)	0.0	0.0	1.9	4.4	7.4	10.4	13.1

The preferred modes of transportation for evacuating different commodities from Vadhavan port is presented in the table below. Eight commodities are considered in the table while 3 modes of transportation are implemented. Some commodities would be evacuated via only a single mode of transportation while other commodities would have access to all three modes of transportation. In FY50, the total volume by roads would be 16 million tonnes, by rails would be 5.3 million tonnes and by pipeline would be 4.8 million tonnes. Ro-Ro vehicles are excluded from the total as they are tallied based on the number of units. In 2050, 227,100 vehicles would be evacuated by road from Vadhavan

2.8 Vessel Calls

Vessel calls signify the number of vessels docking at the port to load or unload their cargo. The statistics for the next 25 years in terms of parcel size of the vessels and the number of weekly vessel calls is mentioned below. These values are given for proposed container and other principal commodities volume proposed for Vadhavan Port.

Table 8 Container Vessel Capacity and Parcel Size Assumptions

Design Capacity of Vessels	Carrying Capacity @ 14 T	Parcel Sizes
1,500	1,050	683
2,000	1,400	910
5,000	3,500	2,275
8,000	5,600	3,640
12,000	8,400	3,360
14,000	9,800	3,920
16,000	11,200	4,480
18,000	12,600	5,040
20,000	13,000	4,800
24,000	15,000	6,000

- Local Trade of Middle East & Asia in Ships less than 8,000 TEU
- Parcel Assumed 60% of Carrying Capacity
- Long Distance trade to East & West in Ships more than 12,000 TEU
- Parcel Assumed 30% of Carrying Capacity

Table 9 Commodity wise Vessel Parcel Size

Parcel Size	FY21 – FY30	FY31 – FY40	FY41 – FY50
Edible Oil	9,000	16,200	27,000
Chemical	4,500	9,000	9,000
Bulk Liquids	22,500	31,500	54,000
Fertilizer	16,200	31,500	54,000
Ro-Ro	1,800	3,600	5,580
General cargo	18,750	30,000	41,250
Coastal Cargo	13,500	18,750	30,000
Other Liquids	30,000	30,000	30,000

The table below describes weekly vessel calls for different commodities. The vessel calls depend on the parcel size of the vessel and traffic projected

Table 10 Commodity wise Weekly Vessel Calls

Weekly Vessel Calls	FY21	FY25	FY30	FY35	FY40	FY45	FY50
Edible Oil	0	1	3	2	2	1	2
Chemical	0	3	4	3	3	3	3
Bulk Liquid	0	3	3	3	3	2	2
Fertilizer	0	2	2	1	1	1	1
Ro-Ro	0	1	1	1	1	1	1
General cargo	0	2	3	3	3	3	4
Coastal Cargo	0	2	3	3	4	3	4
Other liquid	0	0	2	3	3	3	3
Total	0	**14**	**21**	**19**	**20**	**17**	**20**

2.9 Design Ships

2.9.1 Container Ships

General

The success of the container ship story is unparalleled in the history of shipping. Ever since its start in the early sixties, the idea of shipping cargo in locked containers has been widely accepted, resulting in uninterrupted growth, continuing even into the beginning of this century. Consequently, the world container fleet has the fastest growth rate than any other ship type. Economy of scale effects in container shipping have led to a rapid increase in size for all types of vessels, from feeders to the large inter-continental carriers. The trend towards larger ships has accelerated in recent years and can be observed in the increasing size of the line haul as well as feeder vessels.

Container Vessels – World Fleet

Since its start in the early sixties, container trade has grown exponentially worldwide, resulting in significant increase in vessel numbers and sizes.

The distribution of world fleet container vessel sizes is shown in following Table 11.

Table 11 World Fleet of Container Ships and Order Books

Container Ship	Year end ('000' TEU)			2020		Order Book & Delivery Schedule					
Fleet (TEUs)	**2017**	**2018**	**2019**	**No**	**'000' TEU**	**No**	**'000' TEU**	**% Fleet**	**2020**	**2021**	**2022**	**2023**
100 - 999	841	863	887	890	550	5	2	1%	2	3	0	0
1,000 - 1,999	1,129	1,161	1,222	1,263	1,942	17	125	1%	17	0	0	0
2,000 - 2,999	615	659	678	703	2,004	72	174	10%	17	40	15	0
3,000 - 7,999	1,307	1,317	1,325	1,329	6,573	9	30	1%	2	7	0	0

Container Ship	Year end ('000' TEU)				2020		Order Book & Delivery Schedule					
8,000 - 10,000	467	-	-	467	4,123	0	0	0%	0	0	0	0
10,000 - 15,000	347	387	407	415	5,760	43	**549**	10%	10	20	13	0
15,000+	101	131	161	186	4,492	41	**798**	23%	1	27	8	5
Total Fleet	**4,706**	**4,387**	**4,519**	**5,248**	**25,443**	**187**	**1,678**	**4%**	**49**	**97**	**36**	**5**

There is a continuing trend towards larger container vessels and several vessels at the top end of the size range are already on order as of November 2020

- 34 no. 23,000+ TEU minimum ships ordered for delivery between 2020 and 2023.
- 5 no. 23,656 TEU ships ordered by one of the largest shipping line Mediterranean Shipping
- Company (MSC) on Daewoo Shipbuilding & Marine Engineering. Expected delivery in 2021.
- A series of 23,000+ TEU ships have been ordered from Samsung Heavy Industries, Hudong Zhonghua Shipbuilding, Jiangnan Shipyard by Evergreen marine Corporation.
- Orient Overseas Container Line (OOCL) have ordered 12 new 23,000 TEU ships from Nantong COSCO KHI Ship Engineering and Dalian COSCO KHI Ship Engineering. Expected delivery in 2023.
- Other shipping lines like CMA CGM have also ordered 9 no. of 23,000 TEU ships.

Historically, as the mainline vessel sizes have increased, larger vessels operating in primary routes have 'trickled down' to the second-tier routes. It is expected that vessels in the range of 10,000 TEU will 'trickle down' to serve secondary or feeder routes in the future.

In order to establish Vadhavan port's position as a Major Container port, it will need to be able to handle ships normally in the range of 12,000 to 24,000 TEU

Container Ships Dimension

Container ships are classified into seven broad categories viz. Feeder, Feeder Max, Handy, Sub-Panamax, Panamax, Post-Panamax and Ultra Large Container Carriers. The following table, which has been compiled through data from the IHS Seaweb database, gives a broad outline of the principal dimensions of the ships under the different categories. Following Table gives the dimensions of the smallest and the largest ship ineach category. This will help in planning the layout of the container terminal and the other facilities

Table 12 Dimensions of the Smallest and Largest Ship

Category	Capacity	Dimensions (m)		
	(TEUs)	LOA	Beam	Loaded Draft
Feeder	1,000	175	27	10.0
Feeder Max	2,000	210	32	12.0
Handy to Sub-Panamax	6,000	285	40	14.5
>Panamax	8,000	335	42	14.5
Post-Panamax	12,500	397	56	16.0
Super Post-Panamax	21,000	400	59	16.0
ULCC	24,000	400	61	16.5

Selection of Container Design Ship Size

Following Figure shows all active container ships as of Q3 2020 and compares laden draft with Length Over All (LOA). The largest ULCCs in service today will require a berth depth of 18.0m.

A Seaweb analysis of actual ship calls at JNPA over the three months to mid-November 2020 shows that the largest ships are of about 14,000 TEUs capacity with the main ‘workhorses’ being of the 4,500 TEU to 10,000 TEU capacity range representing 55% of all port calls.

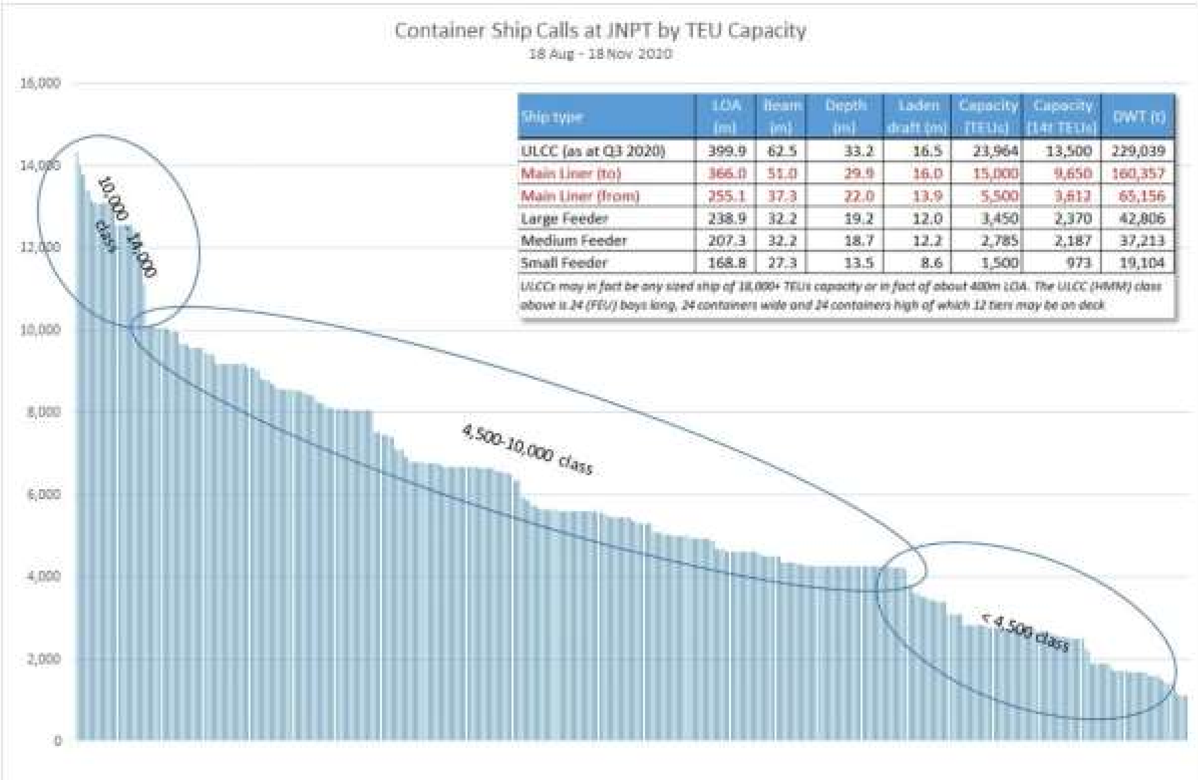


Figure 6 Ships Calls at JNPA, Aug-Nov ‘20
[Source: IHS Seaweb]

Import/ Export Container Vessels

The projected import / export trade through the port hinterland is the primary cargo for Vadhavan Port right from the Phase 1 development. Based on the projections, the maximum vessel size at the port is likely to be driven by the import/ export traffic. For Phase 1, the design vessel considered is 24,000 TEU which is currently the largest container vessel.

Summary of Container Design Vessels

Based on the outcome of ship size analysis for container traffic carried out in the preceding paragraphs, the design ship sizes considered for development of Vadhavan port have been presented in Following Table

Table 13 Design Container Vessels over Master Plan Horizon

S. No	Commodity	Average Parcel Size in moves	Design Ship Capacity		Overall Length	Beam	Loaded Draft
		Moves	TEU		(m)	(m)	(m)
1.	Containers	4,500	Min.	6,000	300	40	14.0
			Max.	24,000	400	61	16.5

2.9.2 Multipurpose Cargo Ships

The breakbulk commodities are likely to be imported / exported in ships, which range from 10,000 DWT to 40,000 DWT. For planning purposes 40,000 DWT is recommended as the maximum design size of general cargo ships.

Fertiliser and its raw materials are imported primarily from the Middle East, USA, Israel, Western African countries, and sometimes Western European countries. Generally, the ships deployed for transportation of fertilisers are dry bulk cargo ships available on charter basis. The Handymax size is the preferred size worldwide because of economics of transportation. The maximum ship size calling at the major ports in the Middle East exporting fertiliser is around 60,000 DWT.

In Indian ports, even though in some ports the facilities have been designed for handling larger ships upto 60,000 DWT, the average parcel sizes have been less than 25,000 T. Considering all these aspects, it is recommended to adopt the design ship size for fertilisers and raw products as 40,000 DWT, however the multipurpose berths are designed to cater 60,000 DWT capacity

2.9.3 Coastal Cargo Ships

For Coastal vessels, the size ranges from 10,000 DWT to 20,000 DWT. For planning purpose, 20,000 DWT vessel is considered as the design ship.

2.9.4 Ro-Ro Carriers

The Ro-Ro carriers generally which range from 10,000 DWT (2,500 car units) to 30,000 DWT (8,000 carunits). For port planning purposes 30,000 DWT is recommended as the maximum design size of Ro-Ro ships.

2.9.5 Liquid tankers

The edible oil and chemicals are generally handled in small ships of sizes varying from 5,000 DWT to 10,000 DWT.

Currently, JNPA handles liquid bulk vessels of upto 30,000 DWT for edible oil. The parcel size of chemical is less because handling of volatile chemical is difficult, and these products have a limited shelf life. As a result, the consigners prefer to import or export optimal volume only.

Considering the above, it is proposed that design ship size of 30,000 DWT is considered for liquid tankers for planning and design purpose.

2.9.6 Bulk Liquid tankers

The present composition of the World Product Tanker Fleet was reviewed to establish the overall numbers and sizes of product tankers available in the world.

Following Table indicates size-wise distribution of the product tankers together with their percentage share of the total fleet

Table 14 Ship size distribution of Tankers

Tanker Size (‘000 DWT)	No. of Tankers	Fraction
Below 20	8,578	57%
20 to 30	355	2%
30 to 45	855	6%
45 to 70	1843	12%
Above 70	3,343	22%
Total	**14,974**	**100%**

Considering the projected traffic of products being moved in small to medium size tankers, it is suggested that the structure of the berth could be designed for the maximum tanker size i.e., 60,000 DWT. However, this being mainly a product handling facility, the berth may be required to handle smaller tankers on exigencies. Hence, for laying out jetty the ship size range to be considered could be from 20,000 DWT to 45,000 DWT.

2.10 Governing Parameters of Design Ships

2.10.1 Range of Ship Sizes

Based on the outcome of ship size analysis for major commodities carried out in the preceding paragraphs, the design ship sizes considered for Phase 1 development of Vadhavan port is presented in the following Table 15.

Table 15 Summary of Design Vessels for Phase 1 Development

S. No.	Commodity	Average parcel size	Design Ship Size		Overall Length	Beam	Loaded Draft
		TEU (DWT)	TEU (DWT)		(m)	(m)	(m)
1.	Containers	4,500 (56,250)	Min	6,000 (82,000)	300	40.0	14.0
			Max	24,000 (233,000)	400	61.0	16.5
2.	Multipurpose Cargo vessels	(30,000)	Min.	(20,000)	166	24.8	10.0
			Max.	(40,000)	209	30	10.5
3.	Ro-Ro	1,200 units	Min.	1,000 (7,200)	153	23.4	7.4
			Max.	8,000 (30,386)	221	32	11.3
4.	Liquid Tanker	6,000/ 18,000	Min.	(5,000)	105	16	6.3
			Max.	(30,000)	175	29	9.5
5.	Bulk Liquid Tankers	32,000	Min.	(20,000)	145	24	9.5
			Max.	(45,000)	180	30	10.5
6.	Other Liquid (m^3)	239,000	Min.	145,000	283	43.4	11.4
			Max.	266,000	345	53.8	12.0

2.10.2 Governing Parameters of Design Ships

Parameters of design ship considered for estimating the navigational requirements (dredged depths, channel widths, safe stopping distance etc.) of the channel and harbour basin for Phase 1 and Master Plan layout development of Vadhavan port, is presented in the following Table

Table 16 Governing Parameters of Design Ship

S. No	Commodity	Average parcel	Design Ship Size	Overall Length	Beam	Loaded Draft
		TEU (DWT)	TEU/DWT	(m)	(m)	(m)
1.	Containers	4,500 (56,250)	24,000 (233,000)	400	61.0	16.5

2.11 Functional Requirements

The Vadhavan port development plan has been prepared to guide the Phase 1 development of the port and identify the facility requirements in terms of number and length of berths, navigational requirements, terminal equipment, terminal storage area, road and rail access for the receipt and evacuation of cargo and other utilities and service facilities. The focus of the Phase 1 development is primarily on container cargo (93% of total traffic), other cargo terminals and port requirements. This section deals with the assessment of port facilities for the projected traffic at Vadhavan Port for Phase 1 development and over the master plan horizon

2.11.1 Berth Requirements

General

The berth length needs to be sufficient to accommodate the length of the vessel plus an allowance at either ends for mooring and clearances between vessels. The amount of clearance required at either end of the vessel depends upon the vessel size. Minimum single berth length for the design vessels is shown in following Table 17.

Table 17 Minimum Berth Lengths

S. No.	Berth Type	Unit	Average Design Ship Size	Phase 1 (m)	Phase 2 (Master Plan) (m)
1.	Container Berths	TEU	13,500 TEU	360 – 430	360 – 430
2.	Multipurpose Berth	DWT	30,000	190 - 240	190 - 240
3.	Ro-Ro berth	DWT	1200 units	180 - 250	180 - 250
4.	Bulk Liquid berth*	DWT	27,000	-	-

S. No.	Berth Type	Unit	Average Design Ship Size	Phase 1 (m)	Phase 2 (Master Plan) (m)
5.	Other Liquid berth*	DWT	205,000	-	-

** unloading platf orm, mooring and breasting dolphin arrangement*

Container Terminal Capacity Analysis

The following table summarizes the key inputs to Preliminary Capacity for each terminal element.

Table 18 Key inputs to Preliminary Capacity

Berth	Container Yard	Rail	Gate
– Cargo moved per vessel call – Cranes used per vessel – Crane productivity – Working hours – Non-working time at berth – Seasonal peaking factors – Maximum allowable berth utilization	– Mix of cargo types – Dwell time – Static storage capacity – Inventory peaking factors	– Number of rail cranes in use – Rail crane productivity – Working hours – Switching delay – Static working track capacity	– Gate to vessel move ratio – Hourly arrival pattern – Number of gate stages – Fraction of trucks that visit each stage – Truck processing time at each stage

The potential maximum number of containers handled over the berth (measured in twenty-foot equivalent units or TEU), is primarily dependent on following factors

***Design Vessel Size*:** Size of vessels is increasing day by day to accommodate a greater number of TEU per vessel call. Considering the order-book of vessels and the vessels under construction, the typical average maximum size of the vessel for direct call at Vadhavan port in Phase 1 is considered as 24,000 TEU (for capacity analysis).

***Available Berth Length*:** The berth length should be optimized to be able to cater to the largest design vessel along with mix of average vessels.

Dock Cranes Assigned per Vessel: Number of dock cranes deployed per vessel call varies based on the vessel size and number of containers to be handled per vessel call. For the vessel of size 24,000 TEU, up to six dock cranes are being used and for smaller feeder vessels two to three dock cranes will be deployed. On average, four dock cranes per average vessel call are considered for the capacity analysis

Productivity per Dock Crane: As per prevailing practice in India, an average productivity of 30 moves per hour is used for initial development of the Vadhavan port. Once the operation stabilizes and core traffic achieved at the proposed port, the productivity is assumed to be reaching 32.5 moves per hour.

Maximum Practical Berth Utilization: It is a key subjective variable in a Berth Capacity Analysis. No berth can effectively run at 100% full. Shipping lines expect a certain level of customer service when calling a terminal; they do not want to queue out at sea for too long waiting for a berth to become available. Conversely, shipping lines work on fairly rigid vessel schedules around the world and filling a berth on a given day of the week may prove difficult to accomplish by changing sailing patterns. Due to the variable nature of vessel arrivals (delays at berth, storms, etc.), and the marketdriven need to service vessels in a timely manner, the maximum practical berth utilization should be limited to avoid vessel queuing. In some locations, especially in Asia where feeder vessels will in fact queue for berth space, terminals can operate at berth occupancy up to 80%. Longer contiguous berths allow for greater occupancy than shorter berths. Vessels start queuing on a twoberthnfacility when average berth utilization goes over 65% on a gateway terminal, whereas for a single berth, it happens at around 50% to 60%. At port of Vadhavan, the initial Phase 1 development will comprise of 1000 m contiguous berth for each terminal and hence a value of 75% has been used for capacity calculations, however upto 80% berth utilization will be feasible for the operator in longer run.

Operational Time: Being an all-weather port, it is assumed that Vadhavan Port will work seven days a week for 350 days, allowing for 15 non-operational days due to weather. Further, it is assumed that the port will operate round the clock i.e., three shifts of eight hours each with allowance for onehour break between each shift. This result in an effective working of 21 hours a day used in the capacity analysis.

Unproductive Time at Berth**:** It accounts for ship tie-up and untie time, which represents time where the berth is physically occupied by a vessel (i.e., no other vessel can be in that berth position) but there is no crane activity, excluding breaks which are captured by the work hours per day input. This activity includes mooring, line fastening, unlashing prior to first container move, administrative clearance, etc. These activities are assumed to take, on an average, 3 hours per vessel call.

Peak/mean Week Seasonal Demand**:** It is assumed that a peak week demand of berth will be 20% higher than the average week demand to account for changes in seasonal demand and adjust peak week berth capacity down to an average week berth capacity for calculation of the annual berth capacity.

Sensitivity Analysis for Berth Capacity: With the perspective that the port would be developed as a landlord port, sensitivity analysis on the berth capacity was carried out with the change in the following parameters.

- Unproductive time at berths
- Work hours per day

With the 22 work hours per day, the annual berth capacity is 7.38 MTEU and 24 MTEU in 2030 and 2040 respectively (Case 1). Similarly, it is 8 MTEU and 23.98 MTEU (Case 2) with 24 work hour per day.

With this arrangement, the number of container terminal requirement would be 3 and 8 for Case 1 while it is 3 and 7.5 for Case 2 providing additional capacity for expansion beyond 2040.

2.11.2 Storage Requirements

Container Yard Capacity

Container yard capacity is defined as the potential maximum throughput of containers handled inside the container yard (measured in twenty-foot equivalent units or TEU), is primarily dependent on following factors:

***Mean Dwell Time*:** The number of days a container sits inside the container terminal (dwell), which significantly varies for transhipment (usually 2 to 3 days) vs. the gateway traffic (varies from 3 to 7 days). For the gateway traffic, it varies by import vs. export vs. empty container. For the capacity calculation, an average of 4 days is used.

TGS Capacity: Represents the static storage capacity in terms of total number of twenty feet ground slots (TGS) or net acres available to store those containers inside the container yard

***Mean Storage Height*:** A mean storage height is calculated which takes into account the peak stacking height of the machine and various utilization factors than can be applied. It represents the maximum overall desired height for grounded operations. Most operators feel that 70-80% of the peak theoretical capacity is a reasonable level for planning purposes in order to account for sufficient empty slots for reshuffling and yard marshalling moves. Mean storage height used for this case is 3.5 high for capacity calculations.

Direct port Delivery: 50% of the import loaded containers are assumed to be part of direct port delivery where the import containers are delivered to the importer directly from the terminal instead of routing it through CFS a push by Government of India with an objective to reduce overall logistic costs.

Seasonal Peaking Factor: It is assumed that a peak week demand of container yard will be 10% higher than the average week demand to account for changes in seasonal demand and adjust peak week container yard capacity down to an average week yard capacity for calculation of the annual container yard capacity.

Weekly Inventory Peaking Factor**:** During a week, when a vessel arrives or departs, there is a sudden surge of inventory of containers that needs to be handled in the container yard, based on the size of the vessel and number of containers handled per vessel call. The factor applied to account for this surge is 10%.

Sensitivity analysis of Container yard: In the 2040 case with a throughput of 23.2 million TEUs, an average dwell time of 4 days across all container types, a yard stack height of 3.5 containers, a utilisation of 65% utilisation (as a TEU yard slot is not instantly filled as soon as emptied) and a peak of 15%, the number of TEU Ground Slots (TGS) required will be almost 100,262.

It is proposed to provide the total ground slots of 55,303 for Phase 1 and 124,434 for Phase 2. The total ground slot for each terminal required is 13,826 to cater the berth capacity

2.11.3 Receipt and Evacuation of Cargo

Rail Throughput Capacity

This section describes the methodology that is used to determine the rail throughput capacity which isexpressed as number of rail tracks required to handle the forecasted gateway container traffic that can be handled from the port.

For capacity calculations, the following container cargo split for rail and road connectivity has been considered based on the traffic assessment.

Table 19 Railroad split for Container Cargo

Cargo	Phase 1 (2030)			Phase 2 (2040)			Phase 3 (2050)		
	Rail (%)		*Road (%)*	*Rail (%)*		*Road (%)*	*Rail (%)*		*Road (%)*
	DFCC	*IR*		*DFCC*	*IR*		*DFCC*	*IR*	
Containers	28.8	2.3	68	31.5	2.3	66	33.3	2.3	65

Following factors impact rail throughput capacity:

Track Length**:** Track length is taken as 1500 m clear length for each track as per the length ofcontainer train operated by DFCC.

Maximum possible number of cranes working to load/discharge containers from railcars: Based on the track length available at the proposed rail yard, it is assumed that two RMGC can be deployed to work simultaneously on the rail track during Phase 1 development.

Amount of railcar double cycling: It is assumed that for 90% of arriving railcars that bring in a container in the port will leave with a container while departing.

Crane Productivity**:** RMGC are assumed for loading/unloading of train racks over a single or double rail track respectively. As per prevailing practice in India, an average productivity of 18 moves per hour is used for initial development of the Vadhavan port. Once the operation stabilizes and core traffic achieved at the proposed port, the productivity is assumed to be reaching 22 moves per hour.

Allowable loading/ unloading, switching hours: Based on the discussions with the railway authority, with the Engine of Load (EOL) operating concept the overall allowable working time for railways for loading/ unloading of container rakes including the switching time is 5 hours.

Work hours per day: 20 hours per day is assumed for Phase 1 development. In future, with increased demand, the work hours can be increased per day for rail yard operation.

Peaking factors: It is assumed that the peak month will be 20% higher than the average month and peak day throughput will be 20% higher than the average day throughput.

Switching time**:** It is defined as time between the first set of railcars getting ready to depart from the port rail yard and going to the mainline and a second set of railcars arriving in the port rail yard through the single rail track. For the capacity analysis purpose, the switching time of trains is considered to be 2 hours. This will account for all the delays incurred in bringing the set of rail carsfrom the mainline to the port

Gate Capacity

Gate capacity analysis is essential feature to get essence of seamless inward and outward traffic movement including major share of trucks having containers. Following factors impact gate throughput capacity:

Throughput share handled by trucks: Share of throughput which is forecasted to be handled by truck is key factor for gate capacity planning. Amount of TEU handled by truck will determine the daily truck traffic at port and the movements at gate complex.

Peak Ratio: For weekly mean moves 20% peak factor is considered. For daily traffic movement 30% peak in daily traffic is considered. For hourly traffic, 30% peak is considered for mean hourly traffic.

Working Hours**:** Working hours of gate directly impacts the gate capacity. For Phase 1 development three shifts each of 8-hour per gate shift is assumed.

Moves per Truck visit**:** Moves per truck visit reflect the container handling movement per truck. It reflects the number of trucks which come with a container and leave port with a container. The amount of such truck traffic is assumed 50% of total daily truck traffic.

RPM Capacity**:** Radiation Portal Monitors (RPM) are passive radiation detection devices used for the screening of vehicles and cargo for detection of illicit sources at port gates. Number of trucks that can be screened by this device per hour determines its capacity, which is being considered as 120 trucks per hour for capacity calculation. This number can increase with reduction in screening time.

It is proposed to provide 6 entry and 6 exit gates in Phase 1 increasing to 26 entry and exit gates.

2.11.4 Other Cargo Requirements

Cargo Handling System

Fertiliser

The fertiliser commodity can be handled at the multipurpose berth using the mobile harbour cranes. The handling rate for fertilizers would be 9,000 TPD during the initial phase increasing to 12,000 TPD. Accordingly, for estimating berth requirements the average handling rates for the fertiliser is 9,000 TPD.

No mechanised handling for fertiliser is envisaged in Phase 1 considering the projected traffic. However, provision for mechanisation has been considered in the overall terminal planning to commensurate with the traffic in future.

General/ Coastal Cargo

For the General/ Coastal cargo at Vadhavan Port, it is proposed to provide two mobile harbour cranes at each berth to achieve higher handling rates. Support dumpers/ trailers shall be provided to match the handling rates at berth. At storage areas adequate number of front-end loaders, mobiles cranes would be provided.

An average handling rate of 12,000 TPD and 10,000 TPD has been considered for general and coastal cargo respectively.

Liquid Cargo – Liquid Bulk, Edible Oil and Chemicals

The Liquid Bulk is unloaded from the tankers by means of marine unloading arms and transferred to the tank farms through the pipelines. The unloading rates mainly depend upon the capacity of the onboard ships provided the matching capacity of unloading arms and pipelines provided. The transfer system of chemicals, which come in much smaller parcel sizes, is also similar.

The average handling rates achieved at berth for Liquid Bulk and edible oil/ chemicals are 24,000 TPD and 6,000 TPD respectively.

Ro-Ro

The auto cars will be loaded to the Ro-Ro carrier at an exclusive berth. The average loading achieved is 1,200 cars per day per berth.

Other Liquid

The average unloading rate for Other Liquid is considered to be 38,000 TPD

Operational Time

Considering that the port is planned as all-weather port, the effective number of working days is taken as 350 days per year, allowing for 15 non-operational days due to weather. Further, it is assumed that the port will operate round the clock i.e., three shifts of eight hours each. This results in an effective working of 20 hours a day.

Time required for Peripheral Activities

Apart from the time involved in loading / unloading of cargo, additional time is required for peripheral activities such as berthing and de-berthing of the vessels, customs clearance, cargo surveys, positioning and hook up of equipment, waiting for clearance to sail, etc. An average of 4 hours per vessel call has been assumed for these activities.

Allowable Levels of Berth Occupancy

Berth occupancy is expressed as the ratio of the total number of days per year that a berth is occupied by a vessel (including the time spent in peripheral activities) to the number of port operational days in a year. High levels of berth occupancy will result in bunching of ships resulting in undesirable pre-berthing detention.

In order to be competitive, it is important that the ships calling at the port should have minimal pre-berthing detention. At the same time the investment at the port infrastructure has to be kept at optimal level. Keeping these in consideration it is proposed to limit berth occupancy of 60% for 1 berth and that 65% for 2 berths for similar commodity. This shall reduce the pre-berthing detention of ships and offer reduced logistics cost to the shippers

Berths Requirements for the Master Plan

Based on the above criteria, the berth requirements for different cargo have been worked out. A summary of the estimated berths over master plan horizon is presented in Table below

Table 20 Estimated Berths for Other Cargoes at the Vadhavan Port

S. No.	Commodity	Phase-wise Berths		Total
		2030	***2040***	
1.	Breakbulk (Fertiliser, General, coastal Cargo)	3	1	4
2.	Liquid Cargo (Chemical, Edible oil)	2	0	2
3.	RO-RO	1	0	1
4.	Bulk Liquid	1	0	1
5.	Other Liquid	1	0	1

2.11.5 Approach Trestle Capacity

The road truck movements to/from the marine and rail terminals on the offshore reclamation has been evaluated to establish the requirements for the road connection to the offshore reclamation. There is a maximum of 112,825 PCU (26,019 trucks) movements in the port when the port is in full operation in 2040. It is proposed to provide the approach trestle with 4 lanes each way for the approach trestle to cater the truck movements in and out of the Vadhavan port.

2.11.6 Port Crafts Berth

For the initial stage development, the port would require 6 tugs (4 operational + 2 standby) with a capacity of 65 T and 100 T bollard pull, 1 pilot cum survey launches and 2 mooring launches.

Berth of 200 m is proposed for berthing of port crafts.

2.11.7 Provision for Coast Guard

The need for effective coastal security in the present security scenario was highlighted by Coast Guard to JNPA. The same was indicated by JNPA, where Coast Guard had put requirement for development of a station at Vadhavan

The Coast Guard requested a dedicated berthing space at Port of Vadhavan to enable operation of its ships. The present docking facility available within the existing Mumbai harbour is insufficient to cater to the increased needs in the region. The Coast Guard is planning to have station at Port of Vadhavan for effective coastal security and monitoring of Sea Lanes of Communication which is located around 70 nautical miles off the north coast of Mumbai. It will also help in providing enhanced training to the Marine Police.

The Coast Guard at Vadhavan requested for a dedicated berth having a minimum berthing space of 100 m, alongside depth of 8 m. A land parcel for onshore Coast Guard facilities is proposed at the Port of Vadhavan. JNPA agreed to the above requirement on a cost sharing basis, considering the coastal security needs of the region

2.11.8 Other Liquid Bunkering

In order to make the proposed port more attractive location for shipping lines traversing through the EastWest/ Middle east shipping channel, a provision for bunkering facility canbe also provided at the proposed Vadhavan port. In order to provide for the latest state-of-the art bunkering facilities, following key elements will be required at the port:

- Bunker fuel loading hydrant system along all container berths
- Bunker fuel storage tanks
- Bunker fuel unloading berth

Currently, most of the ports are thrusting on reducing the carbon footprints and moving to efficient/ clean fuel. Other Liquid is being used by most of the shipping lines and one of the clean fuels as an alternate to diesel. For the proposed Greenfield port at Vadhavan, it is prudent to provide the provision of Other Liquid bunkering facility considering the number of ships calls at the port. With a capacity of forecasted annual demand of approximately 3.5 MT to be handled from the proposed port, it equates to approximately 350,000 T of static storage capacity and one dedicated berth for unloading of the Other Liquid cargo

2.12 Storage Requirements

As per the international practice the storage capacity at port for a particular commodity should at least cater to the higher of the following:

- 5% to 10% of the annual cargo throughput i.e., dwell time at port; or
- 1.5 times the maximum parcel size.

For some cargo, the annual throughput is relatively small as compared to the parcel sizes and hence the frequency of vessel calls will be low to moderate. This will, most likely, allow for the clearance of the stored cargo prior to the arrival of the next shipment. Further, during cargo handling operations at the multi-purpose berths, part of the cargo is likely to be directly evacuated without passing through the storage area. Under these circumstances, the storage areas could be optimised at least for the initial stages of development.

Other factors to be taken into account in determining the size of the storage areas are stacked densities, angle of repose, maximum and average stacking height, aisle space, reserve capacity factor, peaking factor, etc. The norms adopted for calculating the storage areas in port for various commodities are given in Table below:

Table 21 Norms adopted for calculating storage area at port

S. No.	Commodity	Average Parcel Size (T)	Maximum Parcel Size (T)	Criteria for Providing Storage Area		Stacking Assumption
				Days at Port	***% of Annual Throughput***	
1.	Fertiliser	25,000	54,000	30	8%	6 m high
2.	General Cargo	27,700	41,250	30	8%	
3.	Coastal Cargo	18,700	30,000	15	4%	
4.	Liquid Cargo (Chemical, Edible oil)	9,000	9,000	30	8%	18 m dia and 16 m high tanks
5.	RO-RO	7,600	12,834	10	2.7%	16 Sqm/ Car
6.	Bulk Liquid	31,600	54,000	30	8%	55 m dia and 32 m high tanks
7.	Other Liquid	239,000	266,000	15	4%	Pipeline

Based on the above criteria the storage areas have been worked out for various cargos over the master plan horizon.

Table 22 Storage Areas – Master Plan horizon

S. No.	Commodity	Requirement of Storage Area (m^2)	
		2030	***2040***
1.	RO-RO Vehicles	21,699	74,082
2.	Edible Oil	9,543	10,603
3.	Bulk Liquid	42,765	57,020
4.	Chemicals	14,844	16,965
5.	Other Liquid	0	0
6.	Fertiliser	31,983	38,379
7.	General Cargo	59,178	113,425
8.	Coastal Cargo	20,959	39,452
Total Storage Area Required (m^2)		**203,001**	**351,966**
Total Storage Area Required (Ha)		**20**	**35**

2.13 Buildings

2.13.1 Terminal Admin Building

The terminal administration building will be required to house the terminal operator's management, security, admin, and customer service personnel.

The building is located on the site plan to allow visual access to the terminal gate complex from the Customer Service Department and Control Room. Office areas will have visual access to the container yard, container ship wharf, rail yard, and all gate areas. The building location has been planned in such a way that additional annex can be added in the same location for future phases if needed. The buildings area provided within the terminal with a total area of 4650 m^2.

Typical users/uses of the administration building include:

- Terminal Administration
- Customer Service
- Gate Equipment Control
- IT/Server
- Gate Control Clerks
- Offices
- Shipping Lines Offices
- Terminal Security and Communications Hub

The Administration Building generally equips the following systems:

- TOS Computer System
- Container Yard Lighting Controls
- Annunciation and Alarm Systems
- Gate Control and Systems (voice, data, scale, sign bridge etc.)
- Public Address System
- Telecommunications System

2.13.2 Entry Exit Gate Inspection Canopy

The Entry Gate Inspection Canopy is used to process container traffic into the terminal and the Exit Gate Inspection Canopy is used to process container traffic out of the terminal.

Gate canopies provide weather protection for the gate activities and provide a mounting structure for gate cameras and infrastructure. The location of entry exit port for the main port entry and the individual terminals will be based on the requirement of security and surveillance aspects and the accordingly the number gates will be decided. Any statutory scanning of import as well as export cargo will also take place here.

The Entry/Exit Gate Canopy equipment shall include, but not be limited to the following:

- TOS and Gate Computer Systems
- Gate Camera Controllers
- Cameras with automatic vibration correction
- Sign Bridge Controllers
- Scales and Scale Interface Controls
- Communication antennae and associated hardware

2.13.3 Security Guard Booth

Security guard booth provides security surveillance at the main gate truck access and exit lanes. The guard booth serving the main gate should be elevated and provided with sliding windows so that communications with drivers within the truck cabs can be facilitated.

The Guard Booth equipment shall include, but not be limited to the following:

- Central Security Monitoring and ‘Annunciation Panels. Panels shall accurately depict the site plan of the terminal.
- Recreation facilities for seafarers like seafarer club.

- Building for port facility and port users for facilitating business
- Trade promotional building
- CCTV monitors and controls with split screen and view selection capability.

2.13.4 Pre-gate building and Customs Clearance

This facility is provided for the administrative functions of the remote pre-gate facility. The Pre-gate Building houses the Customs and Customer Service Department. The Customer Service Buildings and Kiosks provide facilities for truck drivers to resolve problems they may have with their paperwork, as well as convenience facilities.

The Pre-gate Building is required to provide facility for following functions:

- Customs clearance
- Demurrage payment
- Customer service
- Trouble transactions
- Truck driver canteen
- Toilets and washrooms
- Public phone, fax, and internet

2.13.5 Maintenance and Repair Building

This facility houses maintenance, repair, and related activities for RTGs, yard tractors, top-picks, side-picks, truck chassis, and other container terminal operating equipment. It also supports other service areas such as tire changing, and equipment steam cleaning activities.

Typical users/uses for this building include:

- Maintenance Supervisors
- Power and Chassis Repair Mechanics
- Parts Storage and Control
- Mechanics' Lockers
- Genset Repair
- Offices
- Vendors

Parking for service vehicles and bad order equipment needs to be adjacent to the building. Adequate circulation is required to move vehicles to and from the service bays. Roll-up overhead doors are required in the parts room and service bays. Building location shall allow for the ease of vendor access through the perimeter fence

2.13.6 Quay Crane and Marine Operations Building

This facility houses ship loading/unloading operations and planning functions as well as break facilities for the ship operations. The building should be multi-levelled in an area of 1500 m^2 within the port and terminals.

Typical users/uses of this building include:

- Marine Operations Supervisors
- Labour Breakroom and Restroom Facilities
- Crane Repair Mechanics (Spreaders, Ropes)
- Parts Storage and Control
- Mechanics' Lockers

The building equipment shall include, but not be limited to the following:

- TOS Computer System
- TV Supervisory System

2.13.7 Vadhavan Port Administration Building

A separate building and land area will be required to provide for functioning of Vadhavan Port in managing the port operations. This will include but not limited to office building for the Vadhavan port management and administration staff, office for government officials, security staff and customs and border protection officers. This will also include the facilities for port maintenance and engineering staff

2.13.8 Port Fire Station

A centralized fire station will also be provided for attending to all calls. This station will house mobile fire tenders. Further special firefighting equipment such as foam and gas extinguishers will also be provided for chemical and electrical fires. Fire detection, monitoring and control system will be provided in all vulnerable area of the port.

2.13.9 Rail Master Building

A separate building will be required to provide for functioning of rail operations within the terminal. This building will house the rail master and associated staff managing the rail operations within the port. This building will also house a small workshop for minor maintenance functions.

2.14 Residential Requirement for Staff and Social Infrastructure

A residential colony is proposed for the administrative and operational personnel of Vadhavan Port. The housing accommodation would depend upon the deployment of staff at the port and would need to be augmented over the master plan horizon. In addition to the residential colony other social infrastructure such as primary school, hospital, convenient shopping centres, playgrounds, open spaces etc. need to be provided as per URDPFI (Urban and Regional Development Plans Formulation & Implementation, 2014) as well as NBC 2016 guidelines. The physical infrastructure comprising of a sewage treatment plant, water distribution system, roads, power, and water supply would also need to be provided. Based on the assessment of the port personnel over the master plan horizon, it is assessed that an area of 89 ha. would be required over the master plan horizon for the port housing and social infrastructure.

This colony should be located close to the port but outside the port limits.

2.15 Port Master Plan

2.15.1 Planning Framework

Physical Environment

The following aspects of the physical environment that will influence the port layout:

- ***Winds*:** During the peak monsoon season winds are from W to SW but seldom exceed 13 m/s. The wind veers to NE-N-NW over December-January.
- ***Water levels*:** Mean Sea Level is 2.8 m CD indicating a maximum tidal range of about 5.6 m
- **Waves:** The predominant wave direction is from W to SW during the monsoon season and NE-NW pre- and post-monsoon. Wave heights are generally less than 3.0 m.
- ***Currents***: The tidal streams are generally in a SW-NE direction with the flood tide setting in a northerly direction and the ebb tide in a southerly direction. The typical maximum current speed is reported to be about 1.25 m/s.
- ***Sediment transport***: Sediment transport from north. The suspended sediment concentration at mid-depth is 170-380mg/l [CWPRS March 2018].

- ***Geotechnical*****:** The seabed comprises a superficial layer of silty clay/sand overlying weathered bedrock. The cost of dredging rock and using in reclamation was estimated to be about Rs/m³ 3,100. This is roughly three times higher than the estimated cost of dredging soft clay and reclaiming using imported fill (Rs/m³ 1,150). In this case, it is more economical to reclaim using imported fill than to dredge in rock.
- ***Mangroves*****:** Areas of mangrove are encountered along the shoreline. Any reclamation needs to avoid these areas.

Limiting wave and current conditions for port operations

For carrying out cargo handling operations at the berths, it must be ensured that there are no excessive movements of the ships due to wave action that will hamper the ship-shore handling operations. This limit varies with the handling system for the different types of cargoes. Hence, the breakwater configuration and the overall port layout should ensure adequate tranquillity at the berths so that cargo handling may continueeven when the offshore wave climate exceeds the limit for ships' movement in and out of the harbour.

The maximum acceptable wave conditions for cargo handling operations at the berth are dependent on ship size, the type and method of cargo handling and the direction of the wave attack. Beam waves cause the vessel to roll and affect the cargo handling operations more than head waves.

Guidelines published by PIANC [2014] give the recommended limiting current and wave conditions for ship navigation at the harbour entrance and stopping area, turning, berthing, and loading/unloading ships (following table) Individually these limits may be regarded as conservative since they assume that the limiting wind, current and wave conditions are in combination.

Table 23 Limiting Conditions of Wave Heights for Cargo Handling

Type of Ship	**Limiting Wave Height (H_s)**	
	Head or Stern (0°)	***Quadrant (45°- 90°)***
Break-bulk Ships	1.0 m	0.8 m
Liquid Carriers	1.5 m	1.0 m
Containers	0.5 m	0.4 m
Other Liquid – With unloading arms – With flexible hoses	 1.5 m 2.0 m	 1.0 m 1.5 m
RO-RO	0.6 m	0.6 m

Table 24 Limiting conditions of wind, wave and currents within the harbour

Location/operation	Transverse			Longitudinal		
	Wind (m/s)	Currents (m/s)	Waves (m)	Wind (m/s)	Currents (m/s)	Waves (m)
Harbour entrance	15	1.00	3.0	-	-	-
Stopping areas	10	1.00	2.0	-	-	-
Turning area (tug assistance)	10	0.10	1.5-2.0	-	-	-
Berthing	10	0.10	1.5	17	1.0	2.0
(Un)loading (containers & Ro-Ro)	22	0.50	0.3	22	1.5	0.5

Breakwater

A breakwater is required to protect the berths and other facilities within the port from the predominant southwest to north-west waves which approach the Vadhavan site. These conditions are illustrated in the nearshore wave rose taken from the wave modelling by CWPRS.

CPWRS advised that the main breakwater location and alignment should be as indicated below since:

- Extensive numerical modelling was carried out to optimise the location, length and alignment of the breakwater in order to minimise wave penetration, currents and sedimentation in the harbour.
- Part of the breakwater is located on shallower area offshore in order to limit the CAPEX

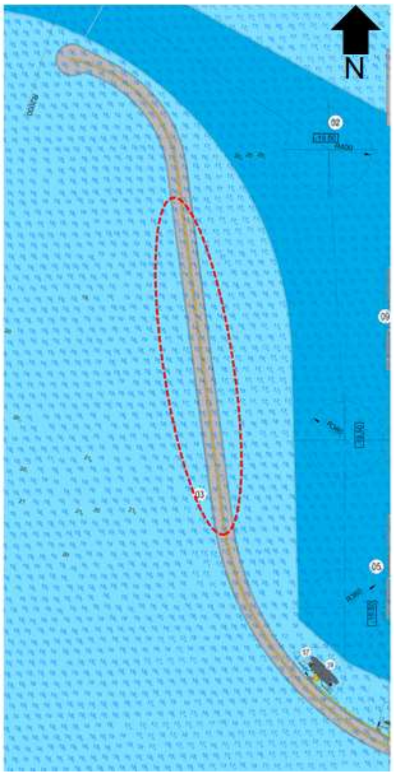


Figure 7 Shallow patch along breakwater alignment

Tarapur Atomic Power Station (TAPS) is located some 11 km to the south of the proposed port site and numerical modelling studies had been carried out by CWPRS to assess the impact of port development on the power station intake/outfall. Based on the outcome of the studies, no impact was found with the proposed alignment.

Layout of Breakwater and Revetments

The final layout of the breakwater and revetment/ reclamation bund has been arrived at through the wave tranquillity and hydrodynamic modelling studies completed by CWPRS:

- Model Studies for Tidal Hydrodynamics and Siltation for the revised layout of Phase-1 and Master Plan development of port at Vadhavan, Technical Report No 5968 (Nov. 2021)
- Model studies to assess the impact of proposed Capital Dredging on Tidal Hydrodynamics and siltation for development of port at Vadhavan, Technical 5970 (Nov. 2021)
- Model studies for assessment of wave tranquillity for Modified final layout of Vadhavan port, Technical Report No 5971 (Nov. 2021)

Report on Impact of Breakwaters and Transport Carrier on the Erosion/ Accretion for the Vadhavan Port, Maharashtra by National Centre for Coastal Research (NCCR) & Indian National Centre for Ocean Information Services (INCOIS) (September 2023).

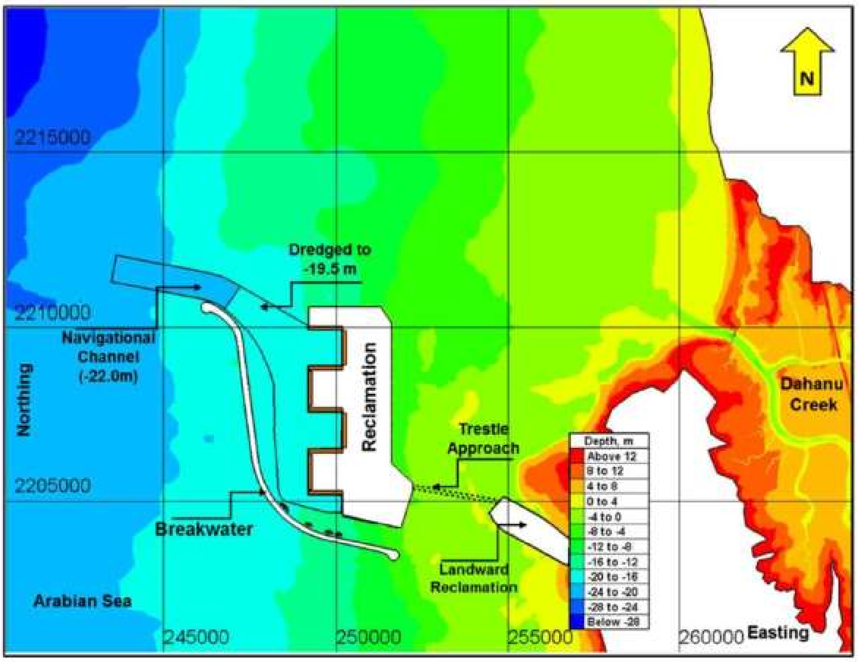


Figure 8 Breakwater alignment for Vadhavan Port

Berths

The estimated berths and the total quay length for the various phases of development have been worked out. Following Table provides the summary of berth/ terminal requirements.

Table 25 Vadhavan Port berths & terminal requirements established from the market study

Berths/terminals	Berth/ Quay length (m)	Ship max. draught (m)	Phase 1	Phase 2	Total
Container quay (1,000 m each)	1,000	16.5	4	5	9
Multi-purpose berths (250 m each)	250	10.5	3	1	4
Liquid bulk berths	200	9.5	2	0	2
Bulk Liquid berth	280	10.5	1	0	1
Other Liquid FSRU berth	400	12.0	1	0	1
Ro-Ro berth	250	11.3	1	0	1
Coastguard berth			1	0	1

A water depth of - 22.0 m CD is required in the approach channel and -19.5 m CD in the basins and at the container berths.

Navigational Requirements

Approach Channel width

The port approach channel consists of the two parts:

- The outer approach channel which is the section of the channel outside the breakwater area; and
- The inner approach channel, which is the section of the channel from the head of the breakwater area to the vessel turning area.

The outer approach channel would be unprotected with vessels in transit along this section sailing under their own power without tug assistance. The inner entrance channel would be protected and should be fairly sheltered from wave attacks. Tugs will be able to meet and fasten to the vessel before it enters the turning area and starts to manoeuvre towards the allocated berth.

The vessels will start slowing down after tugs are attached in the inner approach channel. As per PIANC (1997) guidelines, sheltered inner approach channel should have around 4-5 times length of the design ship. However, considering the capital cost of longer breakwater, it is expected that breakwater will provide an effective length of 3-4 times the design vessel length overall for Phase 1 operations which is deemed adequate.

The channel width has been calculated from the latest PIANC Guidelines "Harbour Approach Channels – Design Guidelines: Report No. 121 – 2014". The detailed calculations are shown in below table.

The calculated channel width for the proposed design ship size is summarised below.

Table 26 Particulars of Navigational Channel for Design Ships

Design Ship Size	Beam (m)	Outer Channel Width (m)		Inner Channel width (m)	
		One-way Channel	***Two-way Channel***	***One-way Channel***	***Two-way Channel***
24,000 - TEUs Container Carrier	61	290	620	230	490

The approach channel can be a one-way or a two-way channel. Based on the above assessment, for a busy port like Vadhavan which handle very large throughput and have many vessel calls, it is recommended to have a two-way approach channel.

Dredged Depth at Port

The depth of the approach channel is a very important parameter in approach channel design. The Vadhavan port location has a very favourable bathymetry and natural depth. Water depth in the channel region is around 17 to 18 m depth below CD. This will minimize the initial capital dredging cost involved.

The depth in the channel is determined by the vessel's loaded draught; trim or tilt due to loads within the holds; ship's motion due to waves, such as pitch, roll and heave; character of the sea-bottom, soft or hard; wind; influence of water level and tidal variations; the increase in draft of the vessel due to squat or bottom suction. In this particular case the bed level comprises of rock and hence additional underkeel clearance of 0.5 m is considered.

The dredged depths at the port entrance channel and manoeuvring areas will be governed by the fully loaded draft of the design ship. Based on PIANC guidelines, the dredged depths have been arrived at different parts of the harbour as per below

Approach channel outside breakwater (m CD)	Loaded draft +30%+Under keel-tide
Inner channel and manoeuvring area (m CD)	Loaded draft+15%+Under keel-tide
At berths	Loaded draft+15%+Under keel

The following dredged depths (after rounding off) at different parts of the harbour for the design ships have been worked out for two scenarios i.e., with tidal advantage and without tidal advantage. The calculated values are given in below table 27

Table 27 Dredged Levels at Port for the Design Ships - With Tidal Advantage

Ship Category	Ship Size	Draft (m)	Tidal Advantage (m)	Approach channel outside breakwater (m CD)	Inner channel and manoeuvring area (m CD)	At Berths (m CD)
Containers	24,000 TEUs	16.5	2	20.0	17.5	19.5
Other Liquid	2,67,000 m^3	12	2	14.1	12.3	14.3
Bulk Liquid	45,000 DWT	12.5	2	14.8	12.9	14.9
Multipurpose	40,000 DWT	10.5	2	12.2	10.6	12.6
Liquid bulk	20,000 DWT	9.5	2	10.9	9.4	11.4

Ship Category	Ship Size	Draft (m)	Tidal Advantage (m)	Approach channel outside breakwater (m CD)	Inner channel and manoeuvring area (m CD)	At Berths (m CD)
RORO	8000 units	11.3	2	13.2	11.5	13.5

As the mean sea level is about +2.8 m CD and the channel is short, it is possible to take the tidal advantage of minimum +2.0 m during the traversing of the design ship through the channel and manoeuvring area, at least during the initial phase of the port development. This is unlikely to result in any significant waiting time.

Taking advantage of tide while entering and leaving the port is a normal practice in major ports around the world. Even the largest ports namely the ports of Dampier and New Castle rely on tides. Having said all this, containerships rarely sail at maximum draft since they are unlikely to be fully loaded in terms of TEU capacity and also will carry empty containers.

However, in case it is desired that there should not be any waiting time for the ships on account of tide levels the minimum dredged levels to be provided at the port are given below:

Table 28 Dredged Levels at Port for the Design Ships - Without Tidal Advantage

Ship Category	Ship Size	Draft (m)	Tidal Advantage (m)	Approach channel outside breakwater (m CD)	Inner channel and manoeuvring area (m CD)	At Berths (m CD)
Containers	24,000 TEUs	16.5	0	22.0	19.5	19.5
Other Liquid	2,67,000 m^3	12	0	16.1	14.3	14.3
Bulk Liquid	45,000 DWT	12.5	0	16.8	14.9	14.9
Multipurpose	40,000 DWT	10.5	0	14.2	12.6	12.6
Liquid bulk	20,000 DWT	9.5	0	12.9	11.4	11.4
RORO	8000 units	11.3	0	15.2	13.5	13.5

Turning Circle

As per the PIANC guidelines, diameter of the sheltered turning circle with tug assistance should be 1.75 times length of the design ship. The design ship length is taken as 400 m so the turning circle diameter required would be 1.75 times 400 m which is 700 m. The vessel navigation study has further confirmed the adequacy of the turning circle diameter and location.

Rail Terminal

The minimum length of the land plot required for the rail terminal unloading/loading sidings will be determined by the maximum operating length of the container trains (1500 m). Straight container unloading/loading sidings are required which are at least the length of the longest train together with additional allowance at either end for the turnouts required for each set of sidings under the container (un)loading equipment together with locomotive run-round loop.

In addition, train reception and despatch sidings will be required for inspection and checks on arriving and departing trains including the removal of any crippled wagons.

Independent/ different tracks were proposed to cater for the Indian Railways rakes and DFCC rakes, which will lead to inefficient utilisation of the rail sidings. Also, the arrangement shown in the rail yard will not suffice the rake loading arrangements as it is required to have the buffer storage in the rail yard to cater the number of DFCC/ IR rakes through RMGC. The optimised/modified rail yard arrangement is as shown below

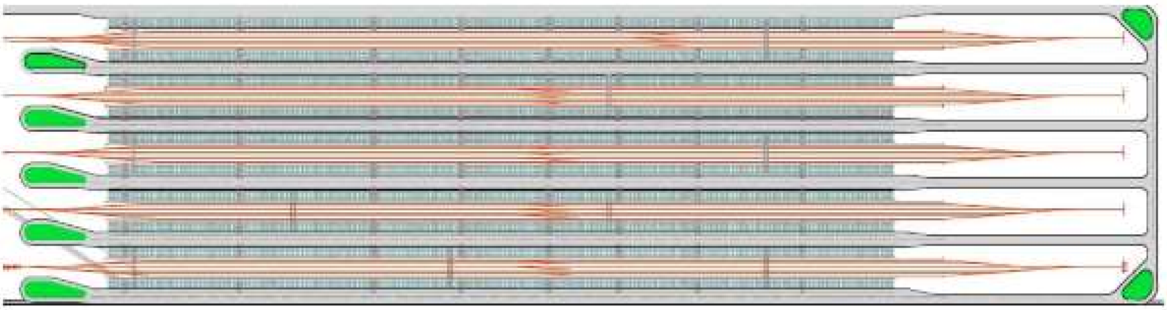


Figure 9 Buffer storage at rail yard

Reclamation Requirement

The layout of the port at Vadhavan has been developed keeping in view the master plan framework, traffic forecast till year 2040. The design ship size for the Phase 1 and master plan development is considered to be Container carrier of 24,000 TEU. The reclamation of land in the offshore area about 4 – 6 km from the shore envisages filling to create land in the offshore.

The main emphasis while developing the port layout is given to balance the cost of dredging and reclamation land area developed. It is estimated that 200 million cum of reclamation material would be required for the proposed port development. On the contrary in case of the harbour located closer to the shore additional dredging of the harbour would be needed which include substantial amount of rock. Therefore, the harbour area should be located so as to minimize the capital cost by optimizing the dredging and reclamation quantities.

Soil is one of the earth's most important natural resources. It underpins human food production systems, supports the cultivation of vegetation for feed and fuel, and has the potential to help combat and mitigate climate change. It's also a rich and complex ecosystem, accommodating a staggering biodiversity. Considering the requirement of large quantity of fill material, it is prudent to source the sand fill from marine borrow pit which is economical to compared to that of land preserving the land resources thereby mitigating the adverse environmental impacts. Majority of the mega international ports viz, Singapore, Salalah, Doha, Jebel Ali, Klang, Khalifa etc. have been developed in the offshore area by using sand sourced from the marine borrow pit.

2.16 Master Plan Overview

The port will be developed on a landlord basis with the terminals to be developed by private operators on Public Private Partnership (PPP) basis with concessions awarded to terminal operators.

The preferred concept for the container terminals is to have the yard area just behind the berth making it more efficient from operations perspective. The port master plan layout was developed taking into consideration the following:

- The capital investment required for the project.
- Minimising the operation cost
- Operational efficiency

2.16.1 Approach

The general approach taken to developing a new layout for the port was as follows:

- The main breakwater location and alignment as shown in the original port master plan was retained
- Marginal quays to be provided for container terminals where possible
- Consideration given to limiting both CAPEX and OPEX.

The cost of a rubble mound breakwater is roughly proportional to the square of the water depth. The main breakwater is located in deep water and although the location was to be retained, the possibility of reclamation and terminal development behind the breakwater was considered as a way of reducing the cost of the armour protection along the inner edge of the breakwater.

However, it was determined that any potential savings in armour protection would be offset by the increased cost of reclamation in the deeper water adjacent to the inner edge of the breakwater.

The following parameters were also taken into consideration for developing the layouts.

Balance in reclamation and dredging

In order to develop a modular container terminal, there is a requirement of creating the reclaimed land in deep waters. The main emphasis while developing the port layout is given to balance the cost of dredging and reclamation for the land area developed.

Material for Reclamation

The reclamation cost would be considerably high owing to high quantity of reclamation when carried out in deep water compared to nearshore. The reclamation is also dependent on the source i.e., marine / burrow earth in which the latter one would be expensive affair and is also dependent on the availability of the required material. For marine source the reclamation is sensitive to the distance of source from the port location.

Marine Terminal Requirements

The preferred arrangement for a container terminal is a straight marginal quay with container storage yard directly behind. The straight quay allows for flexibility of ship berthing and movement of rail-mounted quayside cranes. A container storage yard directly behind the quay apron provides for efficient transfer of containers between quayside and storage as well as limiting the operating costs.

Rail yard at the proximity to container yard

For efficient functioning and evacuation of the container terminal, the rail yard need to the provided close to the container storage yard. Locating the rail terminal away from the container handling facility would result in inefficiency in handling and high OPEX cost.

Trestle connecting offshore reclamation

Trestle connecting the nearshore with the offshore reclamation to be such that there is ample space for the current flow without having any adverse impact on the port facilities.

Sedimentation within the harbour

The phenomenon of littoral drift of sediments along the west coast of India is low. The drift of sediments along the coast is caused by the action of waves impinging on the coastline at an angle, and this slowly drives the material in the direction of the waves. The littoral drift at the project site predominantly driven by the currents along the coastline. This is predominantly from north to south along the west coast of India, along with some reverse drift.

The port layout has been developed to improve the operability of the container terminals. A layout for Phase 1 of the port development has also been prepared.

2.16.2 Proposed Master Plan layout

In the recommended scheme the adoption of solid narrow finger piers will avoid currents perpendicular to the berths. However, container berths on either side of narrow finger piers with the container storage yards located some distance from the berths are undesirable from an operational point of view.

As a consequence, wide reclamation fingers were proposed with marginal container quays and container storage yards directly behind the quay apron.

However, with solid narrow or wide reclamation fingers some increase in siltation may be expected in the basin area between the fingers.

The Proposed master plan layout is shown in Figure below. In summary the Master Plan addresses four main factors:

- **Market:** The master plan is based on the traffic analysis performed by RHDHV and is planned to accommodate the 2040 realistic scenario. In addition, expansion potential of the master plan will allow to port to expand beyond 2040. The master plan is flexible enough to accommodate various types of cargoes depending on the market situation (liquid, Other liquid, multipurpose, RORO cargo). Based on the market forecast, it is recommended that Port of Vadhavan be developed in two phases with Phase 2 bringing it up to the final master plan development.
- **Technical:** The master plan presents the most technically sound option after taking into due consideration the physical constraints at the site and providing a futuristic world class efficient facility with green design concepts.
- **Environmental:** The master plan takes into account various environmental aspects such as:

  - Provides a minimum of 300 m clearance between the shoreline and the bund to avoid disturbing the flow to the mangroves due to the proposed port.
  - Locating the terminal and onshore facilities on the reclaimed land.
  - Provides flexibility to incorporate green initiatives.
- **Social:** The Master Plan has been carefully arrived at to minimize impact on the adjoining population, some of the factors considered are:
  - Fishing community near the proposed port site.
  - Rail and road access have been planned for minimal impact on the adjoining village.
  - Facilities for Coast Guard to improve security of the country.
  - Master plan preserves the existing Shankodhar Point and provides for unimpeded access to it.

The final master plan layout incorporates the following:

- 9 container terminals each with a straight 1,000m long marginal quay. 7 terminals have the container storage yard located directly behind the quay apron whilst for two of the terminals the container yard is located about 1km behind the quay.
- A total of four multi-purpose berths each 250 m long at the southern end of the reclamation
- Three liquid bulk berths located on the leeside of the breakwater
- A Ro-Ro berth at the south-west end of the offshore reclamation with adj acent vehicle parking
- Small craft (pilot boats and tugs) and coastguard berths at the southern end of the reclamation.
- Additional berths for small craft may also be provided at the northern end of the reclamation if required.
- Rail terminal located along the eastern side of the offshore reclamation
- Onshore reclamation for liquid bulks storage and administrative facilities

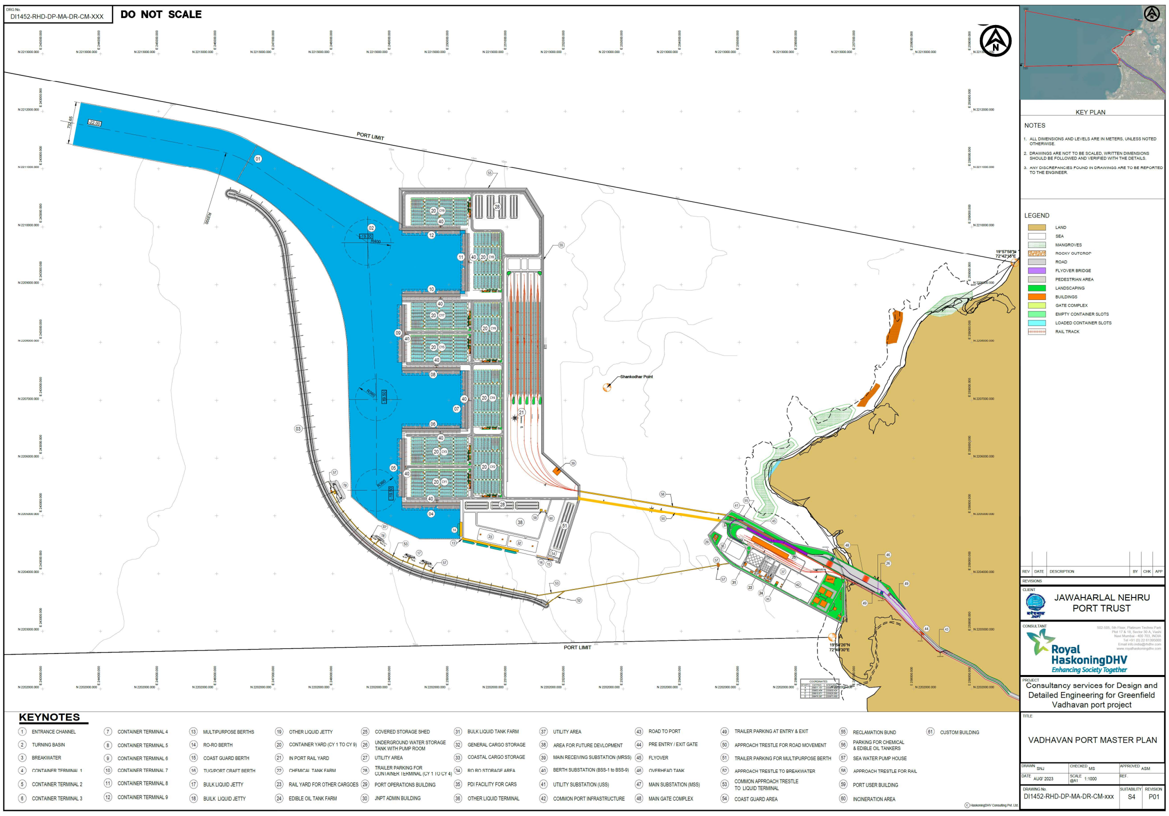


Figure 10 Final Vadhavan Port Master Plan Layout

CWPRS carried out hydrodynamic modelling of this layout. The results (Figure Below) indicate the following:

- Maximum cross current at the harbour entrance of 2.55m/s reduci ng to 1.3m/s at the expected
- ship stopping poi nt
- Maximum currents at the turni ng areas l ess than 0.4m/s i n a S-N directi on
- Currents in the dredged basi ns bet ween recl amati on fingers l ess than 0.05m/s
- Currents ongitudi nal to the berths at the ends of the recl amati on fingers l ess than 0.2-0.4m/s
- The total quantum of siltation in the dredged areas will be about 9.20 M cum.

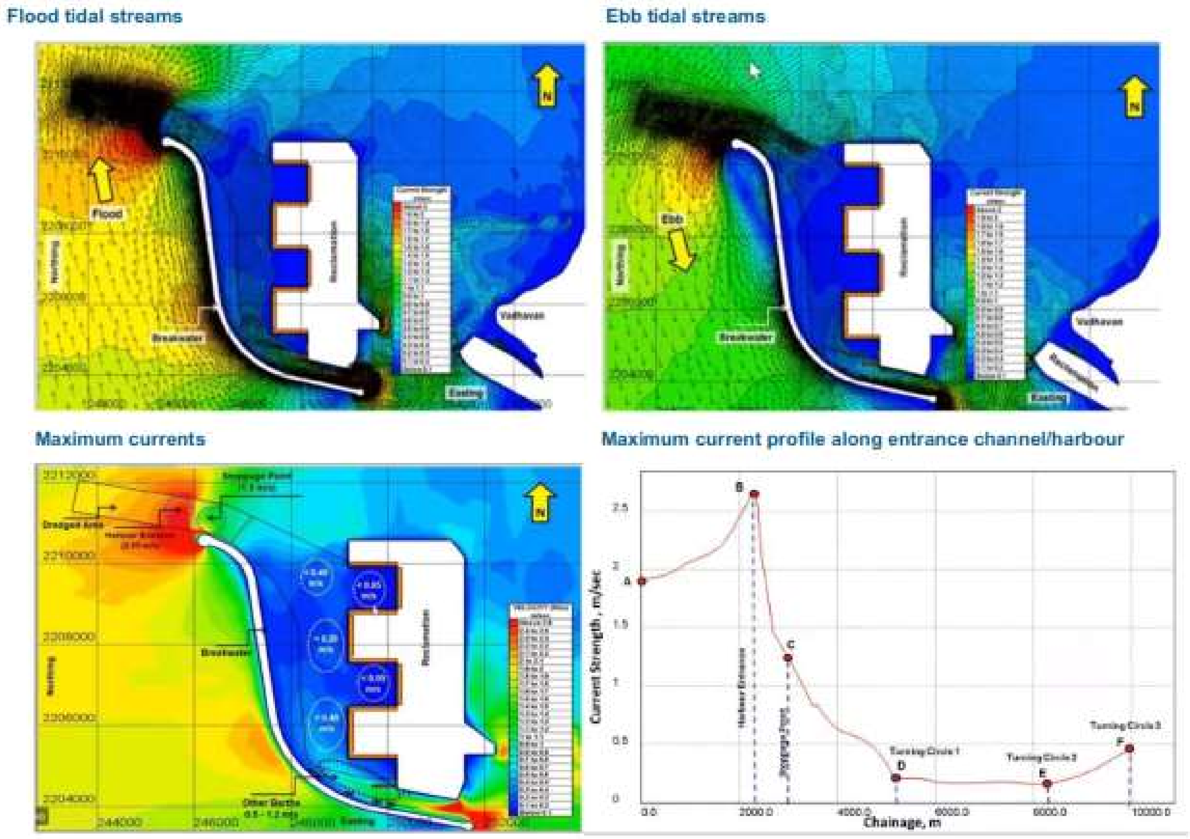


Figure 11 Recommended Vadhavan Port Master Plan Layout - results of hydrodynamic modelling

Based on the flow fields, it was observed that the tidal flow conditions are suitable at all container berths as well as in the manoeuvring area. However, the results of the numerical hydrodynamic modelling indicated that on Spring flood tides the maximum current speed between the southern end of the offshore reclamation and the southern end of the breakwater could exceed 2.5m/sec. In addition, there was indication of eddy formation at the south breakwater head.

Modifications were therefore made by CWPRS to the layout i n order to reduce/improve the flood tide current flows at the southern end of the harbour basin.

- Modification in the area at along the southern end of reclamati on footprint and maintaining a gap of 670 m between the breakwater and the reclaimed area.
- The revised reclamation arrangement facilitated the flow to align along the reclamation face during the flood as well as the ebb tide providing favourable condition for multipurpose berth along the southern end of reclamation, as shown in figure below;

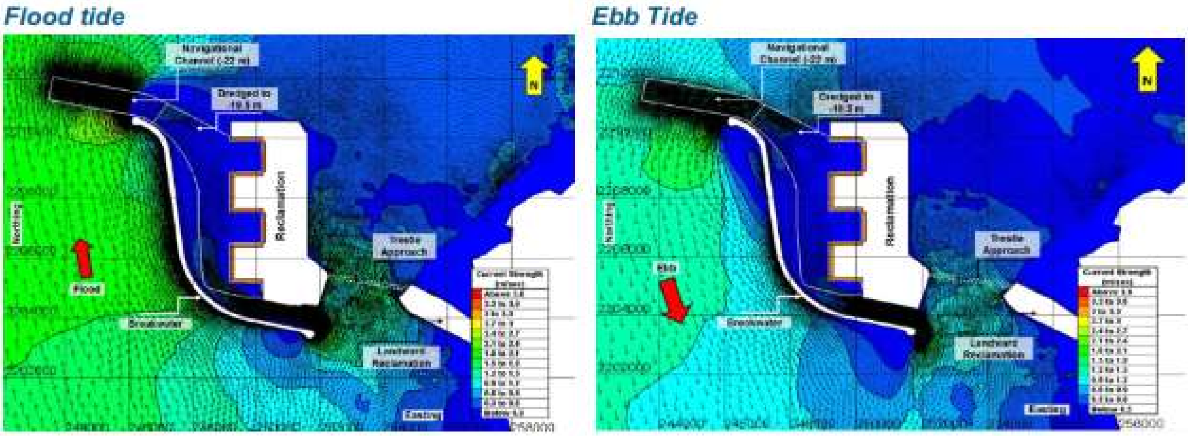


Figure 12 Reclamation face during the flood as well as the ebb tide

- Shifting of the liquid terminal s 500 m along the breakwater towards north to achieve favourable flow conditions.
- The quantum of likely siltation will be about 8.45 M cum per annum with the reduction of 0.75 M cum in annual siltati on due to f avourable tidal hydrodynamic conditions.

Phase 1 Port Development

The port is proposed to be developed in phases and accordingly, the model studies were carried out for the proposed Phase 1 layout to ascertain the flow conditions within the harbour.
The maximum velocities at harbour entrance, stopping distance and turning circle are 2.6 m/s, 1.2 m/s and 0.3 m/s respectively. The maximum current strength at berths is about 0.05 m/s.

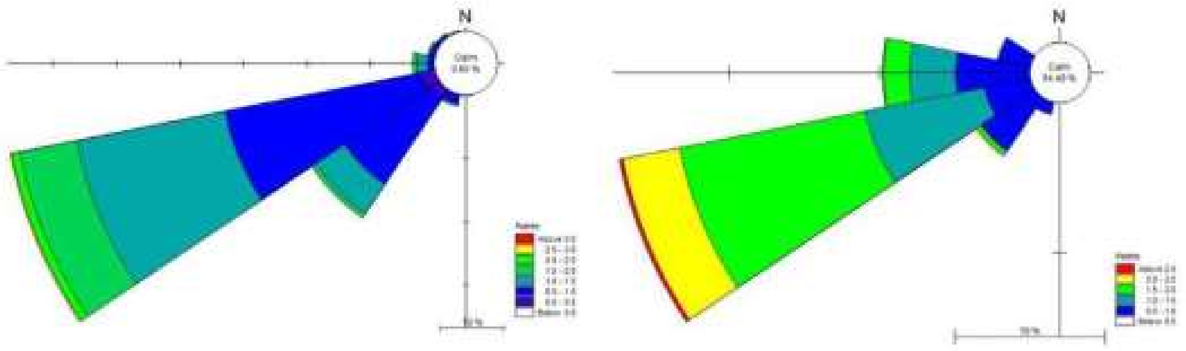
The annual siltation in the dredged areas will be about 6.45 M cum.

2.17 Impact of the breakwaters and transportation on erosion and accretion

The study on "Impact of the breakwaters and transportation on erosion and accretion" was carried out by the National Centre for Coastal Research (NCCR) and report was submitted in September 2023, as per the proposal amended and submitted to MoEF & CC Infra-I Committee and appraised in the 324th EAC meeting. The report is enclosed as Annexure-10

2.17.1 Wave Tranquility

Wave tranquillity studies for the final master plan layout was carried out using MIKE. The hydrodynamic parameters adopted indicate an offshore maximum wave height (at -60 m depth) of 4.5 m with SSW, SW, WSW, W, WNW, and NW as the predominant direction with 55% of the wave from the West for the duration of January and December. The significant wave height of 2.5m (West Direction) is observed at -24 m water depth with W, WNW, and NW as the predominant direction (Figure 12). The tidal data adopted indicates the highest water level (HWL) of 5.5 m as per the feasibility study report. The bathymetry in the model is presented in Figure 13.



(a) UKOMO data at -60 m depth

(b) Modeled wave rose at -24 m depth

Figure 13 Wave Rose for model studies (Source: NCCR report (September 2023))

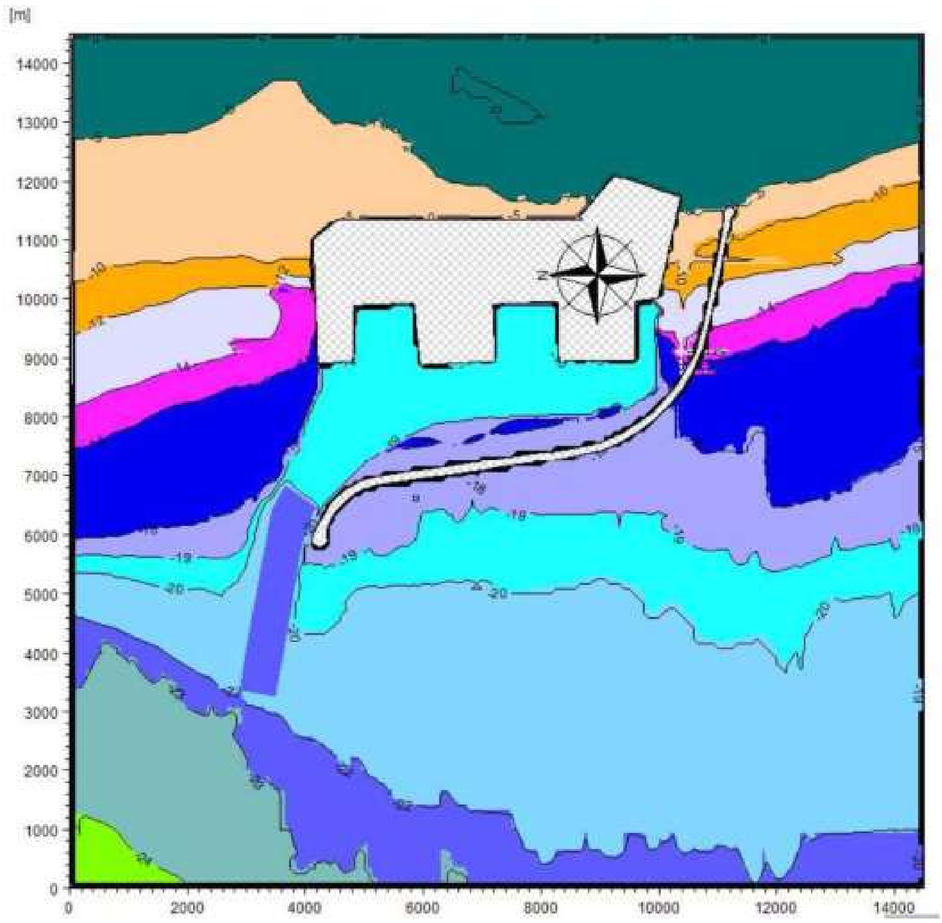


Figure 14 Bathymetry for the model (Source: NCCR report (September 2023))

The nearshore wave transformation inside the port near the berths have been carried using MIKE 21 BW model with the SW model output as input. The nearshore wave transformation indicates a maximum significant wave height of 1 m with a peak wave period of 10 seconds when the wave direction is NW with the wave height slightly higher than the limiting wave height of 0.7 m in the WNW direction wave at CT08. All the other observed wave data are within the limits (Table 31). The wave transformation in the west direction is represented in Figure 14.

Table 29 Significant wave height for Final Modified Master Plan Layout (Source: NCCR report (September 2023))

Wave direction/ Wave height	Average Significant Wave height (m) at Jetties								
	CT01	CT02	CT03	CT04	CT05	CT06	CT07	CT08	CT09
270 (West)/2.5m	0.25	0.25	0.25	0.28	0.30	0.35	0.63	0.60	0.40
292.5 (WNW)/1.5m	0.20	0.30	0.30	0.25	0.25	0.45	0.65	0.70	0.40
315 (NW)/1.5m	0.20	0.30	0.30	0.25	0.25	0.65	0.95	0.50	0.30
Peak wave period T_p: 10 sec									

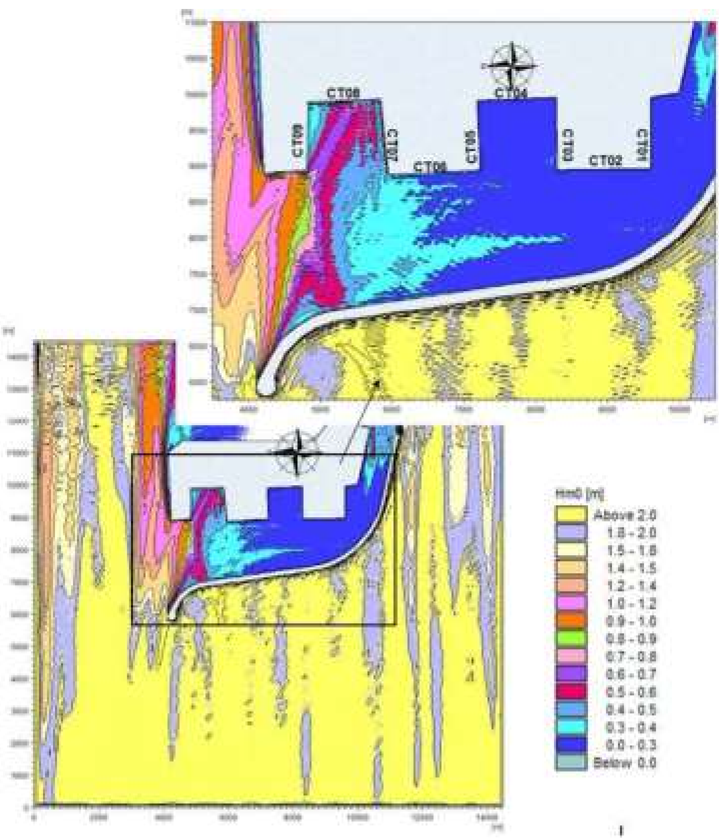


Figure 15 Bathymetry for the model (Source: NCCR report (September 2023))

The study suggests a tranquil condition inside the port basin and also since the breakwater is constructed offshore, blockage of sediments along the coast cannot be anticipated. However, there could be a possibility of the formation of a salient behind and south of the proposed port, which needs to be monitored.

2.17.2 TIDAL HYDRODYNAMICS AND SILTATION

The oceanographic data used for the purpose of mathematical model study includes; the monsoon (September- October 2020) and non-monsoon (January- February 2017) period. The maximum tidal range is about 5.87m during spring tide and 2.1m during neap tide. The current direction with respect to the North varies between 3°-23° and 204° – 215° during the flood and neap tides respectively during the non-monsoon season and varies between 16° – 23° and 203°–210° during the flood and neap tides respectively at monsoon season. The maximum significant wave height is 1.19m during the non-monsoon season and the waves approach from the N-W quadrant whereas it is 2.3 m and waves approach from the SW-WNW quadrant during the monsoon season. Suspended Sediment Concentration (SSC) indicated 380 mg/lit – 170 mg/lit for nonmonsoon season and 473mg/lit–105mg/lit for monsoon season. The grain size analysis observed the presence of 58% of silt and 26% of clay in the study area.

A revised master plan inclusive with the breakwater of length 10.3 km, offshore reclamation, and dredging footprint viz. proposed reclamation area (offshore 1262 Ha. & Shore connected 222 Ha) with 1210 Ha of the dredged area was finalized. From the hydrodynamic and siltation studies as carried out by CWPRS, it was confirmed that the tidal flow conditions are suitable at all container berths and manoeuvring areas and also consider the width between the breakwater and multipurpose berth to 670m.

The hydrodynamic and siltation studies of this Master Plan were carried out by NCCR and it was observed that the maximum current strengths at the container are within 0.15 m/s. The flow approaches at an angle varying between 4° and 7° along oil berths. With these flow conditions, it was reported that the currents would bypass the sediments to the North of the proposed port. The total quantum of likely siltation in the dredged areas will be about 8.45 million cum per annum as per the siltation studies. With the advised maintenance dredging of 6.45 million cum for phase I, a volume of 0.15 Mm^3 from this maintenance dredging can be used for beach nourishment to the immediate North of the port.

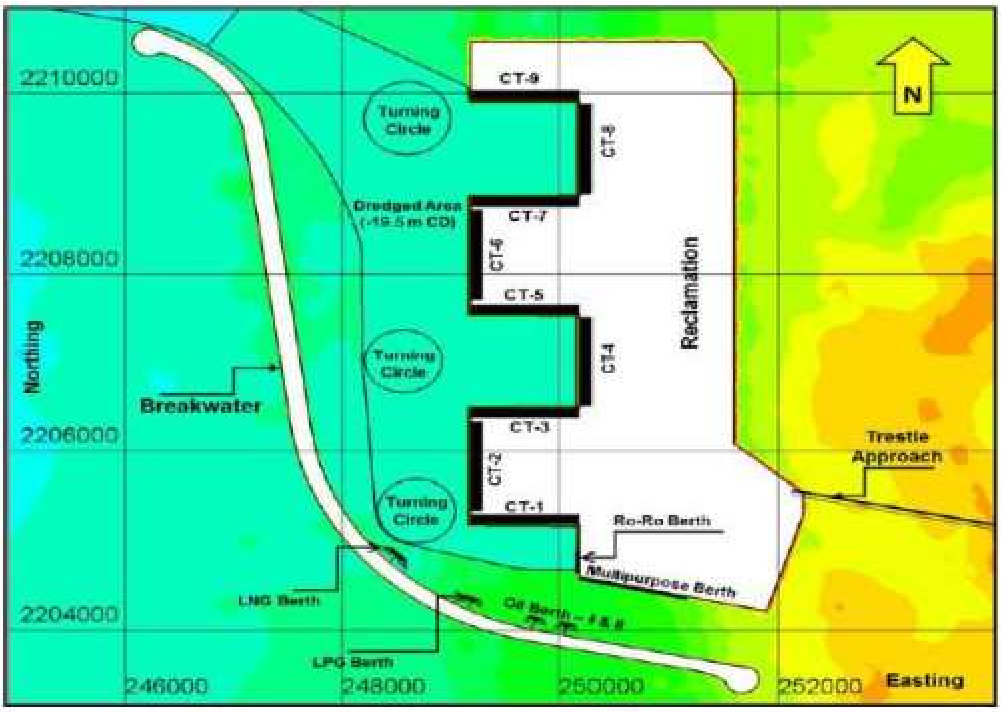


Figure 16 Locations of various berths in Modified Revised Master Plan Layout (Source: NCCR report (September 2023))

2.17.3 SHORELINE CHANGE ASSESSMENT

The study on shoreline change assessment was carried out by CWPRS and submitted to JNPA in April 2022. The analysis covered long-term (1975-2022) and short-term (2000-2022) shoreline changes using historic satellite images and aerial photographs from 2012. In the long term, 61% of the coast was stable, while in the short term, 50% of the coast was considered stable, with some stable areas transitioning to low erosion. Additionally, areas of low accretion in the long term were gradually trending towards low erosion.

It is seen that from Khonda Creek to the North of the proposed port area, the shoreline trend indicates the shoreline transferring from broadly stable to low accretion coast. At the port location and reclamation area, the shore has shifted from broadly Stable to low accretion coast. South of the location till the Varor region, a significant proportion of the regions range from low erosion to medium erosion.

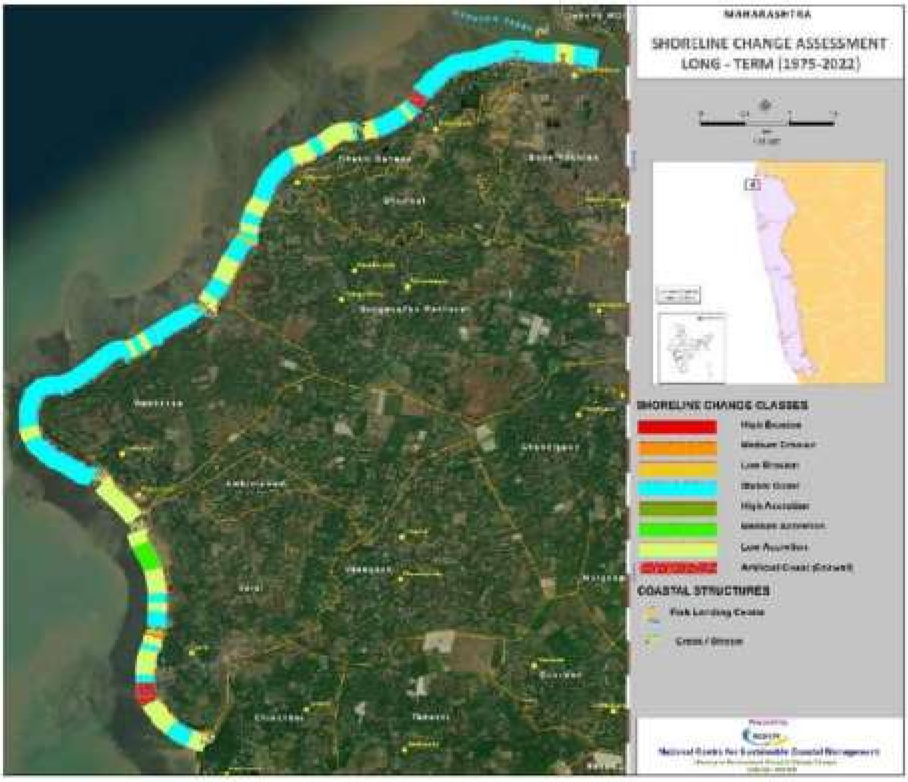


Figure 17 Shoreline Change Analysis by NCSCM (1975-2022) (Source: NCCR report (September 2023))

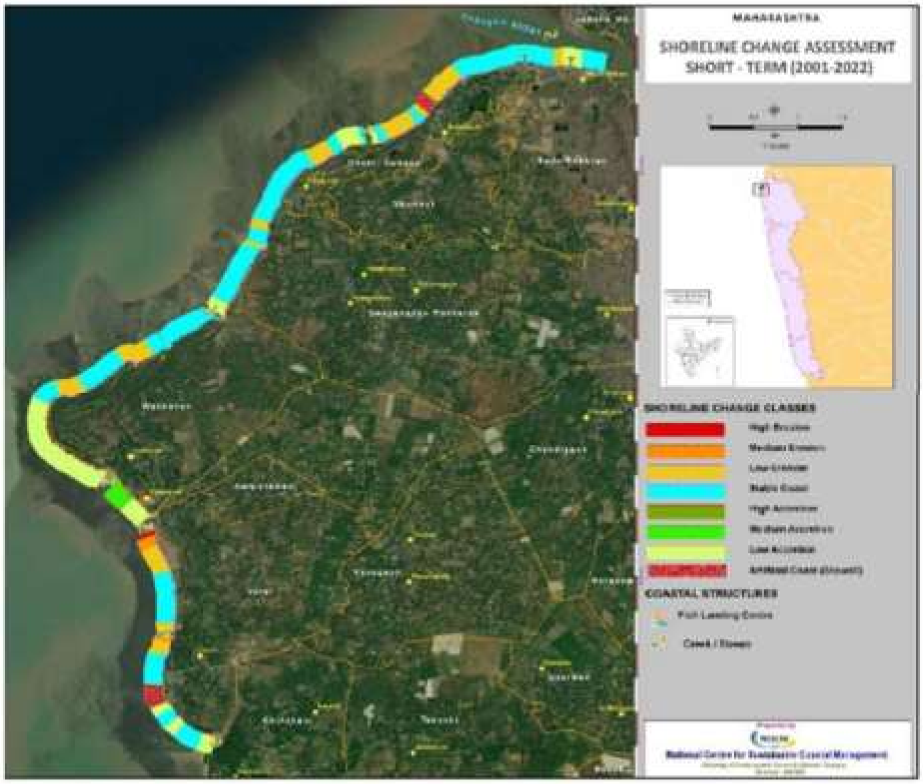


Figure 18 Shoreline Change Analysis by NCSCM (2001-2022) (Source: NCCR report (September 2023))

2.17.4 SHORELINE MORPHOLOGY CHANGES

The alongshore movement of sediments or the 'littoral drift' plays a significant role in emanating the shoreline morphology of the area. With the introduction of an artificial structure along the coast or offshore, the drift pattern may be altered due to the dynamics of the nearshore area. The shoreline morphology change was thereby studied for understanding the effect on construction of port breakwater in the adjacent shorelines. Mathematical model study was carried out using LITPACK modules; LITDRIFT and LITLINE of the MIKE 21 software.

The oceanographic data used for the study includes 14-year offshore wave data from the year 1999 to 2012 off Vadhavan sourced from Ship observations by India Meteorological Society and tide data near Dahanu was sourced from JNPA. The Highest High Water (HHW) is about 5.5m, the Mean High Water Spring (MHWS) is 5.0m and the Mean Low Water Spring (MLWS) is 0.7m.

Mathematical model studies for obtaining the wave climate in the nearshore area were carried out using MIKE 21- SW model and the outputs were extracted at -24m and -10 m water depth. The nearshore rose diagram at -10m water depth is given in Figure 18. The predominant wave direction is between 220° – 300° with a maximum significant wave height of 2.5m. The estimation of littoral drift distribution and simulation of the shoreline was carried out using a one-dimensional LITPACK model.

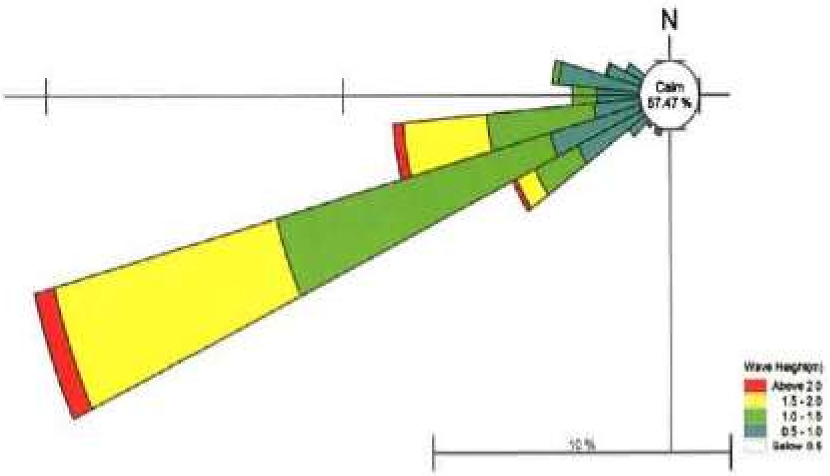


Figure 19 Near shore wave rose at -10m depth (Source: NCCR report (September 2023))

2.17.5 SHORELINE CHANGE ANALYSIS BY NCCR

Shoreline change analysis is carried out for long term (1973 to 2023) using Landsat-MSS (60 m), Landsat-TM (30 m), ResourceSat-I LISS-III (23.5 m), CartoSat-1 PAN (2.5 m), ResourceSat-II LISS-IV (5.8 m) and Sentinel-2A (10 m) satellite images.

Table 30 Details of satellite data used (1973 to 2023) for shoreline change analysis

Year	No. of data	Satellite data	Resolution (in meters)
1973	1	Landsat-MSS	30
1990	1	Landsat-TM	30
2001	1	Landsat-TM	30
2006	1	Cartosat-1 (PAN)	2.5
2008	1	RS-1 (LISS-III)	23.5
2012	1	RS-2 (LISS-IV)	5.8
2013	1	RS-2 (LISS-IV)	5.8
2014	1	RS-2 (LISS-IV)	5.8
2015	1	RS-2 (LISS-IV)	5.8
2016	1	RS-2 (LISS-IV)	5.8
2017	1	RS-2 (LISS-IV)	5.8
2018	1	RS-2 (LISS-IV)	5.8
2019	1	Sentinel-2A	10
2020	1	Sentinel-2A	10
2021	1	Sentinel-2A	10
2022	1	Sentinel-2A	10
2023	1	Sentinel-2A	10

The baseline layer was generated with a buffer distance of 300 m landward from the oldest shoreline, and seaward transects (perpendicular lines) were generated at every 20 m interval along the coastline. Shoreline change statistics is evaluated using the approaches in Digital Shoreline Analysis System v.4.0 (Thieler et al. 2009): Long-term (1973 to 2023) analysis calculated using the weighted linear regression (WLR) method which considers the uncertainty field to calculate the rates of shoreline change. A shoreline change assessment was carried out for long term (1973–2023) period to understand the changes on the shoreline. The rate of shoreline changes from 1973-2023, signifies that among the study area of 10 km, 2.06 km (20%) of the coast and, 0.34 km (4%) were observed to have moderate and high erosion during the 1973-2023 period.

Table 31 Estimation of Shoreline Change Analysis for 1973-2023 (Source: NCCR report (September 2023))

Shoreline Change Analysis (1973-2023)		
Status	Long term	
	Length (in km)	%
High Accretion	0	0
Moderate Accretion	0	0
Low Accretion	0.12	1.2
Stable	1.2	12
Low Erosion	6.36	63
Moderate Erosion	2.06	20
High Erosion	0.34	4
Total	**10**	**100**

Figure 20 Shoreline Change Analysis of long term (1973 - 2023) (Source: NCCR report (September 2023))

2.17.6 OUTCOME & CONCLUSION

The existing reports on wave tranquillity, hydrodynamics, shoreline change assessment, and shoreline morphology study were analyzed and shoreline change analysis was carried out by NCCR. The following were the outcomes of the study:

1. The maximum significant wave height in the port basin is 1.0m in the Final Master Plan Layout as compared to 2.5 m height offshore. Due to the presence of offshore breakwater, blockage of sediments along the coast is not anticipated. However, there could be a possibility of the formation of a salient behind the proposed port, which needs to be monitored.

2. The Tidal Hydrodynamic and Siltation study finalized the Master Plan Layout for favorable operation and maneuvering conditions with minimum effect on the morphology. The maximum current strengths at container terminals are within 0.15 m/s and flow approaches at an angle

varying between 4° and 7° along oil berths and Other Liquid terminals. These hydrodynamic conditions allow the bypassing of sediments towards the North of the port area.

3. The shoreline morphology study reveals that a net transport of about 0.07 Mm^3 is transported just North of the proposed port area. Although Northerly transport is not fully hindered, maintenance dredging of the port can be utilized for nourishment in the North of the port. A minimum of 0.15 Mm^3 of sand shall be used for nourishment of the North which will be dredged from the port basin as a part of maintenance dredging.

4. The littoral drift and shoreline evolution comparing the original shoreline and proposed port indicates an insignificant effect on the adjacent shoreline.

5. The shoreline change analysis by NCCR suggests that a stretch of 2.4 km of the study area is in a moderate to high erosion state for long-term analysis. The construction of the port breakwater is likely to reduce erosion in the south.

2.18 LAND USE PLAN

Large backup area has always been a prime requirement for major port development anywhere in the world. Therefore, especially in the case of a completely new port it will be prudent if a large area is specifically reserved for the long-term development of the port, so that the port facilities which are so vital to the growth of the nation can be developed easily to cater to its growing needs.

The minimum land area required for the purpose of cargo handling, storage, port operations, rail and road connectivity, greenery etc. has been worked out as shown in following Table 32.

Table 32 Minimum Land Area Requirement for Vadhavan Port

S. No.	**Commodity**	**Land Allocation over Master Plan Horizon (sqm)**	
		2030	***2040***
1.	Storage Space for various Cargoes	4,614,560	7,892,833
2.	Internal Roads and Circulation Space in Storage areas @ 25%	1,153,640	1,973,208
3.	Rail and Road Corridor (internal)	1,224,000	1,964,000
4.	Rail and Road Corridor (external)	4,968,000	4,968,000
5.	Port Building Complexes including parking	14,843	30,311

S. No.	Commodity	Land Allocation over Master Plan Horizon (sqm)	
6.	Landscaping, Green belt and other for Expansion	450,000	975,000
	Total Land Area (Sqm)	**12,425,042**	**17,803,352**
	Total Land Area (Acres)	**3,070**	**4,399**
	Total Land Area (Hectares)	**1,242**	**1,780**

2.19 Berthing Facilities

2.19.1 Location and Orientation of Berths

The Phase 1 development of Vadhavan port has been planned with major development of 4,000 m of container berths with 1000 m for each terminal, 4 Liquid bulk berths, 3Multipurpose berth, RO-RO berth and TUG/ port craft and coast guard berth. Container berths have been planned in North-South as well as East-West direction forming a U-shaped dock.

The container berths are located approximately at the depth of 15 to17 m considering the navigational depth requirement and existing rock levels.

Similarly, multipurpose berths are provided on the southern side of the harbour along a straight berthing line oriented at an angle of 283° N and RO-RO berth is provided at 15 m depth in North-South direction considering the navigation requirement. The port crafts and coast guard berth are provided in line with the multipurpose berth on the southern side of the harbour.

2.19.2 Deck Elevation

The maximum significant wave height expected at the location of container berths is about 1.0 m as per CWPRS model studies, under the normal weather conditions (wave height of 3.0 m outside port basin at 24m depth).

It has been proposed by JNPAto adopt a deck level for the berths and marine structures by considering the operational conditions and to bench mark the same with existing facility at JNPA. Hence for assessing the deck top levels of berths, the following levels are considered during operating conditions.

Mean High-Water Springs (HHWS)	4.7m CD
Add for Wave Crest Height (0.7 *Design wave)	0.7m
Clearance for Sea level rise (50 Yr.)	0.2m

Clear freeboard allowance	0.5m
Add for Deck Thickness	1.5m
Total	7.6 m CD

The existing deck elevation at JNPAis +7.1 m CD, which is comparable with the proposed deck elevation. Hence a deck elevation of +7.6 m CD will be considered for all berths at Vadhavan port. The deck level will be revisited during the detailed design stage.

Approach trestle deck levels will be kept same as to match the deck levels of the Berth/Jetty Head.

2.20 Dredging and Reclamation

2.20.1 Capital Dredging

Dredging and reclamation is one of the major costing parameters for any port project. The proposed port site is characterized by available depths with 20 m contour located at 11,500 m from the shore. This substantially reduces the dredging cost and hence enabling the port to provide berthing ability for the largest container vessels (up to 24,000 TEU). The port intends to utilize reclaimed land for the port backup facilities. The volumes have been calculated based on the bathymetry information of the site.

Table 33 Volume of Dredging in various Areas for the Vadhavan Port

S. No.	Dredge Area	Dredged Depths (m CD)	Dredge Volume (m^3)	
			Soil	***Rock***
1.	Approach Channel	-20	717,648	-
2.	Turning Circle and Manoeuvring area	-17.5	2,261,410	2,263,990
3.	Berths pockets			
	– CT 1	-19.5	446,684	26,620
	– CT 2	-19.5	300,294	18182.2
	– CT 3	-19.5	143,853	161,395
	– CT 4	-19.5	102,246	537,364
	Total (cum)		**3,972,136**	**3007,552**
	TOTAL (Soil +Rock) (cum)		**6,979,688**	

Based on the information from geophysical and geotechnical surveys, it is estimated that the volume also consists of rock dredging. The overburden from the approach channel and harbour basin shall be dredged using the cutter suction dredger of suitable power to dredge rock up to compressive strength of 20 MPa. The rock dredged using cutter suction dredger shall be mostly in the pulverised form and could be pumped ashore for the purpose of reclamation.

2.20.2 Characteristics of Dredged Material

Based on the available data from geotechnical investigation carried out in this area, the primary characteristics of materials to be dredged as per the laboratory test results and dredging effort required is discussed below.

- The dredge levels vary from -20.0 m CD at the entrance channel to -17.5 m CD in the basin area with -19.5 m CD at the container berth terminals.
- In absence of sufficient boreholes at the berth location and channel, MBH-35, MBH-37, MBH-40, MBH-42, MBH-43, MBH-44, MBH-45, and MBH-47 have been considered for the present study. Out of these boreholes, MBH-43, MBH-45, and MBH-47 show the presence of weathered rock above dredge level. Weathered rock is encountered at -16 m CD in MBH-45, -16.7 m CD in MBH47 and -17.1 m CD in MBH-43. Hard rock is encountered below -27.1 m CD in MBH-43 hence dredging in hard rock is not anticipated.
- Core recovery values in weathered rock generally varies from 24 to 34% above dredge level and corresponding RQD values varies from Nil to 12%.
- Although values of rock strength are not available in above mentioned boreholes at shallower depths, based on our understanding of general geology in the area, weathered basalt is envisaged with rock strength varying from 6 to 51 MPa with an average of 19 MPa.

The dredged material is considered suitable for reclamation.

Dredging Quantity

The dredging quantity expected from the project is 200 x 10^6 m^3 and generally consists of sandy silt.

Dredging Soil Characteristics

The existing data indicates that the surface soil up to 11m is made of recent deposition of silty sand of particle size varying from 0.075mm to 0.2mm. Hence the representative soil particle size should be 0.15mm.

2.20.3 Utilisation of Dredged Material

The borehole profiles show that the dredge spoils (except the initial surface material up to the depth of approximately 0.5 – 1 m below the existing seabed) comprise of good quality silty sand and is suitable for reclamation for the development of the onshore facilities. The unsuitable material, such as silty clay, will be dredged and discharged to the designated offshore disposal area.

Based on these boreholes, it was deduced that the volume of sand is estimated to be in the order of 3.9 million m^3. The volume of the weathered rock is estimated to be in the order of 3.0 million m^3.

2.20.4 Dredging Methodology

This method statement is prepared based on the information available with the aim of feasibility of the dredging and shall be modified revised by the specialised dredging contractor to be appointed during implementation.

Work Method

The prevailing site conditions and equipment properties dominate the selection of the equipment and work method. The materials to be dredged consist of layers varying from coarse sand to silty clay at the top. The suitable silty sand material will be placed in the reclamation area for container yard construction. The unsuitable material, such as silty clay, will be dredged and discharged to the designated offshore disposal area. Considering the variety of soil/ rock in combination with pumping distance between the dredging and reclamation areas, the work method utilizes a large Cutter Suction Dredger (CSD).

A large Cutter Suction Dredger will be deployed to dredge the materials and hydraulically transport these to the required reclamation areas. The suitable dredged materials will be pumped ashore by means of a system of onboard dredging pumps in combination with floating, submerged and land lines.

The suitable and unsuitable soil layers will be placed in a soil model which will be loaded into the onboard dredge computer. The dredging will take place in several cuts. Based on this plan the dredge master can determine his dredging strategy and synchronize this with the reclamation crew.

Dredging by Cutter Suction Dredger (CSD)

The CSD is deployed for dredging and pumping materials directly into the reclamation area. The pipeline may consist of a combination of floating, submerged and shorelines. In this particular situation, the CSD is connected directly to a shore connection point by means of a floating pipeline where required in combination with a submerged line and there off to the reclamation area, by means of a shore pipeline. As the reclamation progresses, the shoreline will be extended. Two different pipeline configurations are schematized in the figure below.

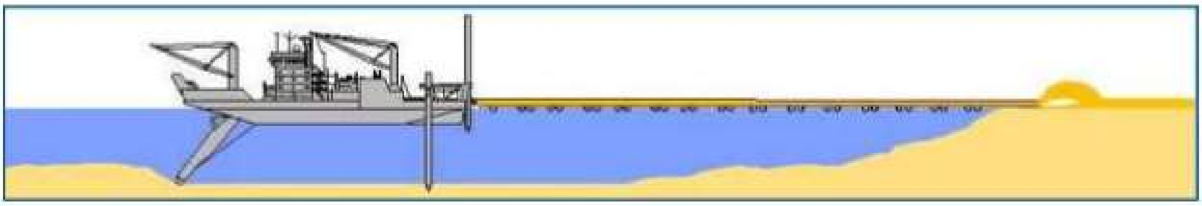


Figure 21 CSD Discharging Onshore through Floating Pipe

Figure 22 CSD Discharging Onshore through Submerged Pipe

Depending on the layer thickness to be dredged and the characteristic of the materials, the CSD will cut and dredge the material in one and more layers. On an average 0.5 m vertical over depth will be dredged by the CSD. The dredging will be carried out by using the box-cut method and slopes will be allowed to fall to natural angle of repose. The example of box-cut cross section is as shown below.

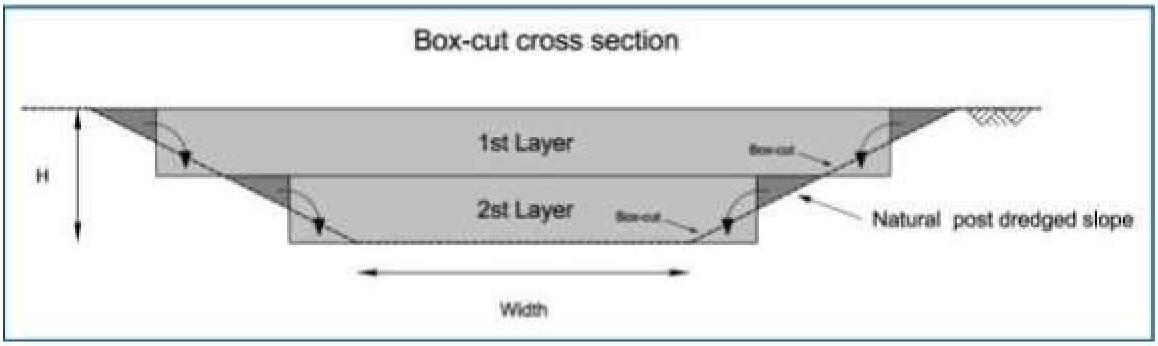


Figure 23 Principal of Box Cut Method

2.20.5 Maintenance Dredging

Based on the mathematical model studies on siltation for Phase 1, the average annual rate of siltation in the dredged areas will be about 7.01 million cum. The siltation rates are not uniform over the area under consideration and seems to vary based on the prevailing hydrodynamic conditions. The dredged material in channel and harbour basin would be disposed at the designated dumping site offshore.

The location of the disposal site which is in deep water (beyond 25 m contour). The disposal site is spread over an area of about 20 sq. km and the depth of dumping will be restricted to only 0.5 m.

2.21 Preliminary Design of Landside Structures

2.21.1 Working Level of Backup area

The finished levels of onshore areas are kept at +7.6 m CD. This level is considered adequate to avoid any flooding of site under the storm conditions and enable better planning of drainage system at site.

2.21.2 Reclamation

Reclamation would be needed for the access corridor from mainland and stacking areas for containers and breakbulk cargo. The reclamation level is proposed to be +7.6 m CD.

Reclamation must be carried out by allowing long passage for the material to settle down and reduce the spillage to bare minimum. Even then, it is expected that about 10% material out of the suitable fill placed would escape (i.e., escape of fines).

2.21.2.1 Source of Reclamation

The fill for reclamation work may be obtained from dredged areas and from external marine source suitable for reclamation. The dredged material will be controlled in order to avoid build-up of fine material and the potential for the formation areas of compressible fill within the reclamation. For underwater filling the fine content in fill material will be restricted to maximum 10%.

2.21.2.2 Reclamation Methodology

It is estimated that around 200 million m^3 of material will be required for reclamation in Phase 1. The dredged material suitable for reclamation is around 7 million m^3. The additional material of around 177 million m^3 over the required dredging quantity may be obtained by sourcing the fill material from external source/marine borrow pit.

The reclamation process comprises of creating bunds in the reclamation areas of suitable heights to receive the dredged material. Considering that most of the fill will be placed under water, the bunds will need to be formed of Rock/ boulders. Thereafter, the reclamation levels within the bunds are raised in suitable stages, to prevent overloading of the underlying subsoil. Placement of the reclamation fill will be mostly sub-aqueous i.e., in the water body, considering that the tidal levels in the area vary between +0.0 to +4.7 m CD. Between the elevations +4.7 to +5.0 m, the placement will be sub-aerial, i.e., in the air. The reclamation sequence should be such that there is no accumulation of silt/clay at one place. The western, northern, eastern, and southern retention bunds will be constructed by rock and boulders.

As the reclamation quantity is much higher, most of the fill for reclamation works will be obtained from external source. The reclamation fill material will be placed in layers with height of each layer is suitably limited to 1.5 to 2 m underwater. The sub aerial filling will be in suitable layers of thickness 200 mm to 300 mm to achieve the required compaction as mentioned the design requirements. Enough resting period will be provided for the subsoil to gain strength after each stage of filling.

The reclamation through dredged material is proposed to be carried out upto a level of +5.0 CD. Murrum fill/burrowed earth is proposed to be used for fill upto +7.0 followed by the pavement layers as per the design requirement.

2.21.2.3 Reclamation through Dredged Material

The suitable dredged materials will be discharged by the CSD into one of the reclamation areas. Prior to commencement of the dredging and reclamation works, land-based equipment will be used to install weir boxes in between the sea and reclamation bunds (where deemed necessary). Bunds will be constructed around each of the reclamation areas prior to start filling.

Permanent bund will be constructed partly by dredged materials and armour stones. The borders/edges (temporary bunds) of the various reclamation areas are pumped in by using hydraulic filling methods. As a result, the reclamation slopes will become natural angle of repose and will be in the order of approximately 1:7 in steepness.

After preparation of the reclamation area, the CSD will be connected to the shore connection point by means of a floating pipeline where required in combination with a submerged line. The shore connection point is installed as close as possible to the reclamation area. From this point, shore pipelines will transport the soil/water mixture to the reclamation area. The layout of the total pipeline trajectory will depend on the location of the shore connection, the local circumstances, the number of earth moving equipment available.

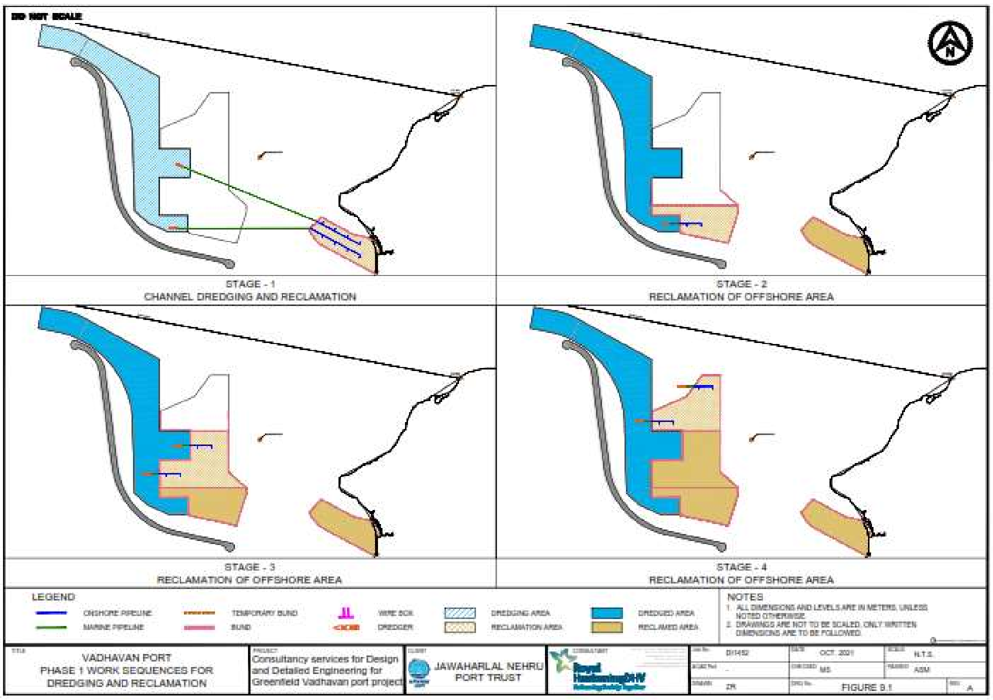


Figure 24 Phase 1 work sequence for dredging and reclamation

The reclamation areas to be filled in maximum six layers to final fill level (+5.0 m CD). Considering vast area of the reclamation, the uniform level is maintained with appropriate slope within the yard to maintain the gravity flow. Suitable sub-grade and pavement will be used on top of the fill level for a depth of around 0.80m. Land-based equipment will be used to spread and level the delivered materials. During the progress of the reclamation works the shore pipeline will be extended as the reclamation area is being filled with material and bunds will be raised.

On reaching the design fill level of +5.00 m CD, vibrating roller compaction is applied before placing of the surcharge loads (if required). This is in order to reach the required 95 % MDD (Maximum Dry Density) for the top 1.5 m of the fill. After a fill area is completed, parts of the shore pipeline can be disconnected and used at the next fill area.

In order to ensure continuity of dredging and reclamation process, the reclamation area is generally laid out in such a way that there are always different discharge points available. The pipeline trajectory is arranged in such a way that switching from the suitable to unsuitable reclamation area can be made quickly using valves system. This will create certain flexibility and provide the ability to respond to external factors.

The transport water will be guided through the reclamation area and in order to control the outflow of transport water from the reclamation area, Weir Box (or water boxes) is installed. With Weir boxes, the water level inside the reclamation areas can be controlled by means of changing the elevation of the weir box boards. By adjusting the weir level, the outflow of fines into the sea can be controlled. As a result, significantly more fines can be retained. A cross section of a weir box is shown below. This will also control the turbidity level of the sea water.

2.21.2.4 Borrow Material for Reclamation

Reclamation will be carried out by filling the area required using suitable material derived from land sources as well. For the proposed development mainly, it is planned to use the sourced good quality granular earth materials available in the nearby identified quarry. Since the quantity of reclamation is much greater than the dredging quantity which in turn is dependent on the suitability of dredged material for reclamation, it is considered that additional reclamation will be carried out by sourced earth. JNPA has identified a burrow pit at offshore of Daman Coast at around 50 km into sea from the proposed Vadhavan port for obtaining sand for creating reclaimed land at the proposed Vadhavan port. The marine sand will be dredged using Trailing Suction Hopper Dredger (TSHD) and the sand will be transported and dumped at the reclamation location.

The sourced materials for reclamation will be as per MORTH guidelines. Where filling or backfilling is to be placed under water, acceptable granular material or rock will be used. Acceptable granular material will consist of well graded, hard durable particles with maximum particle size not exceeding 75 mm. The material should be non-plastic having uniformity coefficient of not less than 10. The material placed in open water will be deposited by end tipping without compaction. The fine contents in the underwater filling will be controlled and should not exceed 10%. If hydraulic filling to be used.

The fill for reclamation work will be obtained from dredged areas and from external marine source suitable for reclamation. The dredged material will be controlled in order to avoid build-up of fine material and the potential for the formation areas of compressible fill within the reclamation. For underwater filling the fine content in fill material will be restricted to maximum 10%.

Geophysical investigations were carried out to locate the marine borrow pit which is located approximately 50 km from Vadhavan site. Suitable reclamation material is available to the north of the proposed port which can be dredged, transported, and used for reclamation from the area A1 and A2 shown in the figure below.

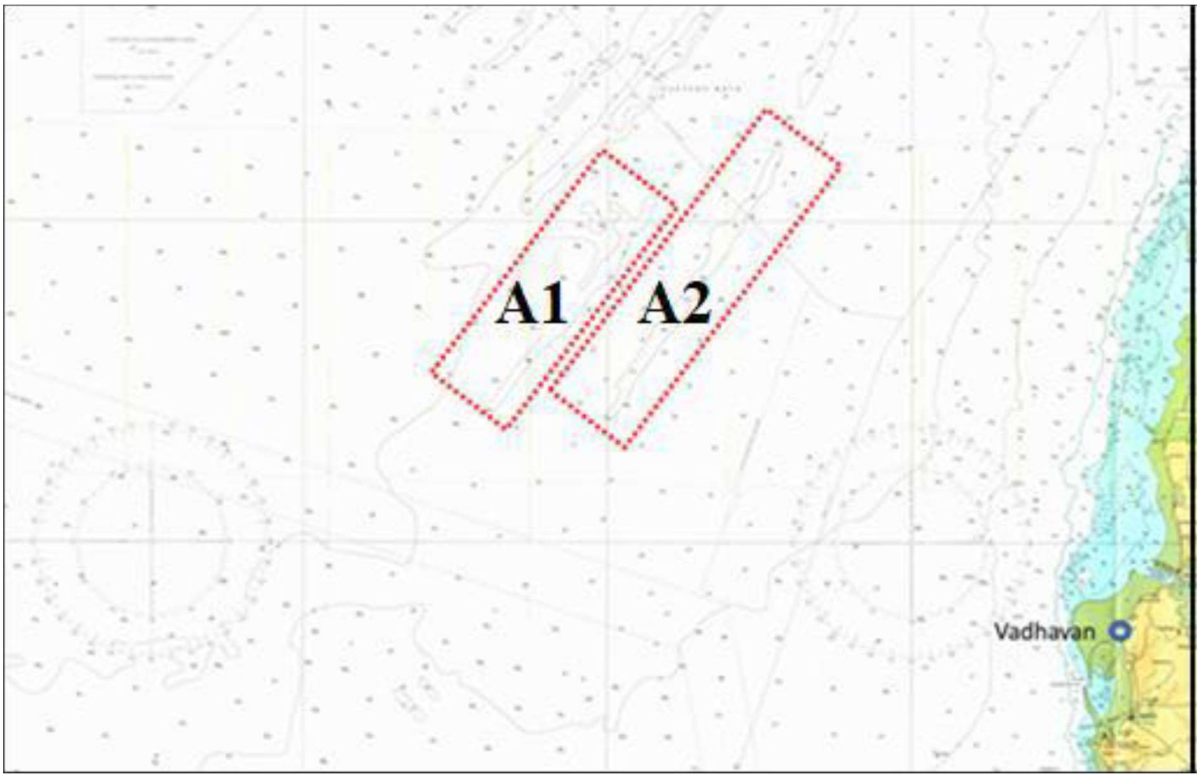


Figure 25: Location of Marine Borrow Pit

Figure 26: Location of Marine Borrow Pit

Good quality sand is available in this area. The pit is located along the shoals at the depth of 20-30 m formed by the deposits of the Narmada River discharge in the north in an area of 60 km × 4 km. The sea strata in this area comprise of sand and silty sand upto a depth of 6-8 m. The area is considered at present based on the geophysical investigation, however, in-case any site nearby the port location is identified the same will be utilised for sourcing the fill material. All necessary precautions will be taken will carrying out the dredging works from the sourcing location.

It is essential to study the dispersion of the silt and sand during dredging operations to ascertain its effect on the coastal sedimentation and shoreline changes if any. Hence a comprehensive simulation has been carried out by IIT Madras to simulate the hydrodynamic conditions and corresponding silt that escapes during the dredging using TSHD has been presented in this report.

Simulation study has been carried out to study the impact of sediment transport from the marine burro pit towards the coastal region of Vadhavan port. Following scenarios has been investigated.

(a) Sediment loss from the drag head of Trailing Suction Hopper dredger (TSHD)

(b) Overflow from Hopper

Sensitivity study has been carried out for 10%, 20% and 30% sediment loss.

As the marine burrow pit location far away from the coastal region approximately 50km to 60km with high tidal range and associated strong currents, the concentration of the sediment plume gets weakened immediately during the dredging activity.

The model simulation shows that the turbid plume does not reach the shore. Based on the above scenarios, it can be observed that, the plume trajectory of the dredged sediment does not move towards the coast, and they appear not to cause any impact on the shore and the marine environment.

DISPERSION OF SILT DURING DREDGING FROM MARINE BURROW PIT FOR RECLAMATION

Study on was conducted by IIT madras and report was submitted in October 2022 (Report attached as Annexure 9).

Conclusions and recommendations of IIT Madrea are as follows;

Simulation study has been carried out to study the impact of sediment transport from the marine burro pit towards the coastal region of Vadhavan port. Following scenarios has been investigated.

(a) Sediment loss from the drag head of Trailing Suction Hopper dredger (TSHD)

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As the marine burrow pit location far away from the coastal region approximately 50km to 60km with high tidal range and associated strong currents, the concentration of the sediment plume gets weakened immediately during the dredging activity.

The model simulation shows that the turbid plume does not reach the shore. Based on the above scenarios, it can be observed that, the plume trajectory of the dredged sediment does not move towards the coast, and they appear not to cause any impact on the shore and the marine environment.

2.21.3 Ground Improvements and Foundations

Container yard/ open storage for Various Cargo terminals

The Container yard/ open storage and the onshore facilities would be developed, by reclaiming the suitable dredged material comprising of silty sand. In order to consolidate the area, surcharge fill would be required. The surcharge is placed in various section of the reclaimed area for consolidation to avoid any liquefaction in conjunction with vibro-compaction. Apart from this no ground improvement would be required for the yard development.

Port Buildings and Covered Storages

Most of the port buildings are low rise buildings and it is expected that these can be safely founded on shallow foundation comprising of a combination of strip and isolated footing. However, the storage sheds, port operations and administration building would be supported on the piled foundation.

2.21.4 Internal Roads

Internal road connectivity of 32 km connecting various terminals will be developed by JNPA and the terminal operator will be develoiping the road within the individual terminals. The approach roads to the Container terminal and other cargo terminal area are designed taking into consideration the density of traffic and the wheel pressure of the tractor trailers, tankers, dumpers/trucks etc. All roads are designed to IRC Class AA standards. Most of the terminal roads will have two-way traffic. The truck lanes under the RTG as well as under the quay crane will have one-way traffic. The quay apron - yard movement will be anti-clockwise or clockwise based on the location of the berth, whereas the yard – gate/ rail yard movement will be clockwise.

Flyover for Trailer Movement

The main entry to the port will be through the gate complex located towards the east of the port. It may be noted that the proposed rail line entering the port is on the left side of proposed road corridor which require to cross the road inside the port to enter into the in-port rail yard. For the entry of external TTs to container terminals a flyover is proposed. This flyover allows the external trucks to enter and exit the container terminals without any criss-crossing the rail line and thereby maintain the seamless operations without any bottlenecks.

2.21.5 Container Terminal Infrastructure

Container Yard

Container Stack Area

For Phase 1, yard area of approximately 204 ha. for container stack will be designed for stacking 5.5 T/sqm (for upto 5 full container high stacks) for four container terminals. After consolidation of reclaimed dredge material, the yard area will be levelled, and fill material will be spread and compacted for base layer.

Proposed Yard Pavement

It is noted that no ground improvement is envisaged for the container and storage yard. It is therefore proposed that CBP solution be adopted for efficient handling and minimise the maintenance cost.

Pavement area of 204 ha. will be designed for stacking 5.5 T/sqm. After consolidation and removal of preload material, the yard area will be levelled, followed by fill material (CBR> 10), and compacted for the base layer. For area other than RTGC beam and cross over, the pavement consists of a Granular sub-base GSB layer 300 mm thick, GB layer of 300 mm, followed with 150 mm CBM layer of crushed rock and base course of 575 and 600 mm thick based on the loading conditions and functional requirements. Sand of 30mm thick is laid over the base course layer. The top layer of the stacking area will be paved with M50 cement concrete CC blocks of 100 mm thick. The precast concrete block paving is based on the guidelines of BPA Interpave manual for 5 stack high containers.

In the container yard, electrical conduits and pits are to be provided for cranes, HT electrical, general lighting, communications, and reefer arrangements. Also, miscellaneous works like kerbs, foundations for lighting, RTGC tie down are to be provided.

For the area covered around buildings (Light traffic areas) Asphalt roads have been proposed. The Asphalt topping is laid on the CBM3 base course

RTG Runways

For the movement of RTGCs, reinforced concrete beams of 500 mm thick are provided with sub-base layer of CBM3 (200 mm thick) material and crushed rock material. For RTGCs, turning pads with structural plates and inserts will be provided. A well compacted granular fill of 1.5 m deep with 1V:2H side slope, is provided below each RTG/RMC track, upto 2 m width, for underpinning the sub strata.

Reefer Gantries

Reefer containers are planned to be stacked up to 4 high. Plug in and plug out the power supply and monitoring the reefer container parameters are the operations carried out in each reefer boxes. To carry out these operations of reefer boxes which are stacked above ground level, an operation platform is required. Hence a galvanized iron gantry structure is planned in each slot to accommodate the power plugs as well as carry out operations. Under these platforms the compact substation and the reefer power distribution panels will be installed. From the reefer distribution panel along the platform structure the power cable will be laid for each reefer power plugs.

In-port Rail Yard

It is proposed to provide a common rail yard for the proposed container terminals at Vadhavan port in phases and at the end of the final phase the total length of track would be approximately 120 track km. It is proposed by JNPA that a Special Purpose Vehicle (SPV) will be appointed for the operation in the rail yard.

The basic purpose of this yard is to:

- Aggregate the containers from different terminals at one location to ensure faster turnaround timeof rakes.
- To allow handling of DFCC rakes which are double the length of current rakes.

The common rail terminal will have the following components:

- In rail yard there shall be sidings for receipt/dispatch of DFCC rakes, assumed to be of 1400 m length.
- Roads for movement of ITVs from the CY area and rail yard
- Stacking space for containers adjacent to rail yard
- RTGs at the rail yards area
- RMGCs at rail yard for loading and unloading of rakes
- ITVs, other equipment, and utilities.

Train coming to the port will be having locomotive with EOL (Engine on load) scheme of Indian Railways and the entire rail operation within port will be carried out by the same locomotive; no separate provision for dedicated locomotive/ shunting loco has been considered for rail yards in port.

2.21.6 Internal Rail Links

In-port rail yard for Container

In-port rail yard for Container is proposed to be developed in 3 phases commensurate with the projected traffic for the years 2030, 2040 and 2050 respectively.

- Phase 1 (2030)
  - In Phase 1, rail yard is proposed to comprise of two groups (clusters) of railway tracks viz Group A & B. Each group comprises of 6 lines for loading/unloading of container rakes and one line as sick line.
  - Total No. of lines in Phase 1: 12 container lines with CSR-1500 each and 2 sick lines with CSR140 each
- Phase 2 (2040)
  - In Phase 2, rail yard will have additional one group viz Group C comprising of 6 lines for loading/unloading of containers and 1 line as sick line.
  - Total additional no. of lines in Phase 2: 6 Container lines with CSR-1500 each & 1 sick line with CSR-140.
  - Hence total combined lines in Phase 1 (2030) and Phase 2 (2040) - 18 container lines with CSR1500 each and 3 sick lines with CSR -140 each.

- Phase 3 (2050)
  - In Phase 3, rail yard is proposed to add two more groups (clusters) viz Group D & E. Each group comprises of 6 lines for loading/unloading of container rakes and 1 line as sick line.
  - Total No. of new lines in Phase 3 (2050): 12 lines with CSR-1500 each and 2 lines with CSR-140 each.
  - After Phase 3, total no. of lines in rail yard will be 30 for container loading/unloading and 6 lines as sick line.

Provision of a sick line of 140 m long for each ‘group’ (cluster) has been made to take care of exigency of placement of sick wagons during day-to-day railway operations.

The schematic key plan of the proposed rail yard within the port is as indicated below.

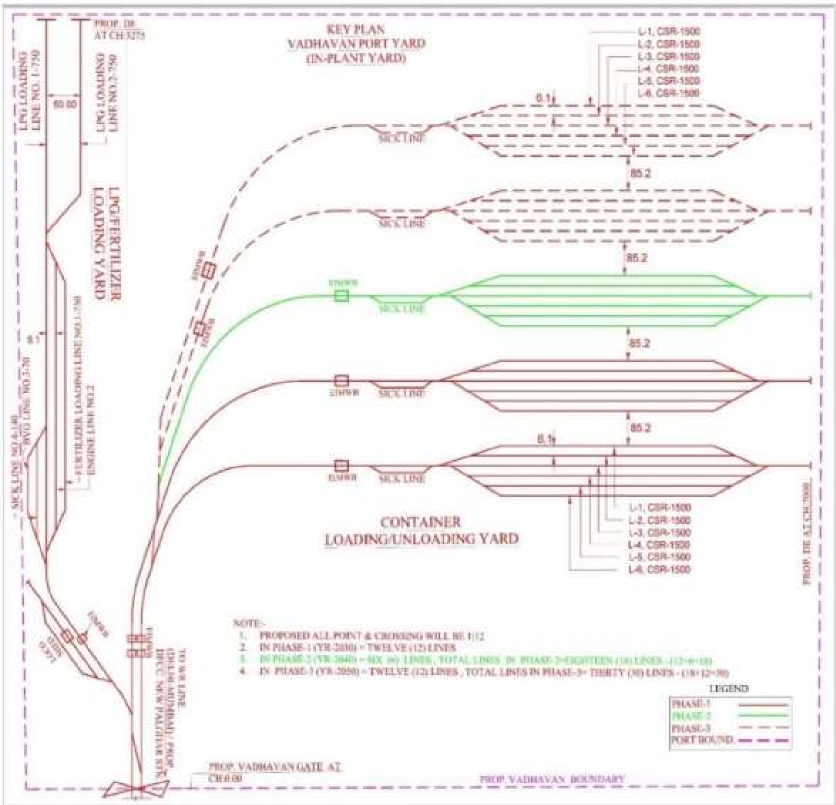


Figure 27 Schematic Key Plan of Vadhavan in port rail yard

In view of the seamless port operations, it is proposed that for Phase 1, 18 rail lines is recommended to be developed which would cater the Phase 1 and Phase 2 capacity.

Container Storage at in-port rail yard

For arriving at the facility requirements at the rail terminal following assumptions have been made:

- Maximum 5 high container stacking is assumed
- Dwell time of containers in the yard is taken as 1 day
- Total time for loading and unloading of each DFCC rake is limited to 5 hours including the switching time

The ground slots required in Phase 1 is 2,200 increasing to 6,300 in Phase 2.

Proposed Railyard Layout for Container Evacuation

The common rail yard shall be located in between the Container yards. The overall yard length is kept as 4750 m and width as 605 m. This would enable handling of DFCC Compliant rakes at this yard. The main line to the port segregates to the container terminal and liquid &

multipurpose terminal. The stacking areas are proposed adjacent to rail sidings with nested RMGCs and RTGs. The storage area in this yard shall be utilised for aggregation and separation of ICD traffic. The Phase 1 layout of common rail yard for container terminal is shown in Figure below.

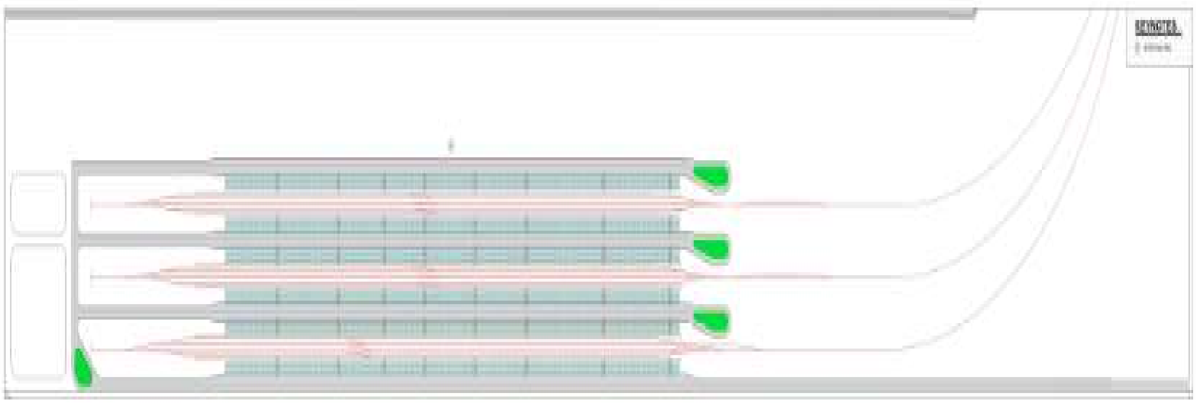


Figure 28 Phase 1 Layout of in-port Common Rail Yard for Container Terminals

Liquid/Fertilizer Yard

- Bulk Liquid yard has 2 line for loading of liquid rakes.
- Loco shed line is provided on liquid/Fertilizer lead line near port gate.
- Fertilizer yard has 4 lines for loading, engine reversal, brake van and sick lines.

The rail yard arrangement for other cargoes is as indicated below.

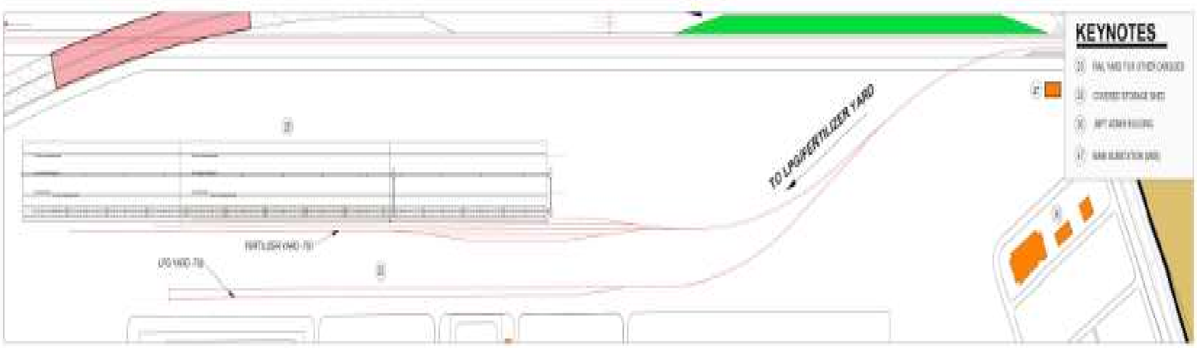


Figure 29 Rail yard arrangement for other cargoes

System Operation at Vadhavan Port Yard

Vadhavan Port yard consists of two separate yards viz Container & Liquid/Fertilizer yards for handling Container and liquid/ Fertilizer.

The container rakes of Vadhavan port will arrive at port yard from proposed New Palghar station of WDFC.The rakes will require reversal of engine inside Port yard for return movement from Port yard to New Palghar station. To avoid engine reversal of rakes in port yard, DFCCIL has proposed that Vadhavan Port rakes from WDFC will be placed at port yard with Electric locomotive at either end. The leading loco will be in 'operation' & the rear loco will be in 'dead condition'.

The container rail yard, loading of containers on 'BLC' wagons require operation from top by Rail Mounted Gantry Crane (RMGC). Hence, the yards earmarked for loading of containers cannot be 'Fully Electrified'. Only 'Top Wiring' will be provided i.e. electrification will be limited to the point which will not infringe use of RMGC and is safe from all other angles. On container handling line, rake can be placed only by 'Backing'. After reaching edge of container loading/unloading line, the leading electric loco will be switched off/dead and rear electric loco will be brought in operation. The rear loco will push the rake to container loading/unloading line through 'Top Wiring' provided at Vadhavan Port gate side of container loading/unloading line. After loading/unloading, the rake will require to be moved to New Palghar station. Now for movement of the rake, the original leading electric loco in dead condition will be at rear position and original rear electric loco will be in leading position for movement to New Palghar station.

For loading of liquid bulk tanker rakes which is carried out from top. Therefore, proposed rail yard for handling liquid cannot be 'Fully Electrified'. Only 'Top Wiring' will be provided till the 'Cut Off' location. Since fertilizer yard is proposed before liquid yard, the cut off location would be before the fertilizer yard.

Pavement in Container Rail Yard

The pavement in the rail yard will be same as that of container yard.

RMGC Runway in rail yard

For the movement of RMGCs in the rail yard, reinforced concrete beams of 500 mm thick are provided with sub-base layer of CBM3 material followed by a layer of lean concrete with subgrade and crushed rock material as subgrade as per MORTH specification. A well compacted granular fill of 1.5 m deep with 1V:2H side slope, is provided below each RMC track, for underpinning the sub strata.

2.21.7 Centralised Truck Parking Area

Considering the various terminals to be developed by various operators and the number of truck movements within the port, it is required to provide a centralised truck parking space close to the respective terminals. It may be noted that the number of ITVs required in Phase 1 is about 1307 (say (1300) increasing to 3542 (say 3600) in Phase 2. Considering the high number of ITV requirements, it is prudent to provide a centralised parking area. A total Parking area of 18 ha. In Phase 1 increasing to 49 ha. is proposed for parking of TT of various terminals.

2.21.8 Entry/Exit Gate Complex

The entry/exit gate has been planned as a two-step gate. A pre-gate will be constructed on the main terminal road which will have parking and facilities for truckers. Only drivers will be allowed to leave the pre-gate area and enter the main terminal gate. The main terminal gate has been provided at the east end of the port. It will consist of a gate canopy with six entry and six exit lanes with two bypass lane in each side for other cargo terminals and ODC in Phase 1 increasing to 26 entry and 26 exit gates over master plan horizon. The gate operations are planned to consist of three shifts of operations from Phase 1 itself considering the traffic movement. The proposed port is essentially to cater the gateway container terminal. The split of gateway traffic coming through road trucks is 68 % in Phase 1 and 64 % over the master plan horizon and 2050. Space has been provided for customs and other regulatory processes near the gate complex. Container scanning can be accommodated within the gate complex itself. Users other than the container trucks such as multipurpose, liquid, port staff etc. has been provided a dedicated lane in the gate complex.

Each container gate lane will be equipped with a weigh bridge that is used to measure and assess truck axle weights for enforcement of axle load highway rules.

Gate Complex

Controls access to and from the container handling and storage areas, and facilitates the transfer of responsibility for the cargo from one party to another and allows for:

- Exchange of information between truck drivers and the container terminal operator's gate clerks
- Verification of container transaction records
- Verification of customs information
- Physical inspection of containers as they enter and exit the terminal
  Inspection of container seals

Gate House

The area can accommodate parking for 175 trucks before the entry of the gate. Provision for additional parking area would be provided on the southern side of the gate complex. The pavement for the gate house area will be provided with a layer of GSB under CBM. 6 no. in-gates lanes and 6 no. out-gates lanes are to be provided for the container gate house area.

2.21.9 Terminal Fencing

Container terminal fencing will be provided as per ISPS requirements. The fencing is planned along the periphery of the individual terminals.

2.21.10 Port Buildings and Other Civil Structures

Suitable number of buildings as per the functional requirements shall be developed within the port in a dedicated area of 18,900 m^2. The following buildings are envisaged in the port for the Phase 1 and Masterplan development.

The list of common user buildings is mentioned below.

- Administrative Building
  - Customs Building
  - CISF Building
  - Police Station
- Port Operations Building
  - VTMS
  - Harbour master
  - Pilot and survey team
- Port user Building
- General Store
- Dispensary
- Restaurants
- Canteen
- Recreational Area like Theatre and shops
- Gate House Building
- Maintenance Workshop
- Fertilizer Shed
- Utility Buildings

- Main Substation Building
- Fire Station Building
- Pump House
- Overhead and underground tanks
- Communication and security
- STP

Details of port users (i.e., Concessionaire) buildings are given below. Since the terminals are operated by other parties there will separate port operations building for each concessionaire. Following set of buildings envisaged for the Phase 1 and Masterplan development.

The table below presents the building list for Phase 1 development plan.

Table 34 List of building envisaged for Concessionaire in Phase-1 development plan

List of Buildings	Container Terminals				Multipurpose Terminal	Ro-Ro Terminal	Bulk Liquid Terminal
	CT1	CT2	CT3	CT4			
Administrative Building	✓	✓	✓	✓	✓	✓	✓
Customs Building	✓	✓	✓	✓	✓	✓	✓
Gate House	✓	✓	✓	✓	✓	✓	✓
Maintenance Workshop	✓	✓	✓	✓	✓	✓	✓
Storage Shed	-	-	-	-	✓	-	-
Electric Substation	✓	✓	✓	✓	✓	✓	✓
Fire Pump House building	✓	✓	✓	✓	✓	✓	✓
Tank Forms	-	-	-	-	-	-	✓

The table below presents the overall building list during Master plan

Table 35 The overall building list during Master plan

List of Buildings	**Operating Terminal Buildings**											
	Container Terminals									**Multipurpose Terminal**	**Ro-Ro Terminal**	**Bulk Liquid Terminal**
	CT 1	**CT 2**	**CT 3**	**CT 4**	**CT 5**	**CT 6**	**CT 7**	**CT 8**	**CT 9**			
Administrative Building	√	√	√	√	√	√	√	√	√	√	√	√
Customs Building	√	√	√	√	√	√	√	√	√	√	√	√
Gate House	√	√	√	√	√	√	√	√	√	√	√	√
Maintenance Workshop	√	√	√	√	√	√	√	√	√	√	√	√
Storage Shed	-	-	-	-	-	-	-	-	-	√	-	-
Electric Substation	√	√	√	√	√	√	√	√	√	√	√	√
Fire Pump House building	√	√	√	√	√	√	√	√	√	√	√	√
Tank Forms	-	-	-	-	-	-	-	-	-	-	-	√

2.22 Rail and Road Corridor

2.22.1 External Rail Connectivity

The nearest railway stations to Vadhavan port along Western Dedicated Freight Corridor (WDFC) will be the proposed New Palghar crossing station of WDFC which runs parallel to Mumbai – Delhi western railway main line. WDFC is passing parallel to the existing western railway main line on east side in the same corridor. Vadhavan Port is located on west side of existing Mumbai – Delhi Railway line as well as the proposed Western DFC i.e., on the opposite/other side of Western DFC.

During the initial stage of the study, Progen-Pentacle suggested the rail through surface connectivity to Western Railway and Western Dedicated Freight Corridor (WDFC) from a Marshalling/ R&D yard located to the west of these lines. The existing WR Main line is already 'oversaturated' with line capacity of more than 150%. Hence, surface connectivity by 'puncturing' the WR Main line is not feasible. This was confirmed by Divisional Railway Manager (DRM), Mumbai Central, Western Railway, during the course of project meeting with

WR. Connectivity from Vadhavan in port rail yard to WDFC at proposed New Palghar station is only 'feasible' by crossing proposed WDFC main lines, existing WR main lines and the proposed MRVC lines by a 'Rail Fly Over (RFO)/ Rail-Over-Rail (ROR)' and then connect to WDFC network. WDFC is creating facilities at New Palghar station to accommodate 'Long haul container rake'. Vadhavan Port traffic arriving at New Palghar station will have direct connectivity to port yard through RFO/ROR. Further, the overwhelming majority of traffic from the Vadhavan port is 'Container' traffic which will be transported by 'Double Stacking' in 'Long Haul' trains. Dedicated Freight Corridors (DFC) in India are being developed specifically to fulfil the requirements of this type of transportation needs.

The railway alignment design of Vadhavan Port siding has considered "Design Criteria' compatible with DFC standards as well as those of Indian Railway. The cross section and other dimensional stipulations are in compliance with "Standard Schedule of Dimensions (BG) for Western Dedicated Freight Corridor of Indian Railways -2013".

Based on numerous meetings and discussions with various stakeholders, and the Consultant's own assessment as described above, the 'surface connectivity' by puncturing of main lines of WR and then connecting to Western DFC seems highly 'improbable'. Four 'Conceptual' Options for direct connectivity to WDFC have been identified as part of rail connectivity DPR for this port and accordingly, the recommended option is indicated as below.

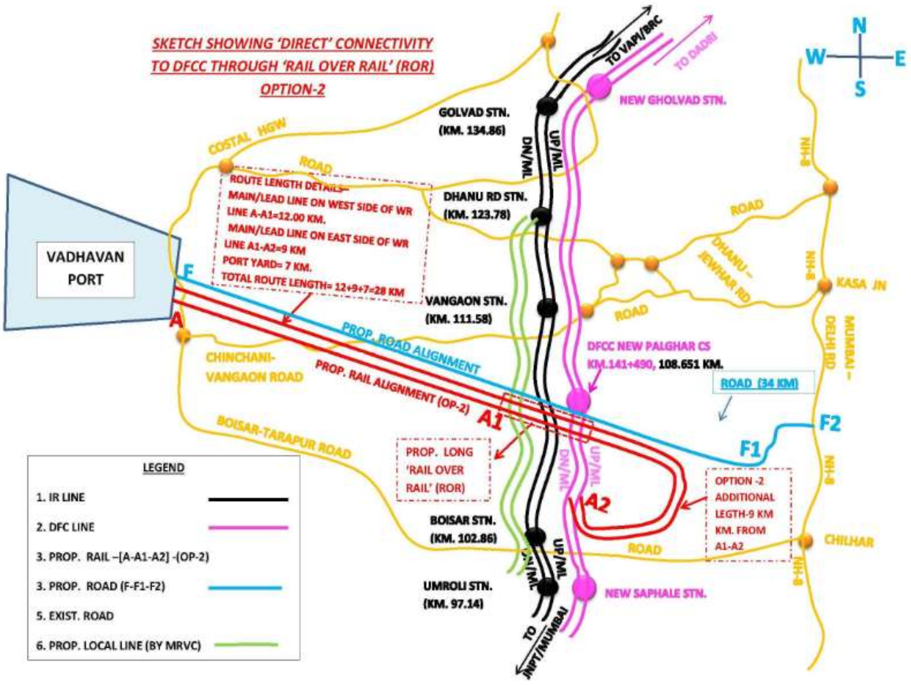


Figure 30 Sketch of 'Direct Connectivity to WDFC through 'ROR

The concept layout of the new Palghar Station along with the ROR crossing the DFCC, MVRC and WR line is as shown below

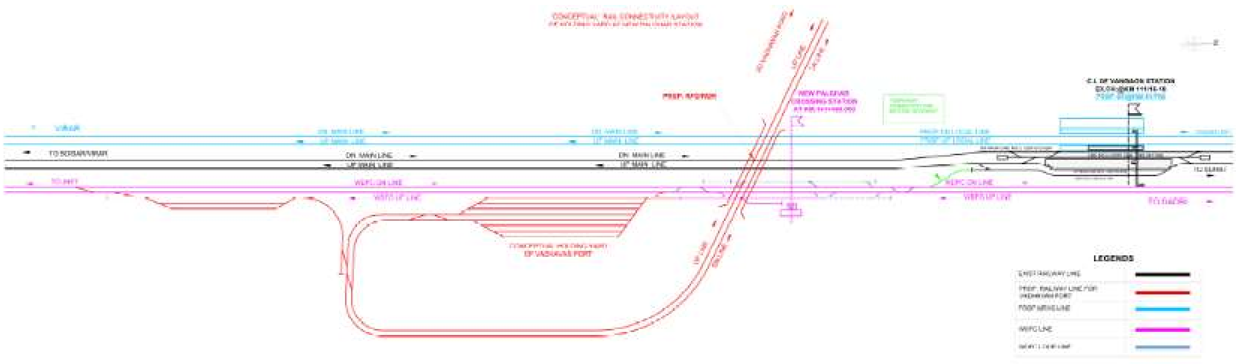


Figure 31 Concept Layout of ROR and New Palghar station arrangement

The rail link to Vadhavan Port will be a double line with automatic signalling to ensure that the trains can be moved efficiently.

It is estimated that around 42 trains per day would be calling into the port for the forecasted hinterland traffic for Phase 1 development.

2.23 External Road Connectivity

It is proposed to have a road connecting Vadhavan port to NH-48 and Mumbai-Vadodara expressway. For ease of study and design, the road alignment has been split into Three sections as under:

- From Varor (Vadhavan port) to Western Railway line - Ch. 0.00 to 12.00 km
- From Western Railway line to Surya River - Ch. 12.00 to 21.00 km
- From Surya River to NH-48 junction - Ch. 21.00 to 34.00 km

From Varor (Vadhavan port) to Western Railway line - Ch. 0.00 to 12.00 Km

- The proposed road starts from Varor (Vadhavan port).
- It crosses two (2) village roads near Varor and moves toward southeast.
- Again, it crosses five (5) village roads and crosses Chinchani - Vangaon road at CH: 8663.
- It crosses Suburban lines of WR (under construction by MRVC); Western Railway Mumbai – Delhi
- Main line, & Western Dedicated Freight Corridor Lines under construction at CH: 11310. ROB with

- approach roads will be provided at this location
- The route length of proposed road for this section is 12.00 km.
- The Vangaon Western railway station is 2.50 km from proposed road.
- The proposed road is. about 0.50 km away from DFCC-New Palghar crossing station

Figure 32 Varor (Vadhavan port) to Western Railway line- Ch. 0.00 to 12.00 Km

From Western Railway line to Surya River- Ch. 12.00 to 21.00 km

- After crossing the Railway lines, alignment moves southeast.
- Certain stretches of the terrain in this portion are hilly. Hence, the road alignment has been designed avoiding hilly areas (as shown in figure below).
- It crosses three (3) village roads near Hanuman Nagar.
- It crosses Vanai - Shigaon road at CH: 17420 and turns toward south.
- It crosses Shigaon road at CH: 19450 and moves toward east.
- It crosses Surya River of approx. 210 m with 400 m approach width at CH: 19510
- The route length of the road for this section is 9.00 km

Figure 33 Western Railway line to Surya River- Ch. 12.00 to 21.00 Km

From Surya River to NH-48 (Tawa junction)- Ch. 21.00 to 34.00 km

- After crossing Surya River alignment moves toward North.
- It crosses Mumbai-Vadodara expressway at CH: 22080 which is 8 lane Greenfield Project.
- It crosses stream of Surya river at CH:30220 & CH: 33520 of approx. width of 40 m & 25 m respectively.
- The proposed road alignment ends at NH-48 junction near Tawa.
- The route length of the road for this section is 14.00 km.
- The total length of the road/ expressway is about 34.00 km

Figure 34 Surya River to NH-48 junction- Ch. 21.00 to 34.00 km

Intersection and Junction

The road is planned as an entry restricted road connecting with Mumbai Vadodara Expressway and NH-48. The recommended connectivity is designed as per MORTH Guidelines for traffic transfer shown in the figure below

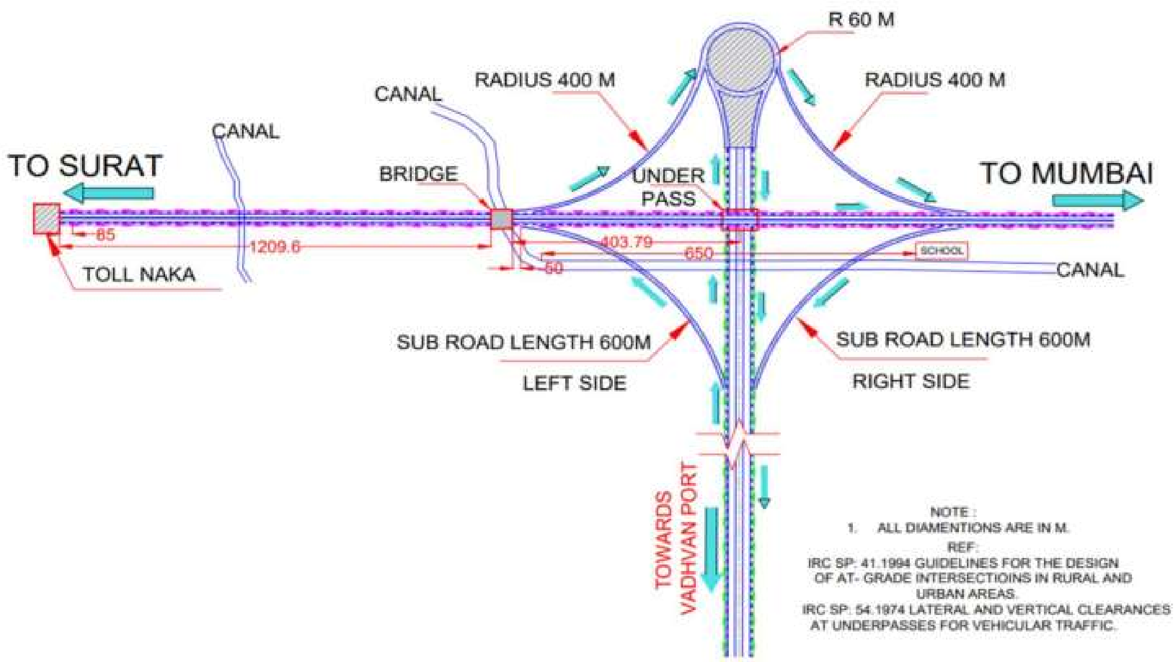


Figure 35 Recommended Connectivity to NH-48

The connectivity to Mumbai Vadodara expressway is as shown in the below figure

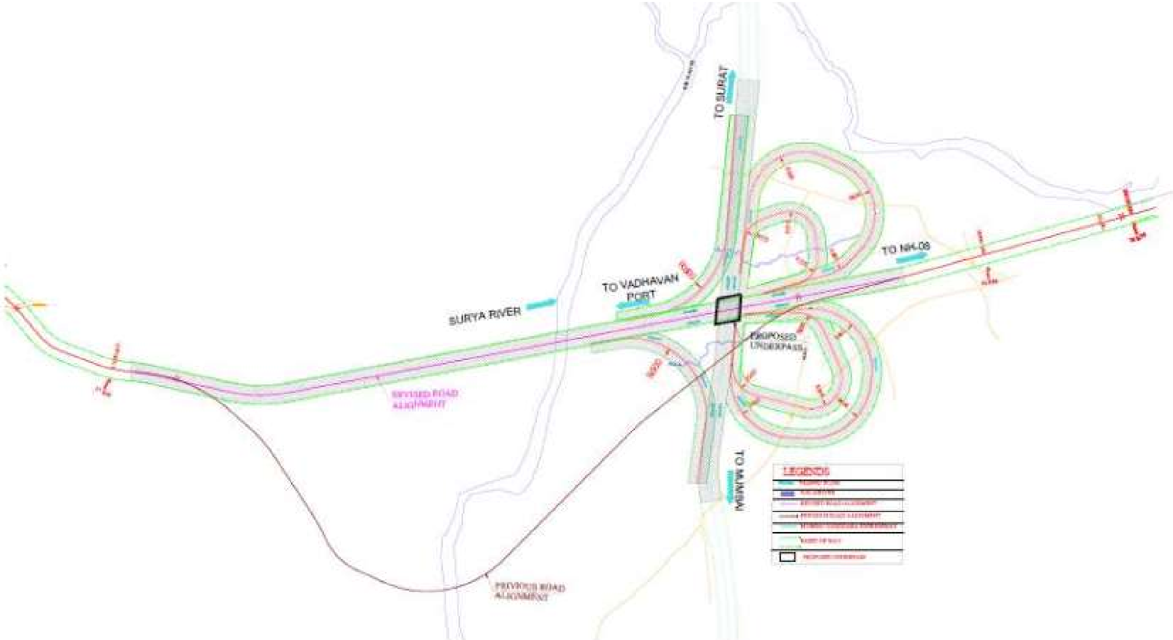


Figure 36 Recommended Connectivity to Mumbai-Vadodara Expressway

The port road crosses NH-48 via underpass.

- The proposed port formation level at the point of crossing is 39.340 m, ground level is 44.658 m.
- The existing level of NH-48 is 47.00 m at chainage 33.547 Km

The port road crosses expressway (Mumbai-Vadodara) via underpass.

- The proposed port formation level at the point of crossing is 25.407 m; Average ground level is 25.159 m.
- The proposed level of Mumbai-Vadodara Expressway is 28.89m at chainage 65.900 km, which has to be revised to Average 30.907 m by raising the expressway by 2.01 m for attaining the height of underpass for port road

Connectivity to Port

The connectivity of the port can be further divided in three portions.

- Road towards gate and container terminal,
- Road connecting JNPA Port Administration Building and
- Road connecting Multipurpose terminal, liquid terminal, and RORO terminal

- All roads will be merging with the road connecting port to the NH-48 and Mumbai Vadodara expressway.
- Road from custom gate to container terminals will be of 8 lane wide road and the other roads from gate complex to JNPA Port Administration Building will be of two-lane wide road. The 4-lane road from the gate complex bifurcate to the multipurpose/ liquid/terminal.

2.24 Terminal Equipment and Utilities

2.24.1 Terminal Handling Equipment

Container handling System

The Phase 1 development will have 4 container terminals with a total quay length of 4,000 m with each terminal of 1,000 m, which can cater minimum of 3 container ships at any time. It is proposed to provide 48 (12 at each terminal) Rail Mounted Quay Cranes (RMQCs) on these terminals. There would be flexibility of moving the quay cranes to the adjacent berths so that 2 to 5 cranes can be deployed on a ship, depending upon its size. For handling in the Container Yard 36 electric Rubber Tyred Gantry Cranes (e-RTGCs) are provided for each CY. Similarly, 5 Rail Mounted Gantry Cranes (RMGCs) are provided to handle containers being moved by rails. For movement of containers between quay, container yard and rail yard Internal Transport Vehicles (ITVs) are provided.

Container Terminal Equipment

Ship-to-Shore handling facility (Rail Mounted Quay Cranes - RMQCs)

These are rail mounted travelling cranes on quay provided as a ship-to-shore handling facility. They will have a front outreach of up to 72 m for handling upto 24,000 TEUs vessels. It is not envisaged to stack any containers on the quay except in emergency situations. The cranes will be provided with telescopic twin lift spreaders.

RTGs (Rubber Tired Gantry Cranes)

RTG cranes have long been the most common mode of operating worldwide in a container yard. As the name implies, these machines operate on rubber tires and can roam anywhere in the container yard. They typically run on reinforced concrete runways to minimize the rutting that can take place along the RTG travel paths.

Although, RTGs have traditionally been diesel powered, there is a major trend in the container handling industry to shift to electrically powered RTGs. RTGs can be powered from a cable reel but the most common electrical solution is an above ground bus bar power system.

Taking due care of the green nature of the proposed port, spatial provisions are provided in the planned development for E-RTGs (Electric RTGs) for container yard handling. It will run with zero emission compared to a diesel-powered RTG, a greenhouse gas emission free container yard operation and saving in energy costs on long run. Local NOX, PM, CO emissions can be reduced at greater level with use of E-RTGs.

RMGCs (Rail mounted gantry Cranes)

Loading / Unloading of containers on rakes will be done by Rail Mounted Gantry Cranes (RMGCs). They move on a straight rail track slightly longer than the length of the rake. This equipment has cantilevers at both end through which the containers are lifted from trailers and then loaded to wagons and vice versa.

The requirement of 5 RMGCs is calculated for Phase 1 based on the time required to clear a rake within the specified time. However, based on the operational requirement, a greater number of ITVs maybe deployed.

Reefer load container storage

Refrigerated loaded containers (reefers) are envisioned to be stored at the west end of the middle RTG stack row. The reefers will be stored for access via multi-level reefer racks, stacked to a maximum of five containers high. The racks will provide power and maintenance access. Reefers will be delivered and retrieved by ITVs.

Reefer racks provide grounded storage for reefers. Multi-level reefer racks are provided to allow mechanics access to plug and unplug units, to check reefer machinery status, and to perform low level maintenance and repair. Refrigerated loads are plugged into power receptacles, located on the reefer racks, to maintain temperature while stored in the container yard.

Empty reefer containers can be stored in designated areas of the empty storage area and/or the RTG container storage rows.

Empty reefers are plugged in and tested (pre-tripped) to confirm their operating condition. Pre-tripping can be done in the grounded reefer stacks

Empty container handlers

Empty containers will be block-stowed in grounded rows with containers stacked up to eleven-wide by six to seven high. Empty Container Handlers (ECHs) will service these rows

ECHs may include, at the discretion of the concessionaire:

- Medium-duty forklift trucks.
- Side-pick cranes.
- Top pick cranes.
- Reach-stacker cranes.

Side-Pick empty container handlers are recommended as the primary equipment for ECH operations. Should the concessionaire elect to do twin-picking of twenty foot boxes, a twin-pick reachstacker can be used in the proposed layout.

The dedicated empty storage area is provided at the rear of the individual container terminal yard area.

ECHs may transport empty containers over short distances to or from the container repair shop or reefer washout area. Containers will be transported between the quay and the empty storage areas by ITVs. Traffic through the ECH storage rows can be either unidirectional or bidirectional based on the preference of the operator.

Reach Stacker is the equipment used for handling containers within container yard and intermodal operation of the containers. It can transport containers for short distances and stack them in various rows depending on its access. In small to mid-size ports reach stackers are also used in the yard operation for stacking containers. Reach stacker has gained ground in container handling in rail yard because of its flexibility and ability to stack across rail tracks

Internal transfer vehicles (ITVs)

These are the vehicles used for cargo movement within the terminal area from berth to storage area and storage area to rail yard or vice-versa. Generally, trucks with a forty feet long trailer are used for container handling and dumper trucks are used for dry/ break bulk cargo. The battery-operated ITVs are also in practice in place of diesel-based ITVs in upcoming terminals developing on green and eco-friendly mechanisms.

ITVs requirement for container handling has been identified as 1317 no. for Phase 1 development of Vadhavan Port. The actual requirement and classification of the ITV procurement will be decided by the awarded terminal operator

Yard Service and Support

Reefer Wash Facility

A reefer wash facility is used to clean and sanitize the interiors and clean the exteriors of refrigerated containers using manually operated high-pressure hot spray washing machines.

The number of reefer wash slots required will depend on the operator's requirement. However, from the land use plan, the Reefer Wash Facility should be located adjacent to the Maintenance and Repair Building. All the buildings are provided to the shorter length of the individual terminals

This area shall be graded, and berm be made so that water and wash materials will be contained and flow to a sump equipped with an appropriate water separator and shut-off valves. Grading of the surrounding areas shall cause rainwater to drain away from the area.

Yard Equipment Parking

Yard equipment parking area is provided to allow for consolidated storage of inactive terminal equipment. This area is provided adjacent to workshop areas with easy access from the entry/exit gate so as not to interfere with terminal operations.

As shown in the terminal plan, this area is provided at the end of the terminal adjacent to the Maintenance and Repair Facility. Additional yard equipment parking is provided along the landside edge of the terminal adjacent to the terminal POV parking area.

Most powered vehicles will be fuelled at the Fuel Station in the parking area. Therefore, the pavement in these areas shall be graded so that spills are contained and flow to special drains and/or sumps provided with oil-water separators and drain shut-off valves.

POV Parking Areas

Parking spaces for management employees, visitors, and other personally owned vehicles (POVs) is provided on the gate entry/exit area of individual terminal. It is assumed that the yard personnel will arrive by port-operated bus service or personal vehicles. Additional POV parking is not provided for the yard personnel. Vehicle parking is provided inside the POV parking area.

2.24.2 Break bulk handling system

General/ Coastal cargo

The general cargo shall be loaded/ unloaded to the ships using two Mobile Harbour cranes on each berth. The transfer of material between the berth and storage area shall be by means of dumpers, which shall be loaded/unloaded by pay loaders/ front end loaders at the storage yard

Fertiliser

The fertilizer unloading from ship to shore can be carried out by a variety of arrangements like Gantry type grab unloaders, Mobile harbour cranes with grab and integrated hoppers due to the following reasons

- Flexibility to handle different grades of material and variety of cargoes unlike their compatibility issues with the screw unloaders
- Combination of MHCr and mobile hopper arrangement for loading trucks is proposed in Phase 1.
- Once sufficient traffic is realised the terminal can be converted for mechanised handling of the cargo.

Bulk Shed

The proposed bulk shed shall be mainly built using structural steel. Portals are kept at a distance of 12 m and to support the sheeting, extra portal is kept at 6 m transferring its load to main portal via tie girder. A small retaining wall shall be provided towards the stack so as to provide required profile to the floor to enable reclaiming by scrapper reclaimer. On top of the retaining wall, along the entire length, a small rail shall be provided to support one end of the mobile hopper, the other end of which shall be supported on the rails of scrapper reclaimer.

Bagging and Evacuation Requirements

The bulk material stored in the bulk shed will need to be transferred to the bagging shed for bagging and stitching. For this purpose, it is proposed to deploy a portal type scraper reclaimer at the bulk shed. This machine shall reclaim the material from the relevant stockpile and transfer it to the connected conveyor system. From conveyor the material shall be taken to the top of the bagging shed, where a series of hoppers shall be provided along its length. The material shall be dropped to the main hopper one by one using the plough feeders.

There shall be an intermediate floor in the bagging shed for the bagging and stitching of the fertilizers from where the bags shall be transferred to the platform level through chute. A total of 8 bagging machine shall be provided in the shed along its length. The bagging machines are proposed to be semiautomatic type with design capacity of 700 bags per hour each. With this system, it would take about 4 hours to bag the material for loading to one rake.

Bagging Plant and Wagon Loading Shed

A separate bagging plant cum wagon loading shed is proposed along the length of the southern boundary of the port. The overall width of the shed is taken as 23 m so as to provide cover to the wagons positioned for loading beside the shed platform. The overall length of shed is 700 m.

Bagging plant structure will also be a pre-engineered steel structure but will be designed without side and gable walls. It shall be designed as framed structure with bracing system and steel beams to serve as support to Bagging Plant unit. Adequate steel doors /rolling shutter and windows for natural lighting / ventilation shall be provided.

2.24.3 Liquid Bulk, Bulk Liquid Handling System

General

Liquid terminal is planned to handle Chemicals & Edible oil and Bulk Liquid. The liquid bulk, Bulk Liquid received in tanker will be unloaded at berth using the marine unloading arms and transferred to the tank farms by means of pipeline. The cargo is pumped directly from the vessel's pump. From the tank farms, the cargo wills bedispatched to the destinations by loading into trucks or through pipelines.

Marine Unloading Arms

For transfer of products from the tankers to shore, marine unloading arms will be provided. There will be two arms each for Chemicals, Edible Oil and Bulk Liquid with two arms as standby exclusively for Bulk Liquid. These arms are not interchangeable and hence the connections from these are made to the respective pipelines of the users. The marine arms will be designed to withstand a pressure of 16.0 Kg/cm2 while the normal operating pressure will be about 12.5 Kg/cm^2 under ambient temperature. However, the arms will be tested to withstand a maximum pressure of 24 Kg/cm 2. The capacity of these arms shall be a maximum discharge rate of 1,500 cum/hr.

Operating Envelope

The marine unloading arms are required to move in sync with the tankers' movement due to tidal variation, wave motion, drift due to currents and wind and variation in tanker's deck elevation during product discharge.

The arm should also accommodate the change in position of the tanker due to sway and surge. The other factors are the physical characteristics of the tanker manifold, the fender stand-off at the berth, the set-off of the arm from the face of the service platform, etc.

The proposed marine loading arms are therefore designed for an operating envelope based on the following conditions:

- The highest position of the tanker manifold considering the largest tanker at near empty condition during high tide.
- The lowest position of the tanker manifold considering the smallest tanker fully loaded during the lowest tide.

2.25 Power Supply and Distribution

The required electrical system for the project will consist of:

- The incoming electrical supply at 80 MVA level.
- 220/33 kV substations containing transformers, switchboards, control equipment, etc. to supply the electrical power to various parts of the site at the required voltage levels of 11kV or 6.6 kV & 0.415 kV.
- Control and Monitoring systems.
- 11 or 6.6 kV underground cabling system for medium voltage supply like for quay cranes etc.
- Fibre optic communications from the substation to the quay cranes.
- 0.415 kV cabling system from the 11 or 6.6 /0.415 kV substations to the reefer area. The cables should be run in cable trenches.
- Provision of underground power cabling to the buildings and gate complex shall be provided.
- Provision of underground power cabling to terminal light towers.

In addition, consideration of future electrical requirements of the terminal shall also be taken into account, and all necessary provisions shall be made in the design and installation of the electrical system, to take account of future requirements. This applies to switchboards, transformers, underground cabling system etc.

Details of the electrical load and demand requirements are as discussed in the section below

2.25.1 Electrical Load and Demand

The handling systems for containers are power intensive. Hence require considerable high-tension electrical power for their operation. The terminal development will contain all the features of a modern first-class terminal, and as such will require a reliable power supply system. The following energy requirements have been considered when defining the electrical supply requirements

High Voltage Supply

It is understood that the power to the site will be supplied at 220 kV through overhead double circuit transmission line which would be stepped down at 33 kV level through 4 numbers of 220/33 kV 50 MVA transformers.

It is envisaged that Medium Voltage (MV) supply at 6.6 kV or 11kV depending upon operators' requirement will be provided for the MV power requirements of container yard and terminal support facilities like;

- Power Supply to Quay cranes.
- Provision for Power Supply to ERTGs for yard operations

Low Voltage Supply

It is envisaged that Low Voltage (LV) supply at 415 V will be provided to each installation. LV requirements for the wharf and access include lighting, the operation of the fire pump house and miscellaneous LV power services.

The LV power requirements for the container yard and terminal support facilities include:

- Reefer Points,
- Yard Lighting,
- Miscellaneous LV power Requirements, and
- Power Supply to the Gate Complex and Terminal Buildings

Electrical Demand

The electrical demand for the Phase 1 development for Vadhavan Port is estimated to increase from 75 MVA in the Phase 1 development to about 150 MVA over the master plan horizon. The overall electrical demand will vary with the use of eRTGS with adequate provision for the electrical infrastructure at the terminal and "Cold Ironing" requirement. The estimated demand takes care into account the above requirement.

2.25.2 Source of Power Supply

Two locations of the nearest 220 kV source from PGCIL and Tarapur-Boisar power line were identified, which are 20km away from the port. Regarding tapping from Dahanu, it was discussed that 220 KV GIS bays would be available in near future however the generating station is already loaded and MSETCL will have to check availability of 80 MVA by 2023.

MSETCL has assured that 80 MVA will be available from Assangaon through a tapping from double circuit line, hence even if capacity is unavailable at Dahanu, reliable power supply at Vadhavan is ensured.

New 220 KV bays are required to be created by MSETCL at 220 KV switch yard in order to provide connectivity for 80 MVA Power at 220 KV through new power transmission line to the port from existing power lines.

Power supply to Vadhavan port can be brought through overhead transmission lines through a suitably selected route. The route to the port is one of the complex activities which involve the constraints to the alignments, obstructions, site level and geotechnical conditions. The feasibility study of the alignment needs to be taken up by MSETCL or relevant approved agency.

It is required to run a new receiving line to the port main receiving substation to draw the power load requirement for the port development activities and some critical loads such as emergency lighting, headed equipment of ELV systems etc

2.25.3 System Arrangement

The power will be made available from the selected source to Vadhavan by constructing a new 220/33 kV Main Receiving Switching Station (MRSS) along with dedicated GIS, outside the proposed Vadhavan port premises.

As per MSETCL, an area of 120m x 120m space is required for MRSS at Vadhavan port.

220 kV Transmission line shall be double circuit to have better reliability, each circuit shall be distributed using outdoor busbar distribution system to 2 feeders each for 1 no. of 30 MVA Transformer. Four transformers shall step down voltage to 33 kV for further distribution.

MRSS switchyard shall consist of metering, switching and protection devices to distribution company standards. From MRSS, power shall be distributed inside the port premises to Main Substation (MSS) using single core cables. MSS Switchboards shall be so arranged that substations (SB-1, SB-2, SB-3) each of 30 MVA capacity feeders with all redundant feeders connected to SB-4 which is spare / standby in case of failure of any of the transformer or the cable, for maximum reliability of power availability in case of equipment or cable failures

From MSS, power distribution will be to various substations, located at different terminals in ring formation in order to have higher reliability and minimize the probability of failure. For Phase 1 redundant feeders shall be used from SB-1, SB-2, and SB-4 and for Masterplan Phase, redundant feeders from SB-3 and SB-4 to have maximum utilisation thus providing reliability from both circuits.

Power Distribution for Container Terminal

Each container terminal will have Distribution Substation (DSS). The DSS will receive power from MSS at 33 kV using redundant ring feeders. Load demand for each container terminal is 9.6 MVA. Hence 2 no. 10 MVA Transformers shall be considered.

At the DSS, voltage will be stepped down to 11 kV or 6.6 kV (depending on operator) from 33 kV,11kV or 6.6 kV is considered ideal as RMQCs, eRTGs and RMGCs will operate on 11 kV or 6.6 kV. RMQCs and berth services will be supplied by 11 kV or 6.6 kV using redundant feeders through Berth Substations (BSS) with MV switchboards and 1 Packaged or Compact Substation (PSS) at berths.

eRTG and RMGC shall be fed at 6.6 kV from several distinct Substations (SS), depending upon location and number of RMGCs and eRTGs. SS will receive power from DSS at 6.6 kV.

Reefers shall have dedicated Reefer Substations (RSS), RSS will be Packaged Compact Substation consisting of RMU. RSS will step down to 0.415 kV from 6.6 kV for power distribution to Reefer Sockets. RSS shall vary depending upon number of Reefers.

Each Container terminal will have 1 no. Building & Services Substation (CBSS) for External Illumination, building services and utilities. CBSS will step down to 0.415 kV from 6.6 kV received from DSS. Each CBSSshall have APFC to achieve P.F of 0.95 at 415 V.

These requirements will vary from operator to operator, only infrastructure will be provided by the JNPA

Power Distribution for Multi-purpose Berths and STS Cranes

For berth side equipment there will be Berth Substation (BSS). The BSS will receive power from DSS at 11 kV or 6.6 kV using redundant ring feeders.

For STS cranes 11 kV or 6.6 kV feeders shall be used, Multipurpose berths 6.6 kV shall be used for Crane and further stepped down to 433 V for LV Loads. For Illumination and pumping loads 6.6 kV from shall be stepped down to 433V from BSS

These requirements will vary from operator to operator, only infrastructure will be provided by the JNPA

Power Distribution for Terminal Operation Services and Buildings

For overall terminal operations services and and Liquid Berths, there shall 1 no. strategically located Utility Substation (USS) consisting of 33 kV / 11 kV 10 MVA Transformers for services distribution, as follows:

11 kV feeders from USS shall be further distributed to Buildings, Utilities and Services. Depending upon location, some of these substations can be part of USS itself or if remotely located, a small Compact Substations (CSS) can be considered.

USS shall have dedicated DG sets for Emergency Loads for Terminal Operation Admin Building and some essential services of 1250 kVA.

These requirements will vary from operator to operator, only infrastructure will be provided by the JNPA

Power Distribution for Liquid Berths

USS will draw power at 33 kV from DSS. Other berths shall have dedicated substations (SS) connected in ring to the Berth Substation BSS-4 depending upon lowest loaded substation. SS shall receive power from BSS-4 at 11 kV, this is further stepped down to 0.415 kV for berth services. Each Berth shall have 1 dedicated D.G Set of 100% capacity for emergency use

2.25.4 Emergency Power Requirements

The diesel generator in the substation as well as installed at different locations shall have sufficient capacity to provide power for the following functions in the event of an interruption to power from the supply authority:

- The security, firefighting, and communication system.
- 25% of lighting in the Administration Building.
- 25% of lighting in the Workshop Offices.
- Computers of key staff as nominated by the Client.
- Computer system main server and back-up server UPS.
- All gates function.
- All Operations Team functions.
- The slow operation of 1 or 2 cranes acting simultaneously, for the purpose of installing back the vessel hatch covers.
- 25% of terminal flood lighting.
- Compact Substations (CSS) of Reefer Plug Points.

In addition, appropriate electrical connections shall be provided at the reefer area to allow the RTGs, acting as electrical generators, to supply power to reefers stacked at the terminal when needed.

DSS shall house 4 no. of 6.6 kV DGs each of about 1 MVA for Emergency power, for CBSS and Crane Emergency, DGs shall operate in Parallel. This will support closing operation of vessel during power failure as well as backup to Reefers and power functional requirements.

Each BSS shall have 1 dedicated D.G for Critical Loads. Sizing of the same will be detailed later.

DSS shall have Power Factor improvement at 6.6 kV itself, as all the loads are located at 6.6 kV and RSS being compact will not have APFCs. APFC shall be designed to achieve P.F of 0.95.

2.26 Water Supply and Distribution

2.26.1 Water Demand

The water demand for Vadhavan Port over the Master plan horizon has been worked out in the following Table.

Table 36 Estimated Water Demand over Master Plan Horizon

	Consumer	Demand (kL /day)	
		Phase 1	Master Plan (incremental)
A.	**Raw Water**		
	Greenery and Landscape	900	1,950
	Reefer Wash and Misc.	292	819
	Total Raw Water (A)	**1,192**	**2,769**
B.	**Potable Water**		
	Port Personnel, Users & Misc.	1,173	1,978
	Township	3,807	7,678
	Ship Supply	654	895
	Total Potable Water (B)	5,634	10,551
	Total (A + B)	**6,826**	**13,319**

It /can be seen from the table that daily water demand for the Phase 1 development is estimated to be around 6.8 MLD (million litres per day) and for the master plan phase, the anticipated demand is at 13.3 MLD. Out of this the potable water demand for port usage is 1.8 MLD in Phase 1 and 2.8 MLD in master plan phase, with the balance being the demand for raw water and supply to port township. A static storage of raw water of 1-day storage is provided for the port while half a day storage is provided for the township.

The proposed freshwater mains will mainly serve the purpose of potable water supply to the usage points. Since the raw water quality is a crucial parameter while deciding any treatment process, it is recommended to get the quantity and quality of available water analysed. The water treatment plant must ensure that it produces water of acceptable quality as per the provisions of IS 10500: 1991.

The water source identified for the port operations is Surya River about 22 km away from the proposed Vadhavan Port.

Maharashtra Jeevan Pradhikaran (Government of Maharashtra) will be facilitating the required water supply to Vadhavan Port.

2.26.2 Raw Water

The water supply for the port is combined with the requirement to provision water to the port township located outside the port boundary. The water required for the port is stored in various underground water tanks for Potable and firefighting purposes. The total underground water storage is designed to hold upto 2 days of port's cumulative water requirement. The untreated raw water is directly supplied to various firewater tanks to meet the requirements for various Terminals / Buildings.

Additionally, raw water is used to supply the sanitary flushing system, reefer wash and various miscellaneous uses including the supply for storage and utilities, workshops, and operational areas. Requirement for landscaping and green areas is primarily met by reuse of treated water from the sewage system.

2.26.3 Firewater

Separate firefighting facilities will be provided for all the port areas and facilities, viz, for

- Container terminals
- Chemical / edible oil terminal
- Bulk Liquid terminal
- Other Liquid terminal
- Ro-Ro terminal
- General & coastal cargo terminal
- Common user buildings and utilities

The system involves the distribution of firewater that comprises a seawater-based pumping and hydrant system for the jetty and approach trestles and freshwater based sprinkling and onshore hydrant system.

Separate raw-water fire pump houses and storage is provided for the closed loop hydrant systems for terminals, storage and yard areas with single/multiple heads located in such a manner that hose lines can effectively reach any part of the area.

2.26.4 Potable Water

Based on an assessment of the input supply of fresh water, a suitable water treatment plant will be selected before the water is pumped to an overhead tank for potable supply distribution. An underground reservoir in the port utility area stores the portable water required to accommodate the requirement of the port for 2 days of potable water supply. The capacity of the same is estimated to be approx. 550 m^3 as per Phase 1 requirements. Consideration of future potable water requirements of the terminal shall also be taken into account and all necessary provisions shall be made in the design and installation of the distribution system.

A pump house next to the main underground reservoir will supply water to one or more overhead tanks in order to have min. head of 30m at the foot of the tank and the cumulative storage capacity of the same will be one day's requirement of potable water demand for the buildings in their respective areas.

Gravity supply to the port users will be augmented with the use of booster pumps to supply potable water to the remote locations of the port.

2.26.5 Storage of Water Supply

RCC underground storage tanks will be used for designated storage of potable water, firewater and raw/recycled water for landscaping / miscellaneous uses. Overhead water tank is for gravity supply of potable water distribution system. Wherever overhead tanks on top of buildings are intended, prefabricated plastic tanks of appropriate capacity will be used

2.26.6 Distribution System

The distribution of the water shall be using the pressurised pumping system or the gravity system. System components and material of piping shall be compatible with the marine environment of the location. The pipes shall be cement lined where the sea water is used as conveying fluid. Proper wrapping and coating shall be provided on all underground pipes. The pipes routed underground shall be routed at sufficient depth to protect from heavy loads and this shall be as per codal requirements. The road crossings of buried shall be within RCC Hume pipes. All above ground pipe shall be supported suitably as the per the specifications.

2.26.7 Waste Water Management Plan

The sewerage system is limited to the areas wherever office buildings, canteens, and other operational buildings are constructed. For the isolated buildings where the quantity is negligible, it is proposed to setup STPs for disposal. STP of 5000KLD with Sequential Batch Reactor (SBR) Technology is proposed to be installed for phase -1. During monsoon months, the sludge will be stored separately in a storage structure with adequate capacity. The treated water will be recirculated for gardening and non drinking purposes. The sludge from the treatment plant will be processed and converted into Biomass used as manure.

There will be very little sewage water generated at the berths and hence separate treatment proposals are not contemplated. Portable sanitary cabins are proposed to be provided on the berths. Sewage from cabin-toilets shall be disposed to a septic tank and further treated by vacuum suction sewage trucks and handling equipment on a regular basis

Two pipe sewage systems with vent facility shall be provided for buildings in various terminals as per ASPE standard & NBC standard. The soil and waste will be carried down in separate independently vented pipes. The sanitary, waste & vent system will be watertight, and gas tight designed to prevent escape of foul gases and odour from various fixtures

The ships will not be allowed to discharge their sewage in the port complex. As per MARPOL convention, the ships are now required to have STP on board. Sewage generated from various buildings with-in a terminal shall be disposed to a Sewage treatment plant (STP) proposed near each terminal operator facility building / administration building. Treated water received from outlet of Sewage treatment plant shall be reused for flushing and landscaping / gardening.

A separate sewage treatment plant is required to be provided for township and the type of treatment will be as per the population and township conditions. Sewage is collected from various buildings and disposed through collection chambers, manholes and lifting station or through gravity as per the population and available site conditions.

The following parameters/ site conditions will be considered when designing the sewage system:

- natural slope of the area;
- layout of different facilities in the complex;
- sub-soil water table;
- soil conditions;
- provision of sewage lifting station;

  - provision of venting arrangement for manholes;
  - construction of manholes and laying of pipes considering ground conditions;
  - termination of vent cowl at terrace level;
  - provision of adequate slope for horizontal header in the under slung pipes especially for toilets

- The system will be designed as per design criteria stipulated in the "Manual for Sewerage & Treatment" published by the CPHEEO (Central Public Health and Environment Engineering Organization), Ministry of Urban Development, Govt. of India, IS-SP/35 (S&T)-1987 and National and International practices on the subject. The treated water properties shall meet the CPCB norms and the requirements of re-use.

- Following material for piping is proposed to be used in the sanitary system;
  - CPVC pipes in chases and in shafts
  - HDPE/UPVC material for sewage & drainage pipes within the core of the building

2.27 Drainage and Sewerage System

2.27.1 Stormwater Drainage System

The stormwater drainage system needs to be designed to minimize the potential pollution in the port basin. The rainy season persists during the Southwest monsoon. June to August is the wettest months of the year with an average rainfall in excess of 274 mm per month, with a maximum of 451 mm in July. The average annual rainfall is around 1163 mm. The average number of rainy days per year is 51 days. The maximum rainfall intensity assumed for the storm water drain assessment is 75 mm / hr.

It is proposed to lay the RCC trench drain parallel to the proposed internal road. All the drains will be via trenches and buried pipelines, which will be discharged out into the sea through various outfall points. These drains are connected through various cross drains bringing the water from the different areas of the terminals covering the port operational buildings.

A drainage system will be provided below the stacking area, with buried perforated drain lines. An impervious layer will be placed in the ground below these transverse drain lines. The storm water runoff from the yard area and adjacent roads will be collected, via trenches and buried pipelines. Following Figure shows a typical arrangement for drainage system over gravel bed container pavement

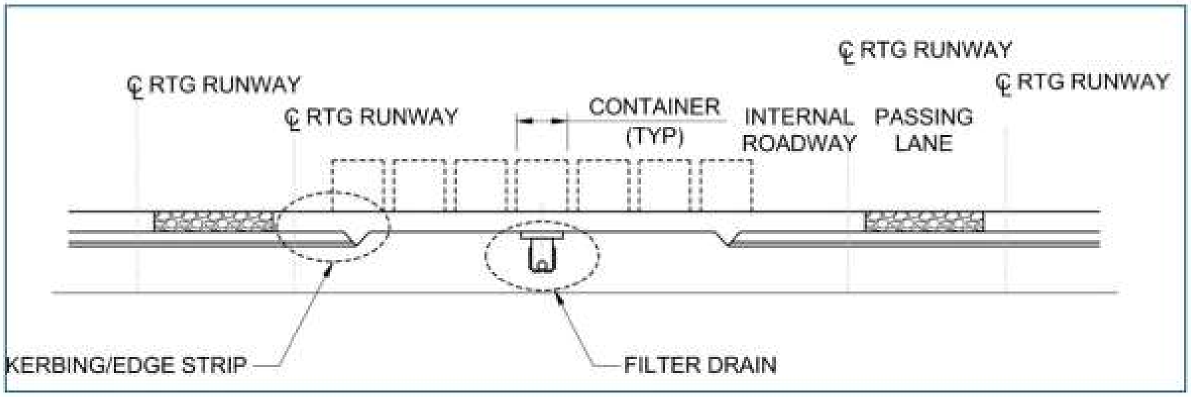


Figure 37 Typical Representation of Drainage in Container Yard

The storm water from the administrative offices, all terminal operator facility buildings, transit sheds and all other buildings from the different areas of the terminals will also be connected to the storm water drain. The wastewater collected from the workshop will be treated in an oil skimmer before disposing off to the storm water drain

2.27.2 Sewerage System

The sewerage system is limited to the areas wherever office buildings, canteens, and other operational buildings are constructed. For the isolated buildings where the quantity is negligible, it is proposed to construct septic tanks and connect the septic tank outlets to soak pits for disposal. The treated sewage shall be discharged to the main drainage network. During monsoon months, the sludge will be stored separately in a storage structure with adequate capacity. The treated water will be discharged into the main drainage system of the port. The sludge from the treatment plant will be processed and converted into Biomass used as manure.

There will be very little sewage water generated at the berths and hence separate treatment proposals are not contemplated. Portable sanitary cabins are proposed to be provided on the berths. Sewage from cabintoilets shall be disposed to a septic tank and further treated by vacuum suction sewage trucks and handling equipment on a regular basis.

Two pipe sewage systems with vent facility shall be provided for buildings in various terminals as per ASPE Standard & NBC standard. The soil and waste will be carried down in separate independently vented pipes.

The sanitary, waste & vent system will be watertight, and gas tight designed to prevent escape of foul gases and odour from various fixtures.

The ships will not be allowed to discharge their sewage in the port complex. As per MARPOL convention, the ships are now required to have STP on board. Sewage and sullage generated from various buildings with-in a terminal shall be disposed to a Sewage treatment plant (STP) proposed near each terminal operator facility building / administration building. Treated water received from outlet of Sewage treatment plant shall be reused for flushing and landscaping / gardening.

A separate sewage treatment plant is required to be provided for township and the type of treatment will be as per the population and township conditions. Sewage is collected from various buildings and disposed through collection chambers, manholes and lifting station or through gravity as per the population and available site conditions

The system will be designed as per design criteria stipulated in the "Manual for Sewerage & Treatment" published by the CPHEEO (Central Public Health and Environment Engineering Organization), Ministry of Urban Development, Govt. of India, IS-SP/35 (S&T)-1987 and National and International practices on the subject. The treated water properties shall meet the CPCB norms and the requirements of re-use. Following material for piping is proposed to be used in the sanitary system.

CPVC pipes in chases and in shafts

- HDPE/UPVC material for sewage & drainage pipes within the core of the building
- HDPE/ DI for external sewage disposal (manhole to manhole connection)

2.27.3 Solid Waste Management

The solid waste generation will be basically from 2 sources – cargo handling and the garbage/ human waste. It is estimated to be 2000kg/day of Municipal waste generation from port operations, which shall disposed off as per the Municipal Solid Waste Management Rules 2016 and the amendments thereof.

The cargo envisaged at the port is primarily container cargo. The garbage and human waste generation will be minimal and is proposed to be disposed off using the normal measures. The garbage will be carried through covered trucks and disposed at the designated dumping grounds in the locality. The port will have solid waste processing and disposal mechanism for management of wastes generated within the port.

2.28 Terminal Support Systems

2.28.1 Harbour Crafts

Tugs

The main activity of harbour tug is providing assistance to vessels entering / leaving the harbour, turning of the vessel in the harbour and the berthing / de-berthing operations.

Phase 1 development of Vadhavan Port envisages a creation of approximately 6.7 km long inner channel within breakwater dredged to -17.5 m CD depth and outer channel of 1.6 km dredged to -20 m CD with four container terminals for handling large size container vessels, 3 berths for handling multipurpose cargo, 4 berths for liquid bulk. The maximum size of the ships to call at this port during initial development is fully loaded 24,000 TEU container vessels. As per the results of the 3D ship navigation simulation studies carried out by DHI through Force, July 2018, for berthing / de-berthing of the design container vessels a minimum of two ASD tugs of 65T and two ASD tug of 100T bollard pull capacity are required along with 2 tugs on standby or instant use during vessel’s outbound departure channel transit

Mooring Launches

The main activities with these small boats are the transfer of mooring ropes between vessel and quay and transfer of mooring crew.

The mooring launches with good manoeuvrability will be about 10 m long with open deck and single screw.

The propulsion power shall be delivered by an electrically starting diesel engine of approximate 75-100 kW, driving the propeller shaft via a reverse reduction gearbox. Two mooring launches will be provided at the port.

Pilot cum Survey Vessels

Pilot boats transfer pilots to and from the incoming / outgoing vessels.

It is proposed to provide two all-weather type pilot launch. The pilot launch should be a twin screw with 15 to 20 m overall length and of steel construction. The speed range shall be 15-20 knots. The pilot launches will be provided with survey equipment and it can be used for hydrographic surveys and for buoy lights maintenance

The summary of the requirements of Harbour Crafts envisaged for the Phase 1 development of Vadhavan Port development are given in Table below based on the Ship Navigation Studies

Table 37 Harbour Craft Requirements for Phase 1 Development

S. No.	Harbour Craft	Phase 1 (No.)
1.	Tugs	
	– 65 T bollard pull	2
	– 100 T bollard pull	2
	– Standby tugs	2
2.	Mooring Launch	2
3.	Pilot cum Survey Vessels	2

Also, based on the simulation studies, it is also suggested that all the large and deep draft vessel berthing to Vadhavan port should have an operational ECDIS (Electronic Chart Display and Information System) and a Doppler side log mandatorily

2.28.2 Navigational Aids

Navigation aids for the port are required to ensure safe and efficient navigation of ships entering and leaving the port through the approach channel as well as berthing / un-berthing requirements inside the harbour. It is envisaged that navigation will be carried out throughout the year, by day and night, except during cyclonic weather. These aids will assist the captains and pilots in determining the position of vessel while transiting the navigational channel and manoeuvring inside the port.

The approach channel stretching from the breakwaters head to 20.0 m contour has a width of 732 m. The channel has a total length of about 4 km.

These aids as listed below are proposed to be installed on land or in water for guidance to all vessels for safe and regulated navigation in channels, basin, berths, and docks.

- Buoys
    - Fairway buoys
    - Port and Starboard buoys

- BEACONS and
- Vessel Traffic Management Information System (VTMIS)

VTMIS will have the requisite communication, Radar system integrated into it.

Fair Buoys, Port and Starboard Buoys

Fairway buoy (FB) marks the entry to the approach channel and indicates the location of the pilot boarding area. Hence the vessels calling at port should be able to detect the fairway buoy while approaching the port.

As per PIANC guidelines the maximum spacing of paired navigation buoys is 1 nautical mile. However, as per IALA guidelines the ideal spacing of paired buoys should be 3 times the width of the channel in the straight portion and 2.8 times the channel width in the curved portion of the channel. IALA maritime buoyage system as per Region A in which Vadhavan port falls will be followed. The lateral marks will be red and green colours to denote the port and starboard sides of channel.

A total of 11 buoys, which include 4 channel buoys i.e., 2 port side buoys (3m dia.) & 2 starboard buoys (3m dia.) would be required for the navigational purpose

BEACONS/ Breakwater Lights

Roundhead of the main breakwater will be provided with Beacon. It will also be provided with RACON. The structure would consist of 200mm CHS with an access ladder on mass concrete block foundation to reach light position

PAGA System

Public Address and General Alarm (PAGA) system shall confirm to NFPA 72. The PAGA system shall be designed for public annunciation and emergency evacuation. PAGA system shall consist of all the essential functionalities – such as system supervision, power amplifiers and switching, loudspeaker and line surveillance, digital message management.

PAGA system shall be capable of delivering a sound pressure level of 85 dB at the listening level for general areas and 100 dB at areas with higher noise levels, e.g., plant rooms, machine rooms and material handling areas.

Fire resistant cable which has low smoke properties shall be confirming to NFPA 72 shall be used (min 2.5 sq.mm. Cu.). The cable shall provide circuit integrity according to NFPA 72 and shall be fire resistant to IEC 60331

2.29 Communications

Radio Communications

The efficiency of port terminal operations depends on a speedy flow of information between the key personnel who are directly involved in the handling of cargo.

A radio communications system will need to be developed in order to handle the flow of information which passes between the personnel engaged in the following operations:

- Ship working duties.
- Quay crane and mobile equipment operations.
- Shore side duties.
- Control office.
- Terminal engineering services
- Operations management.
- Supervision; and
- Port Security.

In order to ensure an effective radio communication network, the port operations have been divided into the following four organizational segments each of which requires a dedicated radio channel(s):

- Ship work.
- Quay and Storage work.
- Control (base station); and
- Port Security/Customs

The system will need to reflect the importance of establishing and maintaining contact between the following areas of operation:

- Ship and crane
- Ship and quay/stacking yard/storage area(s)
- Ship and base station.
- Base station and engineers.

- Engineers and supervisors.
- Supervisors and all foremen, ship, and quay/stacking yard/storage area(s).
- Base station and supervisors.
- Management and supervisors; and
- Port security staff and customs officials.

For planning of the radio communication system, it is essential that the installations provided in Phase-1can be readily expanded in response to the future growth of the port.

Public Address System

The public address system will supplement the above two systems. The central control for the system will be kept with the control room.

The public address system would provide a comprehensive paging system for oral communication and announcement by loudspeakers covering all working areas of the port terminal. The loudspeakers would be mounted on purpose-built supports provided on permanent structures. The exterior speakers would be weather-proof.

CCTV and Access Control System

CCTV and Access control system shall consist of Layer-2 Access switches located at Admin. building and connected to various buildings with access switches by FO backbone network. CCTV and Access control monitors shall be located at gatehouse and Terminal Operations Admin building.

The CCTV system shall be designed to cover all the external areas of the project with IP-66 weatherproof PTZ / fixed cameras strategically located on high mast or dedicated CCTV poles as per requirement.

IP-66 Fixed type cameras shall be considered for strategic locations like Entry / Exit gates, security gates and entrances of buildings / structures etc. to monitor vehicular movement and personnel entry/exits

Indoor type PTZ/Fixed type cameras shall be considered for internal areas of building/structures as per operational requirement of the project and critical aspects of the room.

The gates and turnstile shall be considered with smart card reader. This Access control system shall enable only authorised personnel to enter/exit through the main gates.

Access control system shall be designed to secure the following areas with suitably sized access controllers in ACS panels to control the following.

- Inbound and Outbound gates with arm gates for each lane if any.
- Swing Gates
- Access gates for Container yard if any
- Car Park
- Staff Entrance
- Substations, offices etc.

CCTV & ACS unitized racks shall be located across various buildings and/or at CCTV masts consisting of suitable size FO patch panels, Ethernet switches, Power supply units (PSU) and Patch cords as required.

Final distribution to cameras shall be through CAT-6A Cables

Fire Fighting System

The firefighting system is to be designed to be capable of both controlling and extinguishing fires. There will be two types of system i.e.

- Sea Water and
- Fresh Water

The sea water system would broadly consist of a fire water intake to draw water from the sea, pump house with pumps, ground water monitors for all POL products, nozzles for water curtains along the front side of operating platform, hydrants, and distribution networks. The container and car carrier berths will also be covered under the sea water system.

A centralized fire station will be provided for attending to all calls which will house 5 mobile fire tenders. One fire tender will be provided with snorkel attachment.

Fire Alarm Bells will be located on permanent structures at strategic locations that can be heard by the terminal operators. Buildings where the hazard of fire and the occupancy are high will be provided with alarm bells (e.g., the workshop, administration building etc.). The fire alarm system will be activated by push buttons located at strategic places within the terminal areas and around the port's perimeter

Container / Multi-purpose / Ro-Ro Terminal

Being a deep-water port extending seawards from the mainland, seawater will be the primary mode of fire fighting for container, RO-RO, and general cargo berths. The onshore buildings, storage sheds will have separate freshwater based firefighting system. Each concessionaire will develop separate fire-water networks to independently operate and maintain the fire-fighting systems of their respective concession areas

System Requirement

The fire hydrant system is the principal means of the terminal fire protection system for major fire incidents. In this system, a solid jet of water is directed around the seat of fire. The extinguishing is affected by smothering and quenching the fire. The design of the system conforms to the guidelines of Fire Protection Manual and Rules for Water hydrants, Portable Fire Extinguishers etc., published by Tariff Advisory Committee (TAC). Wherever TAC does not address any issue, NFPA guidelines are to be followed

The system is designed in such a way that it can supply water under all conditions for firefighting purposes at the fire hose / hydrants points. For supply of fire water under all conditions of power supply, electric motor driven pump and diesel engine driven back-up pump are provided to ensure firewater availability under blackout conditions.

The hydrant system will have piped network supplying independent ring mains in the container terminal. The hydrant network with intermediate loops/ sub networks are provided with isolating valves so that water can be diverted from any damaged section to the point of use to maintain the continuous availability of fire water supply at all remote locations along with the optimum water pressure at the seat of fire.

Fire water pumps are to be optimally located within the concession areas to have independent sea-water intake and tap into the raw water network for storage and pumping systems.

As per TAC norms, considering ordinary hazard category, the pumping capacity selected should cater to a minimum of 3.5 kg/cm pressure at the remotest location.

All common duty pumps are fed from the fire water reservoir through a common suction header. The discharge is connected to a delivery header from where the hydrant mains are tapped off. Every yard hydrant point has a hose box along with accessories (02 x 15m long rubber lined firehoses, 01 branch pipe with nozzles for various fire applications) to be pedestal mounted alongside the jetties, trestles, and onshore hydrant locations.

Different types of portable fire extinguishers – DCP, AFFF, CO_2 based on the nature of the fire hazard are provided at significant locations like security cabin, admin building, sub stations, parking, and other areas.

Operation of hydrant system

Pipelines of the hydrant system will be charged with pressurized water up to the hydrant valves. Minor system leakages will be made up by replenishment of firewater, from jockey pumps. The jockey pumps will be stopped automatically through system interlocks in the pump control panel, on operation of Main fire pumps.

In the event of fire taking place or during routine fire drills, when the hydrant valves are opened, the water pressure in the system will fall rapidly. Water will be supplied by the jockey pump to make up this water loss but would be inadequate to meet the demand. As a result of this, water pressure in the main line will further fall and a signal from a pressure switch will start the motor driven main fire pump through the auto starting panel. If this pump is not adequate to meet the demand or if it does not start due to any fault, the pressure will further drop and the signal from another pressure switch will start the standby diesel engine driven pump. Based on the size of the terminal and usage, adequate back up to meet all eventualities of power supply and equipment availability will be catered.

Liquid Terminal

Sea water will be used for firefighting for the liquid terminal approach trestle and berths. The onshore buildings areas shall have separate fresh water based firefighting system.

The liquid terminal will be provided with fixed fire-fighting facilities according to the requirements of the following design codes and standards.

- TAC - Tariff Advisory Committee
- OISD - Oil Industries Safety Directorate
- NFPA - National Fire Protection Association
- TAC Fire Protection Manual - Latest Addition.
- OISD -116

- OISD -117

The hydrant system will be designed as per OSID/TAC for the Liquid Terminal considering it to be as “Highly Hazardous – Type A” risk.

The facilities include firewater pump house equipment, fire water distribution network and monitoring system, automatic (Mechanical) MVW Spray System with QBD Detection, fixed foam / water monitor with appropriate supply of bulk concentrate and portable / wheeled fire extinguishers.

System Requirement

The system design is adherent to OISD/TAC norms. As in ports with many terminals or in congested industrial locations, the local authority or port authority may provide the back-up fire-fighting capability. The type and quantity of fire-fighting equipment will be related to the terminal size and location, the frequency of terminal use, and the additional factors identified below.

In addition to statutory regulatory requirements, capability should be based on the general guidance of the local authorities and the outputs of a formal risk assessment. The risk assessment would consider the following criteria for each berth:

- The sizes of tankers that can be accommodated on the berth.
- Location of the terminal and the berth.
- Nature of the cargoes handled.
- Potential impact of oil spillage.
- Areas to be protected.
- Regional fire response capability.
- Level of training and experience of local emergency response organizations.

Distribution system

Where the firewater supply is obtained from a static storage, such as a tank or reservoir, then the reserve for firefighting purposes will be equivalent to at least 4 hours of continuous use at the maximum design capacity of the fire-fighting system. The reserve for firefighting, would normally be additional to that required by any other user taking water from the same static storage. The piping arrangements at such storage facilities should be arranged to prevent use of the firefighting reserve for other purposes and the integrity of the makeup water supply will be assured through the raw water network, with backup connection to the seawater network wherever necessary.

Fire water flow rates and pressures will be sufficient to cover both extinguishing and cooling water requirements for a fire that might realistically occur.

Permanent fire water mains and / or foam-water solution mains shall be installed in terminals and along the approach routes to berths. Mains will extend as near to the head of the terminal as possible and be provided with a number of accessible waters take-off (hydrant) points. The hydrant points will generally consist of headers with individually valve outlets fitted with a fire hose connection suitable for the particular type of fire hose coupling in use locally.

Isolating valves will be fitted to prevent the loss of all firefighting systems due to a single fracture or blockage of the fire-main network. The isolating valves shall be positioned so that, in the event of fire-main failure in the berth area, there will still be a supply at the berth approach. Where the berth fire-main is extended from a shore installation, an isolating valve(s) shall be provided at the shore side end of the jetty. Additional fire hydrants will be provided upstream of an isolating valve.

Fire-main construction materials should be compatible with the water supply. The minimum capacities and pressures for fire water mains are dependent upon whether the system is to be used for cooling or for the production of foam, and upon the length of jet required.

Fixed Foam system

The system will be designed for the foam concentrate to be properly proportioned and mixed with water downstream of fire water pumps and upstream of foam making equipment and application nozzles. Fixed pipelines for expanded (aerated) foam are not recommended because the fully developed foam cannot be projected effectively due to loss of kinetic energy and high frictional losses through such systems.

The type of foam concentrates selected, i.e., protein, fluoro-protein, Aqueous Film Forming Foam (AFFF), or alcohol/polar solvent resistant type concentrate (hydrocarbon surfactant type concentrate), will depend upon the fuel type and formulation, whether aspirating or non-aspirating equipment is installed and ease of re-supply. There are several systems that can be adopted for feeding foam concentrate into foam making equipment at the berths. Fixed water-cum-foam monitors (ground and tower mounted) are to be placed as per requirements to optimize bulk liquid terminal capability.

All monitors will be located at a min. 15 m away from the relevant equipment / structure under consideration.

Fixed Water Sprinkling System (MVWS / Deluge) Use of fire detection equipment that is designed to activate fixed fire-fighting equipment automatically is advisable where a terminal extends away from shore in such a way that manual firefighting is difficult, dangerous, or ineffective. The medium velocity fixed water sprinkling (MVWS) and Deluge spraying system for liquid bulk jetties and storage is automatically operated using Quartzoid Bulb Detectors (QBD), to activate the system.

The design of the medium velocity water / deluge sprinkling will be generally in accordance with the relevant OISD. The alarm system would have the capability to raise local audible and visual alarms and possibly a general alarm if the terminal is manned and depending upon local regulations. It will indicate an alarm at a continuously attended central fire control panel showing the location of the activated detection and fire extinguishing system activated.

The isolating valves to the fixed water system are to be manually operated with a status indicator to the fire control panel. Upon actuation of a detector, the detection system should sound a local alarm and send a signal to a continuously attended control panel. If conditions warrant, the fire protection system may be manually activated by an operator, the fire brigade, or by personnel who monitor the alarm. The electrical control and actuation system are designed with back-up electrical supply, to function under all eventualities.

System design flow rates and pressure limit range for the nozzle will be as per OISD.

Fire Extinguishers

Portable and wheeled fire extinguishers will be provided at all liquid bulk terminal berths and storage facilities on a scale relative to the size, location, and frequency of use of the facility. Portable fire extinguishers should be located so that a fire extinguisher can be reached without travelling more than 15m. Wheeled extinguishers will normally be located in accessible positions at each end of loading arm gantries or at the berth approach access point

Fire extinguisher locations will be permanent and conspicuously identified by luminous background paint or suitably coloured protective boxes or cabinets. The top or lifting handle of a fire extinguisher is normally not at a height of more than one meter.

Dry chemical extinguishers are recognized as the most appropriate type of extinguisher for the quick knockdown of small hydrocarbon fires. Carbon dioxide extinguishers have little value at berths or on jetties, except at points where minor electrical fires could occur. However, enclosed electrical sub-stations or switch rooms located within terminals should be equipped with an adequate number of carbon dioxide extinguishers or should have a fixed carbon dioxide system installed.

Foam extinguishers with a capacity in the order of 100 litres of pre-mix foam solution are suitable for use at berths. They are capable of producing approximately 1,000 litres of foam and provide a typical jet length of about 12m.

Fire Protection Summary

The design and planning of Fire Protection System will be done keeping in view the following criteria:

- National Building Code Sept 2005: Part IV for Fire Protection
- Local Byelaws
- Relevant BIS codes: Specifically, IS: 3044, IS: 5290 and IS: 5312, IS: 908 and IS: 2190, IS: 3844, IS: 15105
- TAC Manual
- Compliance to local Chief Fire Officer norms

The specific fire protection systems provided at each area are as follows

Table 38 Facility and type of Fire Protection

S. No	Area	Fire Protection type	
1.	Container & general cargo terminals	i.	Hydrant system
		ii.	Fire extinguishers
2.	LNG, LPG, Chemical terminals	i.	Hydrant system
		ii.	Medium velocity water spray system
		iii.	Fire extinguishers
		iv.	Jumbo curtain, Fire / Foam monitors, Deluge sprinkling systems
3.	Port Fire Station	i.	Water Tender
		ii.	Foam Tender
		iii.	FF gear and extinguishers

2.30 Security System

Security system of the port is required to provide sufficient protection against:

- Sabotage.
- Pilferage and thefts.
- Encroachments by unauthorized persons.
- Trespassers and antisocial elements.

The security system must comply with the requirements of ISPS Code. Keeping in view the importance of various areas in the port, the following proposals are made

Port boundary provided with a rubble masonry wall 2.4 m high with barbed wire fencing of 1 m high.

- Perimeter Fence CCTV System - comprising high sensitivity colour cameras
- A security office and check post at the entrance to the terminal.
- Provision of watch towers at suitable intervals for manual monitoring.
- Adequate Container scanners are provided to scan percentage of boxes as per security plan.
- Radiation Portal Monitors (RPM) for the screening of vehicles and cargo for detection of illicit sources.
- Adequate isolated area would be allocated for storage of dangerous goods.
- The lighting in the port area shall be to the acceptable standards.

For Phase 1 development, it is proposed that the boundary wall be constructed only around the reclaimed land area to avoid any trespassing of the locals and port safety point of view.

The security arrangements proposed would have to be to the approval of the Director General of shipping who is the designated authority under the ISPS code.

2.31 Green Port Initiatives

The proposed port at Vadhavan aims to provide long-term commitment, strong policy push, innovation, and alignment of interests and business philosophies along with serious investment in technologies, systems, and manpower in order to achieve this objective set out in developing the vision of the port by JNPA. These sustainable solutions will range from analysis of climate change risk and resiliency at the planning stage for; (i) Renewable energy, (ii) Alternative energy sources, (iii) Cold Ironing / Shore power supply, (iv) Efficient port operations, (v) Other green initiatives and thereby achieving reduction in carbon footprints and energy costs during the operations phase.

2.31.1 Renewable energy:

- In MIV 2030 Ministry has set a target of increasing the share of renewable energy at ports to >60%.
- Under a 'green port' initiative, the Shipping Ministry had directed all the major ports to install grid connected and roof-top solar and wind power projects to facilitate day-to-day operations including supplying shore-power to visiting ships in an ecofriendly manner.
- Using renewable energy also helps ports cut power bills – a key operating cost – which in turn translates into lower vessel- and cargo-related charges.
- The Clean Power Opportunities in Ports are as below:
    - **Setting up projects for energy generation for renewable energy sources:** Roof top Solar panels and open space will be utilized for energy generation for renewable energy sources e.g. (i) Solar canopies over all auto parking, on roofs of terminal buildings and along port roadways/ right-of-way. (ii) Wind turbines on port land or offshore near port areas / along the approach bridge. For Vadhavan port, the installation of windmills along the approach trestle can be explored and a feasibility of exploring this option of energy can be assessed separately.
    - Encouraging third parties (Vessel operator's / Terminal operator's) to take power from clean energy sources by providing incentives and integrating clauses in Lease and Concession agreement.
    - Terminal operators to purchase power through Open Access and from renewable sources so as to achieve the target of minimum 60% of energy from renewable sources

2.31.2 Alternative energy sources:

- **Electric RTGs:** It is proposed to utilize fully electrified RTGs at the port. These RTGs provide significant reduction in fuel consumptions as well as emissions (both air and noise). Several Asian, European, and North American ports including the JN Port in India have already converted diesel RTGs to electric RTGs / acquired electric RTGs. In E-RTGCs, a smaller size of diesel engines are provided for travelling of

RTG while shifting from one yard to another. This diesel engine can also be eliminated by making use of batteries.

- **Intra-Terminal Vehicles (ITV):** The ITV fleet will comprise of a mix of OTHER LIQUID based and efficient low Sulphur diesel vehicles. The ITVs comprise most of the vehicle movement within a container terminal and the proposed port fleet will provide a considerable reduction in emissions compared to a typical diesel engine fleet. In the future, the fleet can also include hybrid and electric vehicles. The hybrid and electric technology are expected to eliminate emissions during idling. Necessary bunkering facility for OTHER LIQUID needs to be created inside port premises. Successful projects including this technology have been considered at ports including Port of Los Angeles and Long Beach in California, USA. Several European ports are exploring use of biofuels and bio-mass gases as alternate ways to power these vehicles.
- Usage of E-buses and E- cars within the port for port operational personnel. Provision of necessary EV charging infrastructure shall be made.
- **Electric Quay Cranes:** All the quay cranes for the container as well as the future multi-cargo terminals will be fully electrified. The electric quay cranes have been successfully adopted by most of the new port developments and result in significant reduction in emissions compared to their diesel counterparts in addition to providing higher productivity.
- All equipment including Auxiliary equipment shall be operating on either electric or non-conventional clean fuel.
- Standby generator shall be operated by using clean fuel.

2.31.3 Cold Ironing / Shore power supply:

- VPPL will provide shore power supply to tugs and port crafts.
- Berths will be designed compatible to accommodate shore power equipment. The proposed port can utilize the practice of cold ironing at the berths. This concept avoids the use of ship’s engines which burn heavy fuel oil and replaces it with alternative sources of power for a berthed ship. Electrical plug-ins will be provided along the berths for ships while they are berthed.
- In addition, shore power shall be purchased from Open Access through renewable / hybrid sources.

- It has been observed that this technology has shown an average reduction of 90 percent in nitrogen oxide (NOx), Sulphur oxide (SOx), and particulate matter (PM) per vessel call in ports where it is implemented.

2.31.4 Efficient port operations:

- **Port Automation:** The port automation can be categorized into two levels of automation in container terminals.
    - Fully automated and
    - semi-automated.

  When the stacking yard and horizontal transfers between the quay and the yard are all automated, the container terminal is fully automated. Automation that has begun in the stacking yard but has not reached the quay all in one process is semi-automatic.

- **Interventions to Improve Productivity to reduce GHG emissions:**
    - Online port management system that will capture all information on port calls, nautical services, cargo, assets and provides operational decision support
    - Digital asset management solution for ports to monitor asset health, and support predictive maintenance (e.g., smart quay walls) to improve the overall efficiency of the ports.

- **Modern Efficient Operations reduce Emissions & Fuel consumption:** A modern operation at the port utilizing the state-of-the-art IT technologies will avoid bottlenecks and reduce queuing, idling, and dwelling of port equipment resulting in significant reduction in emissions and result in energy saving. A performance evaluation system may also be established as part of maintenance system at the port which will observe and evaluate various port equipment on fuel economy, emissions, and operator baseline performance.

- **Gate Technology:** Street Trucks Emit a Large Fraction of Port Pollution. Appointments and Gate Technology can Reduce Street Truck Time on Terminal.

- Ports and operators have little control over emissions per hour from street trucks
- Terminals can be operated to minimize the time spent on terminal
- Appointments to smooth congestion and to re-handle in advance
- Automated data capture at entry and exit gate to reduce gate time

- **Bigger Vessels:** The proposed port can handle the world's biggest container vessels of 24,000 TEU. These bigger vessels have fewer emissions compared to smaller vessels (up to 14,000 TEUs currently used in Indian ports) proportionate to their cargo.

- **Automated mooring systems:** Vessels generate a large fraction of total port pollution. Automatic Mooring Systems Reduce Ship Idle Time During Manual Line Handling. Techniques to reduce vessel emissions are as below.

  - Electric shore power for hoteling of vessels (AMP)
  - Use of alternate fuels on vessel when in port
  - Reduce the amount of time vessels spend in port via automated mooring devices
  - Voluntary or mandatory speed reduction near the port

- Explore the facility of operating flotillas on dual power like low sulpher fuel and Other Liquid.

2.31.5 Other green initiatives:

- **Green Buildings:** Green building (also known as green construction or sustainable building) refers to both a structure and the application of processes that are environmentally responsible and resource efficient throughout a building's life cycle. These buildings will be designed and constructed based on sustainability and green building principles. The vision is to conserve energy & water, reduce waste, renewable Energy generation, reduce urban heat island effect and use sustainable materials. Minimum 3-Star GRIHA rating for these buildings shall be obtained with due compliance to various criteria stipulated under GRIHA Version 2019.

The sustainability measures should aim to achieve IGBC rating equivalent to LEEDS Gold. Overall goal for sustainability to ensure:

- Use minimum (a) energy in its functioning by its shape and form.
- Generate its own energy as much as possible.

- **Smart Street Light Control System:** The issue of large energy consumption is a concern not only at a local level. The constantly increasing number has made lighting responsible for a staggering 19% of global electricity usage and is contributing towards the already exceeding levels of CO_2 emissions. Functions such as on/off/dimming are the basics of any connected lighting system. Autonomous operation, adaptive lighting and maintenance optimization can further support the cause of smart street lighting. Port can opt for diverse smart street lighting control systems, streetlight remote control software solutions or communication technologies to build connected street lighting infrastructures. Also, highly efficient LED / LEP lamps shall be considered in place of conventional high pressure sodium / metal halide lamps for yard / street illumination.
- **Storm Water Treatment system:** The proposed port is planned to have its own storm water runoff collection system by providing renewable system to collect and treat the storm water. It will treat oil contaminated rainwater (runoff) from impervious areas, e.g., roads, yard areas and will be spread throughout the port area.
- **Waste Management system:** In order to avoid and minimize the potential effects of generated wastes, the port will develop and implement a port waste management plan to provide adequate reception facilities for oil, chemical and garbage wastes, and remove, as far as is practicable, any disincentives to landing waste in the port. As part of this process the port will encourage responsible management of waste, including minimization and recycling, at the point of generation on ships, reception in ports, transportation, and disposal, and ensure that port employees and users dispose of garbage and other wastes responsibly in facilities provided and report any spills or large pieces of floating garbage to the port authority. Solid Waste Management Facility will be setup as per SWM rule 2016 for port users. Reception facilities for MARPOL annex - 1, 2, 5 & 6 will be provided to vessels calling Vadhavan Port.
    - Recycling of waste water.
    - Rain water harvesting.

2.31.6 Sustainability during design / construction phase:

Factors considered and mitigated as appropriate in designing and constructing waterfront structures commonly include, but are not limited to:

- **Site selection, design, and configuration:** The potential for material reuse, access to rail and multi-modal transportation networks, vulnerability to flooding and sea level rise, storm-water best management practices, impact to marine environment and native species, and impacts on the surrounding community including light and noise pollution.
- **Material selection:** Focus on durability in addition to reuse of dredged materials, use of recycled, re-used, sustainably harvested, or locally sourced content where possible, and avoidance of toxic or hazardous materials.
- **Construction Stage:** During construction stage, various sustainable solutions are envisaged for the port. Green additives will be added to our concrete mixtures for almost all specifications. Additives such as fly ash, blast furnace slag, and silica fume are by-products in the combustion of various materials. The use of these materials offers tremendous potential to alleviate their placement in landfills. In addition, because the carbon emissions generated by fly ash are significantly less than that generated by an equal weight of cement, "greenhouse gas" production is reduced. Moreover, these additives enhance the properties of concrete, including its durability, performance, and resistance to corrosion caused by sulphates and chlorides. Steel buildings are considered green structures because 100% of the material can be recycled once its life cycle has been reached. The Port would also incorporate the use of recycled steel, or steel with recycled content, into construction projects whenever possible. The proposed port will require dredging activities and this dredge material will be utilized to the full extent possible for reclaiming the port area and low-lying areas within the port. This will avoid the need for transporting material from far flung areas.

Acquisition of energy efficient equipment.

2.32 Rock Quarrying and Transportation

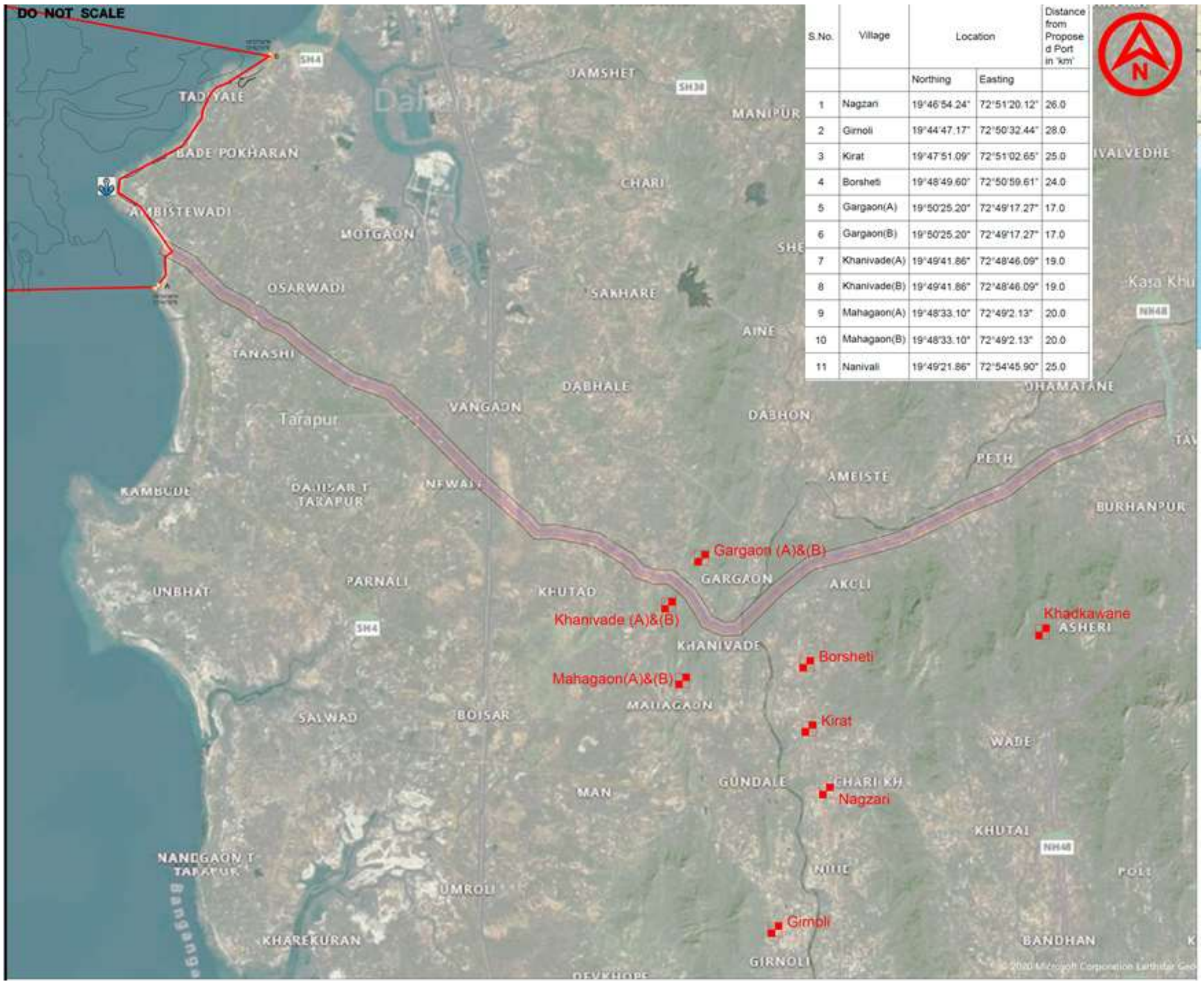
The development of port facilities at Vadhavan would require huge quantity of rock and aggregates for construction of various port structures. The details of the requirements are as indicated below

Table 39 Rock and stone quantity requirement

S. No.	Component	Quantity (Million T)
1.	Breakwater	32.10
2.	Shore protection bund	16.40
3.	Murrum	8.05
4.	Aggregates for the construction of various harbour facilities including rail and road	17.0
	Total	**73.55**

The development of port facilities at Vadhavan would require about 32.10 million tonnes of stones of various sizes for construction of the breakwaters, about 16.4 million tonnes of stones of various sizes for shore protection bund, 8.05 million tones of murrum and about 17 million tonnes as aggregates for the construction of various harbour facilities.

The viable option for rock quarrying and transportation which is socially acceptable, environmentally benign and technically feasible is transportation of rocks to the site through dumpers. The location of potential quarry sites is shown in following figure



S.No.	Village	Location		Distance from Proposed Port in 'km'
		Northing	Easting	
1	Nagzari	19°46'54.24"	72°51'20.12"	26.0
2	Girnoli	19°44'47.17"	72°50'32.44"	28.0
3	Kirat	19°47'51.09"	72°51'02.65"	25.0
4	Borsheti	19°48'49.60"	72°50'59.61"	24.0
5	Gargaon(A)	19°50'25.20"	72°49'17.27"	17.0
6	Gargaon(B)	19°50'25.20"	72°49'17.27"	17.0
7	Khanivade(A)	19°49'41.86"	72°48'46.09"	19.0
8	Khanivade(B)	19°49'41.86"	72°48'46.09"	19.0
9	Mahagaon(A)	19°48'33.10"	72°49'2.13"	20.0
10	Mahagaon(B)	19°48'33.10"	72°49'2.13"	20.0
11	Nanivali	19°49'21.86"	72°54'45.90"	25.0

Figure 38 Location of Quarry Sites

The nearest road connectivity to these sites is through Shigaon road. These quarry sites need to be connected to the proposed port through road network. The approach to the port site is via Boisar through Boisar road then Boisar-Tarapur road. This road passes through the dense habitation in Boisar. Other two options to reach Vadhavan are Kasa junction on NH-48 then - Dahanu-Jewhar road and Kasa Junction then – Chinchani-Vangaon road via Chinchani.

It is estimated that at least 70 million tonnes of stones need to be moved to the site per day. Assuming carrying capacity of each truck to be 24 T, this would mean about average of 8,000 truck movements per day between port and quarry and vice versa for a period of about 2 years.

The details of the various quarries' information collected at the site are given below. However, assessment on the extraction of stones of bigger size and hard murrum from this quarry is required to be carried out prior construction. It is also required to carry out necessary investigations from the availability of stone quality point of view

Quarry Site at Gargaon (A) & (B)

Quarry sites are available at Gargaon in Palghar taluka. Two quarry sites are available at this place. The quarry located at Gargaon is a hillock with an elevation of 140 – 200 m above mean sea level. The projected quantity available in terms of area for the two quarries is 2,548 ha. (6,296 acre) and 4,576 ha. (11,308 acre) out of which a portion of the hill will be used for quarrying of stone based on the yield i.e. 30 to 40 acre. The quarry site can be approached through Vanai- Shigaon road and also through Shigaon road. The total lead distance from the quarry to the port site is 17 km. It is anticipated that the quarry comprises of hard murrum as overburden over the basalt rock

Quarry Site at Khanivade (A) & (B)

The quarry sites at Khanivade is located beside Gargaon quarry hillock. Two quarry sites are available at this place. The quarry located at Khanivade is a virgin hillock with an elevation of 100 – 140 m above mean sea level. The projected quantity available in terms of area for the two quarries is 3,938 ha. (9,730 acre) and 3,740 ha. (9,242 acre) out of which a portion of the hill will be used for quarrying of stone based on the yield i.e. 30 to 40 acre.

The quarry site is located in Palghar taluka and is at a distance of 19 km from the project site

Quarry Site at Mahagaon (A) & (B)

The quarry sites at Mahagaon is located in Palghar taluka and is at a distance of 20 km from the proposed port site. Two quarry sites are available at this place. The projected quantity available in terms of area for the two quarries is 4,230 ha. (10,453 acre) and 1,450 ha. (3,583 acre) out of which a portion of the hill will be used for quarrying of stone based on the yield i.e. 30 to 40 acre.

Quarry Site at Nanivali

The quarry site at Nanivali is located in Palghar taluka and is at a distance of 25 km from the proposed port site. This is a huge quarry with the projected quantity available in terms of area is 84,526 ha. (208,868 acre) out of which a portion of the hill will be used for quarrying of stone based on the yield i.e. 30 to 40 acre.

Quarry Site at Borsheti, Kirat, Nagzari and Girnoli

These are the private quarries and are being mainly used for the supply of stones for road and building construction

The projected quantity area of these quarries is as indicated below

- Borshetti- 8 acre
- Kirat- 6.5 acre
- Nagzari-30 acre
- Girnoli- 15 acre

At present the above locations have been identified for sourcing of stones for the project and a study for the yield and quality of rock is required to establish the extent of land requirement for about 70 million metric ton of stone. The extent of land is expected to be less than 50 ha., as such the approval for mining and statutary clearance will be obtained.

Currently, there is no road connectivity to the quarries from the nearby roads. New road connectivity from the near road as well as some localized road improvement measures will need to be undertaken near the quarries and near the project site to enable moving of the large quantity of stones by road using truck.

The transportation operation will involve development of roads from quarry to the project site. The proposed external railroad corridor passes close to the proposed quarry location. It is proposed that JNPA should initially implement the proposed external road connectivity to the port to facilitate the movement of trucks carrying construction material. Also, based on the quality of stones and material available, quarries Gargaon and Khanivade can be selected for implementation at that JNPA which is located close to the proposed road connecting the port

The selected contractor needs to construct the road connecting the quarries to the nearby road for the efficient movement of rock dumpers to the port site. The final selection of quarry will depend on the EPC contractor

2.33 Project Implementation Schedule

2.33.1 Implementation Strategy

Vadhavan port will be developed as an all-weather port for handling primarily the containers including other cargoes such as multipurpose, Ro-Ro, liquid cargo. Various terminals would be developed to cater these respective cargoes. The port is proposed to be developed as Landlord port. The Management and operations of port facilities will be carried out by Vadhavan Port Project Limited (VPPL – a SPV for the implementation of Vadhavan port) directly by employing suitable personnel. The marine facilities such as breakwaters, reclamation, approach channel, port craft, navigational aids will be common to all these terminals.

2.33.2 Organisation Structure

The port is proposed to be developed as a landlord port in which the construction of basic port infrastructure such as breakwaters, reclamation, shore protection bund, approach channel, port craft, navigational aids, road and rail connectivity, water and power supply will be common to all these terminals. The port will also be supplemented by the green port initiatives as per the notification by Government of India.

As stated above, the port is to be developed on landlord basis, the management of port infrastructure will be managed by VPPL and operation proposed to be developed by private developers as stated below:

1. Management and operations by Vadhavan Port Project Limited (VPPL – a SPV for the implementation of Vadhavan port) directly by employing suitable personnel.
2. Operations by leasing out the terminals to Terminal Operators (TO) with expertise in handling these operations.

Vadhavan Port Project Limited (VPPL) will directly be responsible for the following port management and will be under the following resource personnel and department:

1. Appointing a Harbour for port conservation - Master and conservator of the port.
2. Department for Navigation in the port by having qualified and licensed pilots to pilot ships with aids like tugs etc., attending to berthing and de-berthing of ships calling at the port.
3. Department for providing and maintaining the basic infrastructure like road, rail, water & power supply etc.
4. Department for payment to the State Government as may be contained in the agreement.
5. Department for furnishing management information to the appropriate authority on port operations including cargo-handling activities at the various marine terminals, whether operated directed by it or by subleased to others.

6. Department for co-ordinating with the Collectorate of customs within whose jurisdiction the port falls, for proper accounting of ships entering the port and cargo unloaded or loaded into them.

7. Administering subleases for the various marine terminals leased to users, terminal operators as applicable.

8. Co-ordinating all port activities, monitoring port performance by individual terminal operators and ensuring optimal performance and collecting necessary management information and furnishing the same to the Government authorities as required.

9. Department for Safety and security, pollution control and environmental protection, water supply, power supply.

10. Department for Green Port Initiatives and Environmental Management.

2.33.3 Project Implementation Schedule

Implementation Strategy

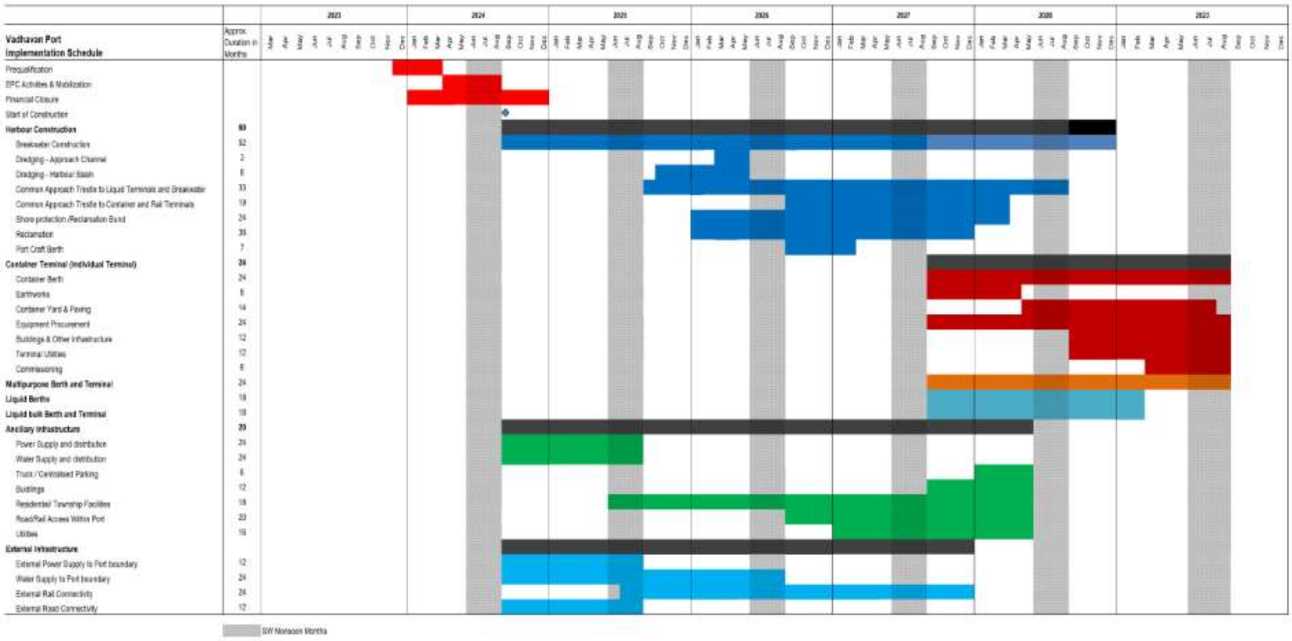
The port is proposed to be developed as Landlord port, the EPC contract for the implementation of landlord component can be carried out into the following tentative contracting packages. The exact packages and modality of implementation will be arrived at based on discussion with JNPA.

- Package 1 – Marine Civil Works – Breakwater and approach trestle for trailer road movement
- Package 2 – Dredging, Reclamation and Shore protection works
- Package 3 – Onshore Civil Works and Utilities – Buildings, Pavements and Utilities
- Package 4 – Road Connectivity to Port - NHAI
- Package 5 – Rail connectivity to Port - DFCC

The Works towards supply of water and power from the respective sources will be carried out by the respective state government authorities.

Following Table shows the implementation schedule and timeframes for various construction elements for Phase 1

Table 40 Vadhavan Port Implementation Schedule



It should be noted that the timeframes have been estimated based on an assumed construction methodology. The EPC contractor may choose a different construction methodology depending on their capability and understanding

2.34 Financial Viability

2.34.1 Basic Project Block Cost Estimates Summary

Based on the "Landlord" port model, below table lists out the estimated capital cost split between JNPA and private terminal operator(s) on the basis of discussions and understanding of the market. It is assumed that JNPA will provide all civil costs associated with the project including breakwaters, dredging and reclamation, external rail and road connectivity, port crafts and navigation aids. Some buildingssuch as JNPA Admin, security guard booth, will be provided by port. Private operator will provide all container terminal and gate complex development costs as well as equipment costs. It is also assumed that port will provide utilities to an agreed upon "hand-shake" point and the private terminal operator will be providing the utilities for the rest of the container terminal.

Table 41 The cost estimates have been summarized in Following Table

S. No.	Item		JNPA (INR in Crores)		PPP (INR in Crores)		Total (JNPA)	Total (PPP)	Total cost (INR in crores)
			Phase -1	Phase -2	Phase-1	Phase-2			
1	Project Preliminaries and Site Development		60	60	-	-	120	-	120
2	Dredging		936	2,016	-	-	2,952	-	2,952
3	Reclamation		9,321	2,586	-	-	11,907	-	11,907
4	Shore Protection Works		2,381	1,111	-	-	3,492	-	3,492
5	Breakwater		5,361		-	-	5,361	-	5,361
6	Berths/ Terminals								
	6.1	Container Terminal 1 (CT1)	-	-	2,689	-	-	2,689	2,689
	6.2	Container Terminal 2 (CT2)	-	-	2,693	-	-	2,693	2,693
	6.3	Container Terminal 3 (CT3)	-	-	2,688	-	-	2,688	2,688
	6.4	Container Terminal 4 (CT4)	-	-	2,699	-	-	2,699	2,699
	6.5	Container Terminal 5 (CT5)	-	-	-	2,703	-	2,703	2,703
	6.6	Container Terminal 6 (CT6)	-		-	2,704	-	2,704	2,704
	6.7	Container Terminal 7 (CT7)	-	-	-	2,684	-	2,684	2,684
	6.8	Container Terminal 8 (CT8)	-	-	-	2,708	-	2,708	2,708
	6.9	Container Terminal 9 (CT9)	-	-		2,717	-	2,717	2,717
	6.1	Multipurpose Terminal - 4 No.	-	-	861	161	-	1,021	1,021
	6.11	RO-RO Terminal	-	-	204		-	204	204
	6.12	Bulk Liquid Terminal	-	-	239	-	-	239	239
	6.13	Liquid Terminal Edible and Chemical -2 No	-	-	299	-	-	299	299
7	Common Port Infrastructure								
	7.1	Reclamation	181	90	-	-	271		271
	7.2	Approach Trestle	1,777	0	-	-	1,777		1,777
	7.3	Port Buildings	248	15	-	-	263		263
	7.4	Tug Berth	71	0	-	-	71		71
	7.5	Internal Roads, ROB, Underpass	1,073	362	-	-	1,435		1,435
	7.6	Utilities and fencing	383	12	-	-	394		394
8	Roads and Railways				-				
	8.1	External Road Connectivity	-	-		-	-	-	-
	8.2	External Rail Connectivity (upto port gate and inport tracks)	-	-	-	-	-	-	-
	8.3	In-Port Rail Yard	-	-	1,478	883		2,361	2,361
9	External Utilities, Township and Others		339	43	-	-	382		382
10	Port Crafts and Navigational Aids		34	1	-	-	35		35
11	Gates Complex		40	57	-	-	97		97
12	Landscaping		90	-	-	-	90		90
Total (1+2+3+4+5+6+7+8+9+10+11+12)			**22,296**	**6,353**	**13,849**	**14,560**	**28,648**	**28,410**	**57,058**
(A) Total (1+2+3+4+5+6+7+8+9+10+11+12)			22,296	6,353	13,849	14,560	28,648	28,410	57,058
(B) GST (@18%) on infra Cost			4,013	1,143	2,493	2,621	5,157	5,114	10,270
(C) Total Infra Cost (including GST) (A+B)			26,309	7,496	16,342	17,181	33,805	33,523	67,328
(D) Contingency at 1%			263	75	163	172	338	335	673
Total EPC Cost (C+D)			26,572	7,571	16,506	17,353	34,143	33,859	68,002
(E) Preliminary & Preoperative Cost			60	0	1,651	1,735	60	3,386	3,446
(F) Financial Cost for Debt syndication			125	25	-	-	150	-	150
(G) PMC charges			150	25	-	-	175	-	175

S. No.	Item	JNPA (INR in Crores)		PPP (INR in Crores)		Total (JNPA)	Total (PPP)	Total cost (INR in crores)
		Phase -1	Phase -2	Phase-1	Phase-2			
(G) Interest During Construction Period (IDC Cost of Borrowing)		2,503	500	-	-	3,003	-	3,003
Land acquisition		885	-	-	-	885	-	885
Compensation to fishermen and fee to TAPS		560	-	-	-	560	-	560
Total (INR in crores)		30,855	8,121	18,156	19,088	38,976	37,244	76,220

2.34.2 Operation and Maintenance Costs

Annual Operation and Maintenance Costs

Based on the various criteria discussed above, the annual operation and maintenance cost for Phase 1 of Vadhavan Port are provided in table below

Table 42 Summary of Operations & Maintenance Cost Estimates

S. No.	Item	Annual Costs (Rs. in Crores)	
		Phase 1	Phase 2
Terminal Operator			
1.	Container Terminal CT1	224.6	-
2.	Container Terminal CT2	224.6	-
3.	Container Terminal CT3	224.6	-
4.	Container Terminal CT4	224.6	-
5.	Container Terminal CT5	-	224.6
6.	Container Terminal CT6	-	224.6
7.	Container Terminal CT7	-	224.6
8.	Container Terminal CT8	-	224.6
9.	Container Terminal CT9	-	224.6
10.	Multipurpose Terminal	46.0	12.8
12.	RO-RO Terminal	7.6	-
14.	LPG Jetty	15.0	-
15.	Liquid Jetty - Edible and Chemical – 2 No.	35.8	-
16.	In-port rail yard	57.4	109.2
JNPT			
1.	Landlord component	577.8	557.7

2.35 CRZ DETAILS

Preparation of Local Level Coastal Regulation Zone Map for the Proposed Green Field Vadhavan Port at Vadhavan Village, Dahanu Taluka, Palghar District, Maharashtra State by

Superimposing on Approved CZMP as per CRZ Notification 2019 is prepared by Institute of Remote Sensing (IRS), Chennai (October 2023). Report enclosed as Annexure - 3

The proposed details viz Approach Trestle, Breakwater, Navigational Area, Offshore Reclamation Area, Sheltered Area within Vadhavan Port Limits lies in CRZ-IVA and Reclamation Area near Shore lies in CRZ-IB, CRZ-III (200m to 500m from HTL), CRZ-III (No Development Zone), CRZ-IVA and outside CRZ areas as per approved CZMP (Map nos: MH 95, 97, 98 & 99) vide CRZ notification 2019 of MoEF & CC.

The reclamation area near shore in within Vadhavan Port Limits lies in CRZ-IB, CRZ-III(200m to 500m from HTL), CRZ-III (No Development Zone), CRZ-IVA, and outside CRZ areas as per approved CZMP (Map nos: MH 95, 97, 98 & 99) vide CRZ notification 2019 of MoEF&CC

The remaining Area where there is no development proposed within Vadhavan Port Limits lies in CRZ-IA, CRZ-IA (50m Mangrove Buffer Zone), CRZ-IB, CRZ-III (No Development Zone), and CRZ-IVA areas as per approved CZMP (Map nos: MH 95, 97, 98 & 99) vide CRZ notification 2019 of MoEF & CC.

The proposed Road and Rail Alignment for the port connectivity lies in CRZ-IB, CRZ-III (200m to 500m from HTL), CRZ-III (No Development Zone) and Outside CRZ areas as per approved CZMP (Map nos: MH 95, 97, 98 & 99) vide CRZ notification 2019 of MoEF & CC. The detailed CRZ status is depicted in Table below.

Table 43 Project site details in CRZ

Development of Vadhavan Port- Port limit details in CRZ					
Sl,No	**Description**	**Project Details**	**CRZ-Classification**	**Area in Acres**	**Total Area in Acres**
1	Area for proposed development within Vadhavan Port Limits	Approach Trestle	CRZ-IVA	45.26	8763.20
		Breakwater	CRZ-IVA	444.36	
		Navigational Area	CRZ-IVA	3004.28	
		Offshore Reclamation Area	CRZ-IVA	3388.87	
		Reclamation Area near Shore	CRZ-IB	131.67	
			CRZ-III (200m to 500m from HTL)	12.14	
			CRZ-III (NDZ)	22.86	
			CRZ-IVA	417.80	
			Outside CRZ	49.56	
		Sheltered Area	CRZ-IVA	1246.41	

Sl,No	Description	Project Details	CRZ-Classification	Area in Acres	Total Area in Acres
2	Remaining Area within Vadhavan Port Limits	Nil	CRZ - IA (50m Mangrove Buffer)	126.48	33214.37
			CRZ - IA	98.25	
			CRZ-IB	426.28	
			CRZ-III-NDZ	19.71	
			CRZ-IVA	32543.64	
Grand Total				**41977.57**	**41977.57**

Sl,No	Description	Project Details	CRZ-Classification	Length in Meters	Total Length in Meters
3	Proposed Road alignment for the port connectivity	Proposed Road	CRZ-IB	277.29	34033.32
			CRZ-III(200m to 500m from HTL)	257.89	
			CRZ-III-NDZ	491.77	
			Outside CRZ	33006.36	
4	Proposed Rail alignment for the port connectivity	Proposed Railway Line	CRZ-IB	217.26	21735.45
			CRZ-III(200m to 500m from HTL)	355.71	
			CRZ-III-NDZ	514.39	
			Outside CRZ	20648.10	
Grand Total				**55768.77**	**55768.77**

The co-ordinates of the HTL points derived from approved CZMP at 1:25,000 scale in WGS84 system are presented as below;

Table 44 Coordinates of HTL Reference Points(WGS 84)

HTL Point	Latitude	Longitude
1	19° 58' 55.591" N	72° 43' 12.361" E
2	19° 58' 24.813" N	72° 42' 59.836" E
3	19° 58' 15.028" N	72° 43' 19.857" E
4	19° 58' 38.976" N	72° 43' 19.924" E
5	19° 58' 58.805" N	72° 43' 22.513" E
6	19° 58' 44.023" N	72° 43' 19.952" E
7	19° 58' 58.831" N	72° 43' 32.560" E
8	19° 58' 51.588" N	72° 43' 33.229" E
9	19° 58' 47.962" N	72° 43' 34.023" E
10	19° 58' 42.764" N	72° 43' 28.684" E
11	19° 58' 33.017" N	72° 43' 21.527" E
12	19° 58' 22.819" N	72° 43' 28.205" E
13	19° 56' 37.861" N	72° 43' 19.950" E
14	19° 56' 46.808" N	72° 43' 22.844" E
15	19° 56' 43.402" N	72° 43' 33.797" E
16	19° 56' 51.023" N	72° 43' 24.987" E
17	19° 56' 48.416" N	72° 43' 34.332" E
18	19° 56' 55.507" N	72° 43' 26.506" E
19	19° 56' 44.497" N	72° 43' 14.384" E
20	19° 56' 47.652" N	72° 43' 06.582" E
21	19° 56' 57.534" N	72° 43' 08.358" E
22	19° 56' 53.757" N	72° 43' 16.637" E
23	19° 56' 58.799" N	72° 43' 29.424" E
24	19° 57' 12.639" N	72° 43' 35.143" E
25	19° 57' 19.981" N	72° 43' 25.592" E
26	19° 57' 23.208" N	72° 43' 9.629" E
27	19° 57' 26.636" N	72° 42' 56.895" E
28	19° 57' 34.198" N	72° 42' 49.601" E
29	19° 57' 38.454" N	72° 42' 43.621" E
30	19° 57' 42.176" N	72° 42' 56.323" E
31	19° 57' 43.079" N	72° 43' 06.772" E
32	19° 57' 52.327" N	72° 43' 05.543" E
33	19° 57' 59.162" N	72° 43' 13.987" E
34	19° 57' 56.607" N	72° 42' 48.090" E
35	19° 57' 58.788" N	72° 43' 01.906" E
36	19° 58' 02.824" N	72° 43' 15.860" E
37	19° 58' 06.514" N	72° 42' 59.721" E
38	19° 58' 07.393" N	72° 42' 41.898" E
39	19° 58' 02.853" N	72° 42' 25.012" E
40	19° 57' 52.635" N	72° 42' 12.908" E
41	19° 57' 44.151" N	72° 42' 5.250" E
42	19° 57' 37.412" N	72° 41' 51.178" E

HTL Point	Latitude	Longitude
43	19° 57' 30.226" N	72° 41' 48.612" E
44	19° 57' 36.298" N	72° 41' 56.676" E
45	19° 57' 38.388" N	72° 42' 08.563" E
46	19° 57' 28.064" N	72° 42' 13.288" E
47	19° 57' 38.006" N	72° 42' 03.928" E
48	19° 57' 30.279" N	72° 41' 45.555" E
49	19° 57' 29.190" N	72° 41' 32.297" E
50	19° 57' 33.396" N	72° 41' 42.406" E
51	19° 57' 37.840" N	72° 41' 47.672" E
52	19° 57' 34.058" N	72° 41' 36.508" E
53	19° 57' 27.428" N	72° 41' 27.354" E
54	19° 57' 19.303" N	72° 41' 17.189" E
55	19° 57' 09.307" N	72° 41' 12.308" E
56	19° 56' 57.663" N	72° 41' 11.318" E
57	19° 56' 50.324" N	72° 41' 03.178" E
58	19° 56' 40.198" N	72° 40' 57.573" E
59	19° 56' 34.769" N	72° 41' 06.578" E
60	19° 56' 25.564" N	72° 41' 03.390" E
61	19° 56' 19.006" N	72° 40' 55.724" E
62	19° 56' 34.011" N	72° 40' 52.666" E
63	19° 56' 30.054" N	72° 40' 44.899" E
64	19° 56' 25.947" N	72° 40' 37.311" E
65	19° 56' 17.822" N	72° 40' 32.127" E
66	19° 56' 13.541" N	72° 40' 18.516" E
67	19° 56' 10.176" N	72° 40' 13.891" E
68	19° 56' 17.433" N	72° 40' 24.750" E
69	19° 56' 22.823" N	72° 40' 33.664" E
70	19° 56' 18.190" N	72° 40' 20.579" E
71	19° 56' 09.497" N	72° 40' 08.693" E
72	19° 56' 05.198" N	72° 39' 55.075" E
73	19° 55' 55.255" N	72° 39' 50.958" E
74	19° 55' 47.372" N	72° 39' 54.926" E
75	19° 55' 39.406" N	72° 40' 11.275" E
76	19° 55' 32.206" N	72° 40' 19.822" E
77	19° 55' 22.875" N	72° 40' 28.517" E
78	19° 55' 16.225" N	72° 40' 35.180" E
79	19° 55' 06.839" N	72° 40' 42.774" E
80	19° 54' 57.519" N	72° 40' 44.665" E
81	19° 55' 00.305" N	72° 40' 57.036" E
82	19° 54' 56.773" N	72° 40' 47.916" E
83	19° 55' 02.387" N	72° 40' 41.108" E
84	19° 55' 12.369" N	72° 40' 35.681" E
85	19° 55' 15.654" N	72° 40' 29.369" E
86	19° 55' 03.366" N	72° 40' 35.823" E
87	19° 54' 49.989" N	72° 40' 37.870" E
88	19° 54' 39.362" N	72° 40' 38.217" E
89	19° 54' 29.600" N	72° 40' 34.256" E

HTL Point	Latitude	Longitude
90	19° 54' 16.692" N	72° 40' 33.717" E
91	19° 54' 08.227" N	72° 40' 39.232" E
92	19° 54' 08.713" N	72° 40' 55.625" E
93	19° 54' 19.721" N	72° 40' 55.376" E
94	19° 54' 27.250" N	72° 40' 57.580" E
95	19° 54' 34.873" N	72° 41' 04.256" E
96	19° 54' 34.059" N	72° 41' 14.562" E
97	19° 54' 31.877" N	72° 41' 19.269" E
98	19° 54' 38.022" N	72° 41' 24.233" E
99	19° 54' 34.403" N	72° 41' 21.740" E
100	19° 54' 32.362" N	72° 41' 12.797" E
101	19° 54' 34.276" N	72° 41' 06.120" E
102	19° 54' 26.732" N	72° 41' 00.957" E
103	19° 54' 19.132" N	72° 41' 00.036" E
104	19° 54' 10.131" N	72° 41' 01.300" E

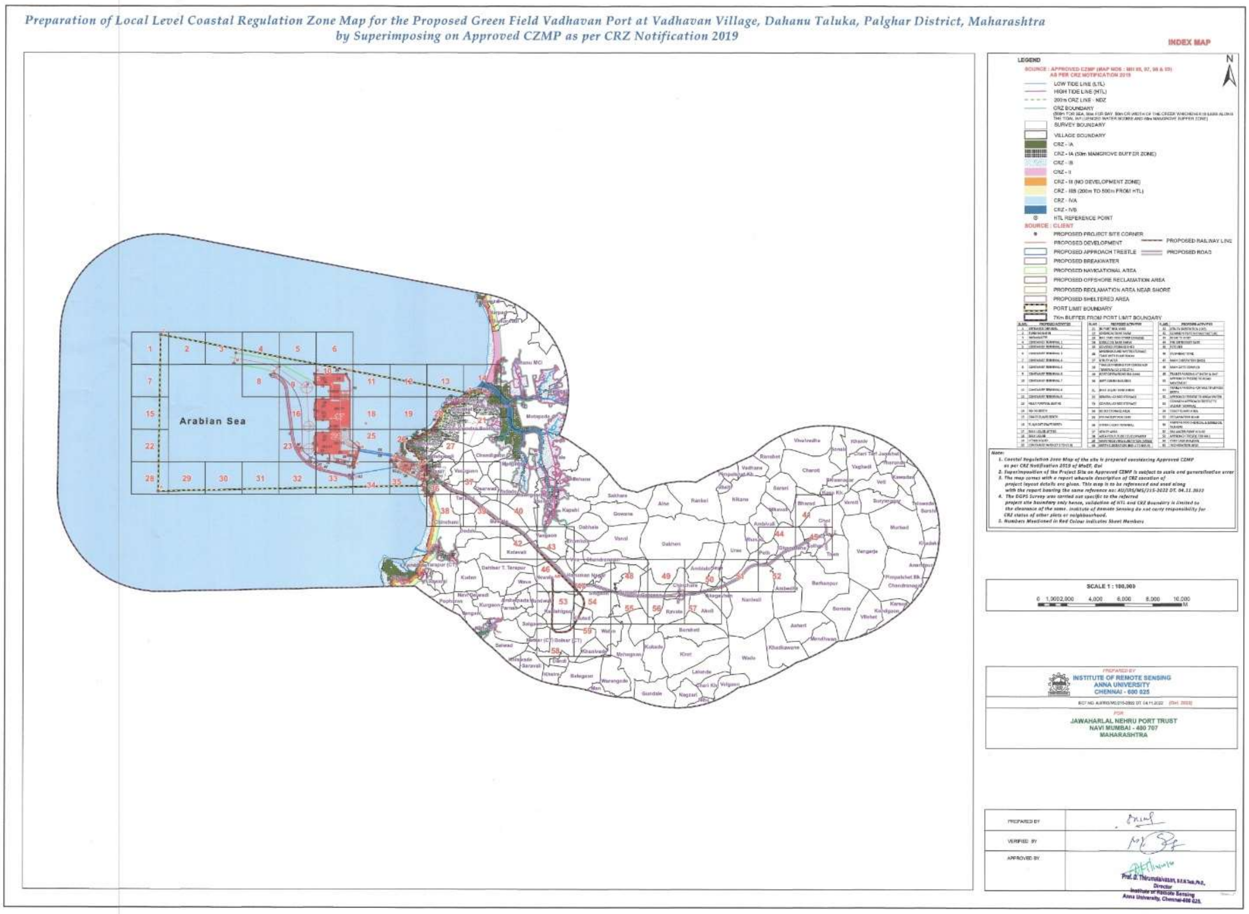


Figure 39 Project site overlaid on Approved CZMP

CHAPTER 3 - ANALYSIS OF ALTERNATIVES

3.1 The Identification of locations

In the year 1996 the Government of Maharashtra issued a global tender notice for the development of an all-weather port at Alewadi, an area some 60 km from Dahanu and in response to this tender was submitted in 16 December 1996 by P&O Ports Australia ("P&O Australia"), a wholly owned subsidiary of P&O Ports UK. After its bid was accepted P&O Australia used a clause in the tender agreement, which allowed it to select an alternative site, to request to shift the site of the port from Alewadi to Vadhavan in Dahanu. The reason for the shift was that the geological features of the new site – in particular the presence of a large rock shelf in the inter-tidal zone – were favourable for building of a large port, and would have enabled P&O Australia to make significant cost savings during the construction phase. On 17 February 1997, the Government of Maharashtra issued P&O Australia with a letter of intent, which conditionally accepted its proposal to build an international port at Vadhavan. The letter of intent was based on a 50-year build-own-operate-transfer scheme, under which P&O Australia - the licensee was granted a right to determine the port tariffs and their denomination. The Government's conditions included a requirement that P&O Australia will submit a detailed feasibility report (including an environmental impact assessment study) within six months, and will obtain all the necessary environmental clearances from the Central Government.

The proposed port by P&O was to be developed for both the import and export of various commodities including Containers, Dry Bulk Cargo (Coal, Fertilizers & Fertilizer Raw Materials, Grain, Deoiled cakes), Liquid Bulk Cargo (Crude Oil, Oil Products, Edible Oils, Liquid Chemicals), and General Cargo at berths constructed within breakwater protection off Vadhavan Point on the west coast of India, 60 NM north of Mumbai.

The geographical location of the proposed site is at Latitude 19°55'55" North and Longitude 72° 39'48" East. The proposed site is at a distance of about 8 km from Dahanu and is accessible by road from National Highway No. 8 connecting Mumbai to Ahmedabad located at a distance of about 28.5 km in the east direction from the site. The proposed site is surrounded on the north by Arabian Sea, northeast by Dahanu Creek, various villages on the north east and south east of the land and on the west and north by Arabian Sea.

Various facilities were planned at the port include approach channel, maneuvering basin, breakwaters, quays, berths, etc in the waterfront. Other facilities such as transportation pipelines, conveyors, storage sheds, bulk storage area, tank farms, and other infrastructure facilities will be planned in the intertidal region and the CRZ III are. The port will also require construction of a road link to National Highway No.8 connecting Mumbai to Ahmedabad, a rail link to the Western Railway Main line at Vangaon, and services to link to the existing facilities in the hinterland.

However, the Port investment could not materialise as expected due to various issues and constraints including non-availability of environmental approvals.

The environmental laws and policies have been issued for development of ports along the Indian coast after 1991 and notification for EIA studies and CRZ classification have been issued to consider port for environmental clearances. The MOEF & CC has issued a clarification on 26th May 2022 for locating Vadhavan port in Eco Frazile Zone (EFZ) of Dahanu Taluka.

The GOI in the year 2015 had initiated projects under Sagarmala and various initiatives have been envisaged under the Sagarmala Programme. The main objective of the project was to evolve a model of port led development. In order to exmine the future requirement of major port along the Maharashtra coast a two-member study group was constituted by JNPA for identification of a new port in order to meet the future demand of handling containers due to high level of conjection at JNPA. The two-member committee had identified to locate the major deep draft port to cater to large container ship and other large vessels from Jaigad in Ratnagiri district to Tarapur in Palghar district. 9 locations were exmined viz. Tarapur Coast, South of Jaigad, North of Dighi Harbour, South of Vijay Durg, South of Deogad, North of Vijaydurg, North of Malvan, South of Ratnagiri and North of Vengurla. The committee had delibrated and decided to locate the deep draft port near Tarapur. The coast near Tarapur was further examined for selection of site for mega port. 9 locations near Tarapur area was considered for evaluation as the coast in these locations was considered to be stable. From Tarpur to Dahanu various locations were examined which included Navapur, Chinchani, Varor, Vadhavan, Boisar, Badapokhran, Gungwada, Tadiyala and Dahanu. The committee had recommended the location at Dahanu where the Maharashtra government has considered to set up a mega port. Thereafter, Ministry of Shipping, Government of India carried out the TEFR studies through consultant M/s AECOM and it was recommended that Vadhavan is preferred for setting up of a Mega Port. The selection of location is based on the nature of stable coast, vicinity of major trunk railway and major National Highways. The location has many advantages apart from geographical consdierations as the Vadhavan Port location falls on the international sea route and direct access to majority of middle east ports.

Table 45 Location Matrix

Criteria	Navapur	Chinchani	Varor	Vadhavan	Boisar	Badapokhran	Gungwada	Tadiyala	Dahanu
Connectivity	4	4	4	4	5	4	4	4	5
Rocky terrain and Mangroves	3	3	3	3	3	2	2	4	2
Dredging requirement	1	1	1	1	1	1	1	1	1
Reclamation possiblility	1	1	1	4	1	1	1	1	2
Shoreline stability	1	2	2	4	2	2	2	2	3
Least Population	2	1	2	4	2	2	2	2	1
Total	12	12	13	20	14	12	12	14	14

As per the above matrix Vadhvan location scores more points as compare to other locations

The proposed project site is located in west coast of India at Vadhavan of Dahanu taluka in Palghar district, Maharashtra. The major site-specific advantages of the proposed site as a natural water depth of around 20.0 m below CD is available at 10 km from Vadhavan point and 15 m contour is available at a distance of 6 km which will allow safe voyage and mooring for the new generation vessels. As deep-water depth is available at 6 to 10 km from the shore, new generation vessels calling for deep draft can be planned without/ minimal cost on dredging. Connectivity to NH-48 (Mumbai-Delhi), upcoming Vadodara-Mumbai Expressway, existing Indian railways link and upcoming DFC (Dedicated Freight Corridor) is available at short distances for providing connectivity to cargo destinations centre in hinterland.

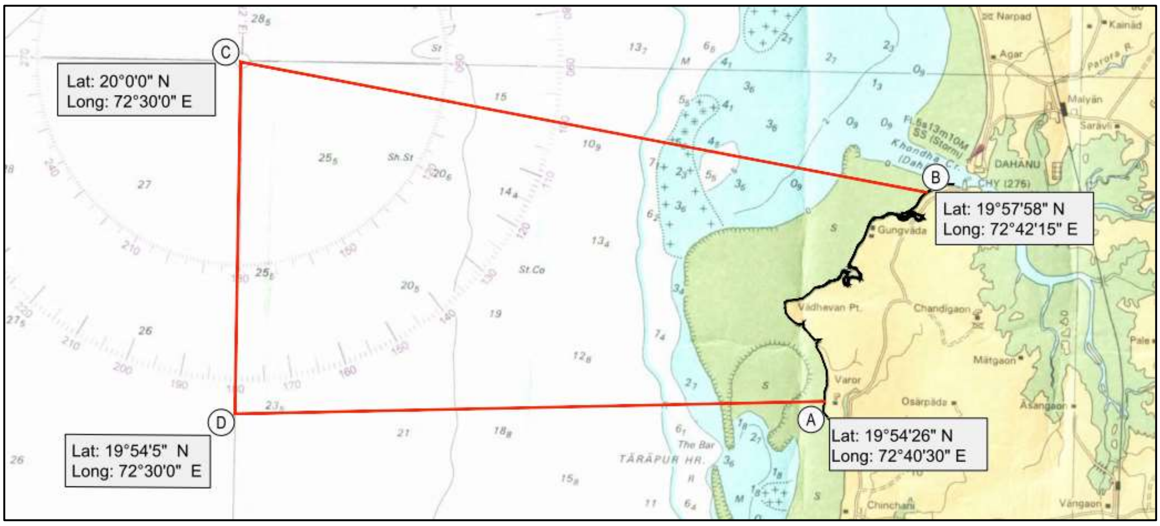


Figure 40 Vadhavan port Limit

3.2 Analysis of Alternative Port Layout

The layout was finalized at the time of feasibility studies is as shown below

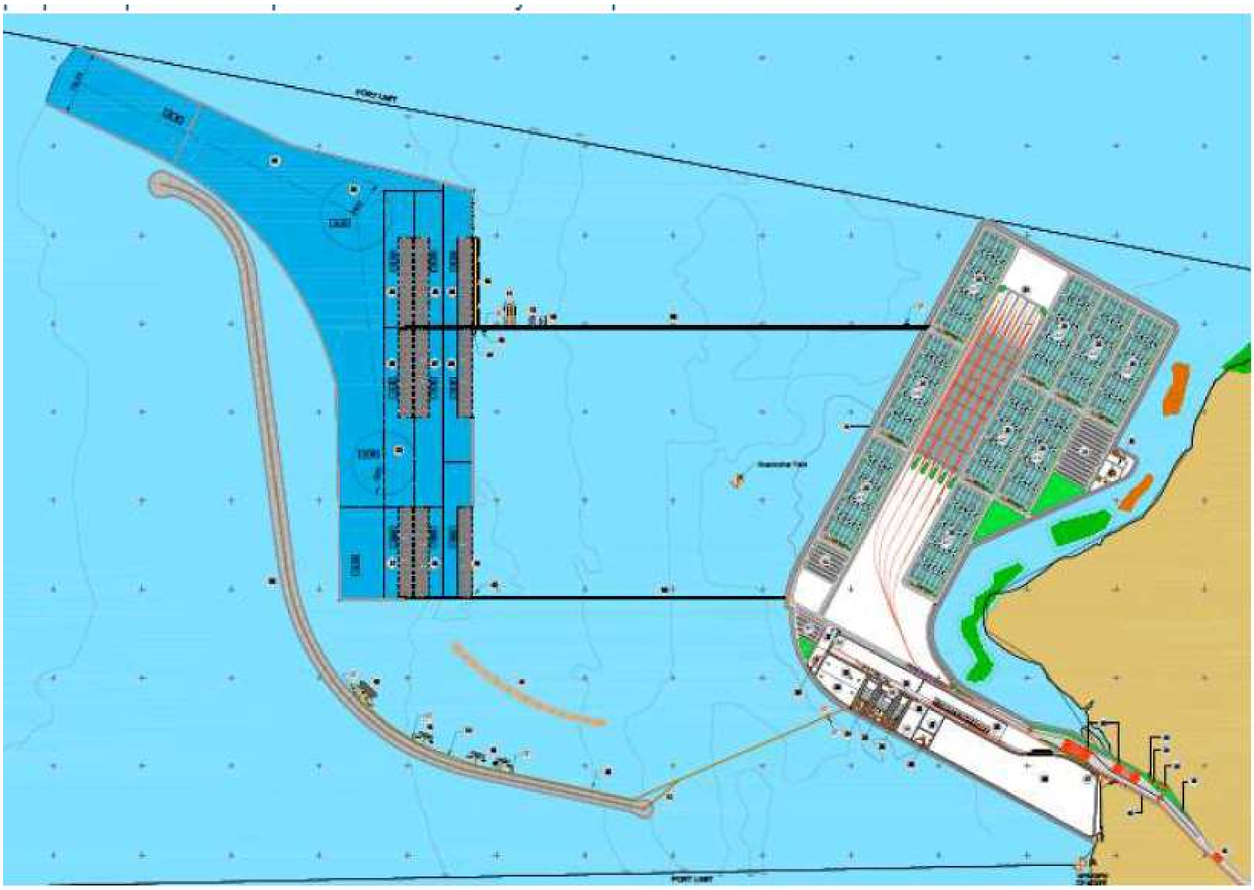


Figure 41 Master plan of the feasibility report

Most of the container terminals across the globe prefer to have the yard area just behind the berth making it more efficient from operations perspective. Accordingly, it was decided to relook into the port master plan layout taking into consideration the capital investment required for the project and operation efficiency. The high operating costs associated with the long access trestles connecting the offshore berths to the onshore back-up storage facilities meant that the project was not attractive to potential terminal operators interested in investing in the project. Based on various level of discussions on the proposed port master plan with various stakeholders especially the various port operators/ developers, it was decided that the port master plan need to relook from the operational efficiency once the port is fully developed.

In view of the above, RHDHV prepared various alternative layouts to arrive at the most optimum one which would be a mixture of balance in the capital as well as the operational cost which is covered in this report.

The preferred concept for the container terminals is to have the yard area just behind the berth making it more efficient from operations perspective. The port master plan layout was developed taking into consideration the following:

- The capital investment required for the project needed to be reduced.
- The high operating costs associated with the long access trestles connecting the offshore berths to the onshore back-up storage facilities meant that the project was not attractive to potential terminal operators interested in investing in the project.
- Operation efficiency

There was a requirement to review the port master plan with a view to reducing both the capital and operating costs (CAPEX & OPEX) and improving the operability of the container terminals.

The main factors influencing the high CAPEX are the breakwater, current deflection wall, reclamation and shore protection bunds. The long access trestles are the main factor influencing the OPEX and also the operational efficiency of the port.

3.3 Approach

The general approach taken to developing a new layout for the port was as follows:

- The main breakwater location and alignment as shown in the original port master plan was retained
- Marginal quays to be provided for container terminals where possible

- Consideration given to limiting both CAPEX and OPEX.

The following parameters were also taken into consideration for developing the layouts

- **Balance in reclamation and dredging**
  In order to develop a modular container terminal, there is a requirement of creating the reclaimed land in deep waters. The main emphasis while developing the port layout is given to balance the cost of dredging and reclamation for the land area developed.

- **Material for Reclamation**
  The nearshore reclamation was proposed in the master plan owing to high quantity of reclamation when carried out in deep water. The reclamation is also dependent on the source i.e., marine / burrow earth in which the latter one would be expensive affair and is also dependent on the availability of the required material. For marine source the reclamation is sensitive to the distance of source from the port location.

- **Marine Terminal Requirements**
  The preferred arrangement for a container terminal is a straight marginal quay with container storage yard directly behind. The straight quay allows for flexibility of ship berthing and movement of rail-mounted quayside cranes. A container storage yard directly behind the quay apron provides for efficient transfer of containers between quayside and storage as well as limiting the operating costs.

- **Rail yard at the proximity to container yard**
  For efficient functioning and evacuation of the container terminal, the rail yard need to the provided close to the container storage yard. Locating the rail terminal away from the container handling facility would result in inefficiency in handling and high OPEX cost.

- **Trestle connecting offshore reclamation**
  Trestle connecting the nearshore with the offshore reclamation to be such that there is ample space for the current flow without having any adverse impact on the port facilities.

- **Sedimentation within the harbour**
  The phenomenon of littoral drift of sediments along the west coast of India is low. The drift of sediments along the coast is caused by the action of waves impinging on the coastline at an angle, and this slowly drives the material in the direction of the waves.

The littoral drift at the project site predominantly driven by the currents along the coastline. This is predominantly from north to south along the west coast of India, along with some reverse drift.

3.4 Master Plan Development Options

Various master plan layouts were developed for Vadhavan port keeping in view of the planning framework as mentioned in section 6.2, for the forecast traffic till year 2040. The design ship size for the master plan development is taken as the container carrier of 24,000 TEU. Also, the port layout has to be developed to fit within the port limit allocated for port purposes.

3.4.1 Master Plan Alternative 1

In this option an offshore island is created to cater for all the 9 container terminals. An offshore box shape arrangement is proposed with 4 terminals located at the west and 4 terminals on the rear side of the box (at the east) and one terminal at the north. The container terminal at the north is completely exposed to the waves from WNW and would pose operation constraints warranting for the requirement of additional protection from the north. The multipurpose, RoRo and port craft terminals are proposed at the south of the offshore reclaimed land.

The rail yard is proposed nearshore. Functionally, this layout provides better and equal interface between the berth and yard for all the terminals. However, pose inefficiency from rail handling perspective which is located away from the terminals.

This option would involve high rock dredging along the container terminals for the approach which is located towards the east where rock levels are at shallow depths and at some stretches at the seabed surface.

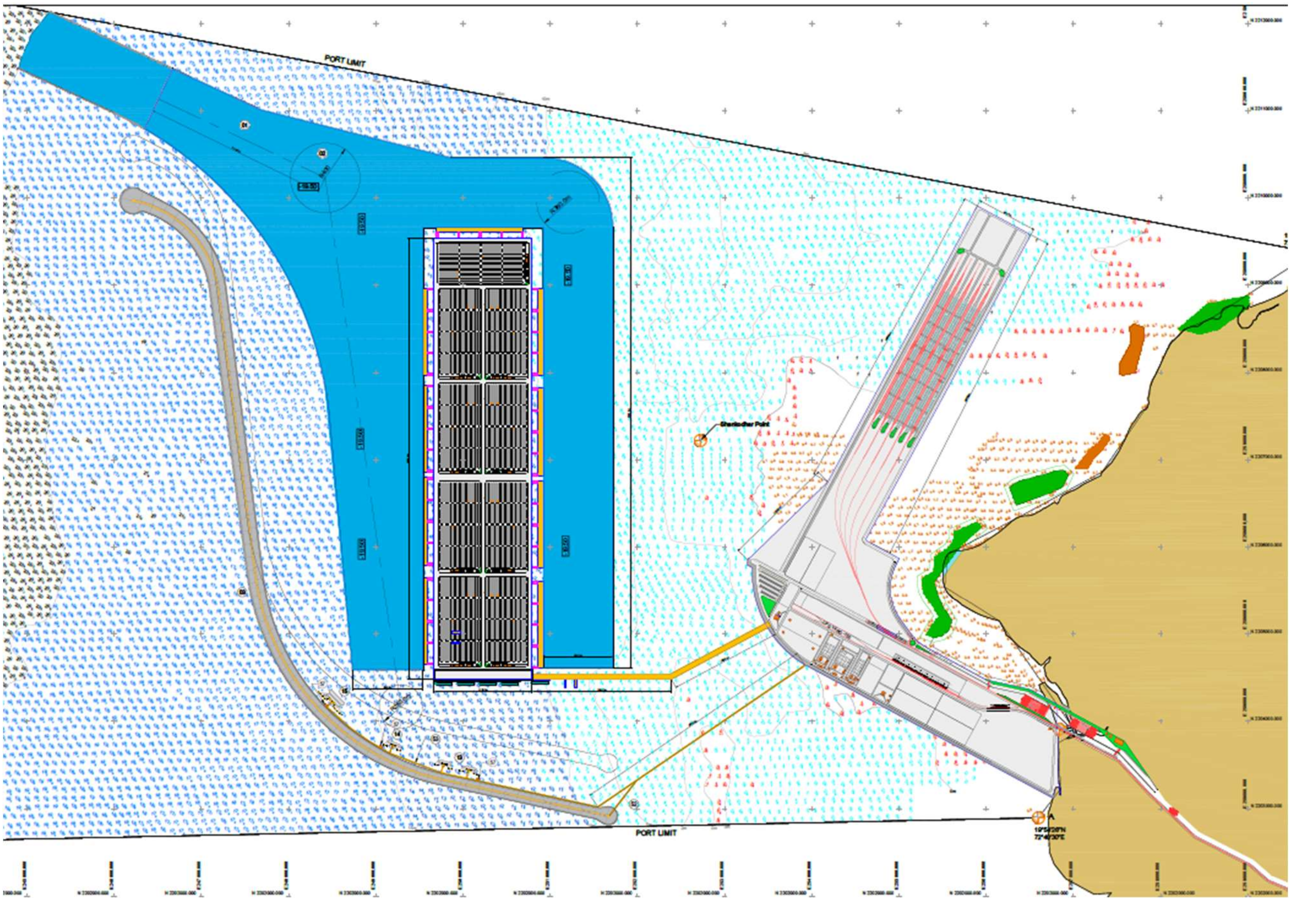


Figure 42 Master Plan Alternative 1

3.4.2 Master Plan Alternative 2

Nine container terminals are planned with a total length of 9,000 m. The container quay arrangement is provided such that the backup area of about 500 m width is available to accommodate the storage for the containers, approach corridors and terminal infrastructure. Finger piers are proposed multipurpose, Ro-Ro and other port terminal. All the liquid terminals are located on the leeside of breakwater as originally proposed.

The scheme comprises a large area of confined water with the long offshore breakwater arrangement. IN order tom streamline the current flow and provide better tranquillity from the waves in WNW direction an additional breakwater at the north is proposed, to cater to the master plan (Phase 2) requirements. The harbour is aligned such that container terminals are provided east west which is connected to the common rail yard adjacent to these terminals. The nearshore reclamation is proposed for the bulk and multipurpose storage.

The gap between the offshore and the nearshore area is very lean and would have an adverse impact within the harbour. However, this option would involve considerable amount of rock dredging for safe manoeuvring of ships and substantial land fill to provide the required yard and other port facilities. This kind of arrangement would result in high CAPEX making the port development financial unviable and also impact the flexibility of terminal development.

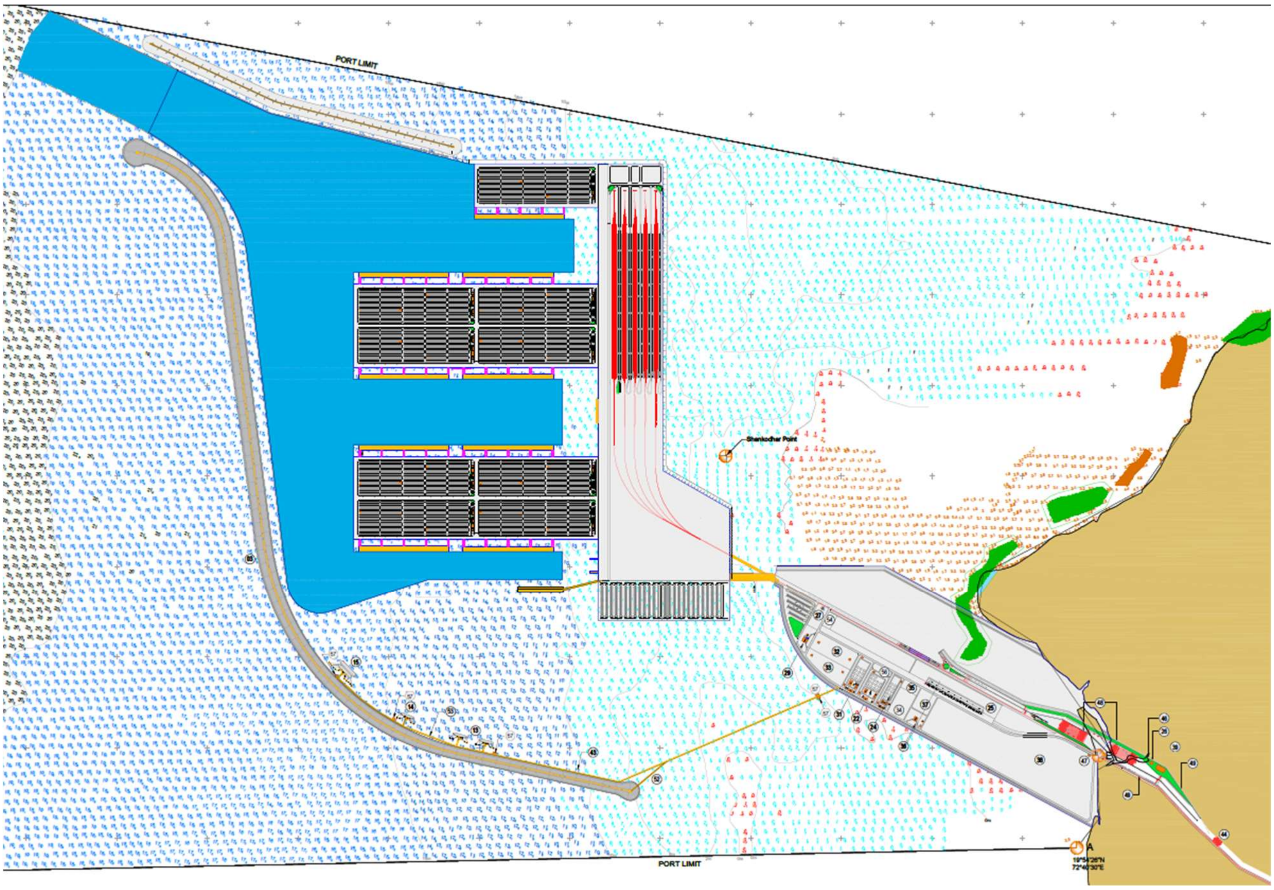


Figure 43 Master Plan Alternative 2

3.4.3 Master Plan Alternative 3

This option was developed addressing the constraints and limitations in the above two layouts. Six finger piers are proposed in the east west direction and 3 marginal quays with the yard behind these quays. The rail yard is located at the rear side of the container yards connecting the onshore reclamation area. This option provides a balance in the dredging and reclamation fill which impacts the overall project cost.

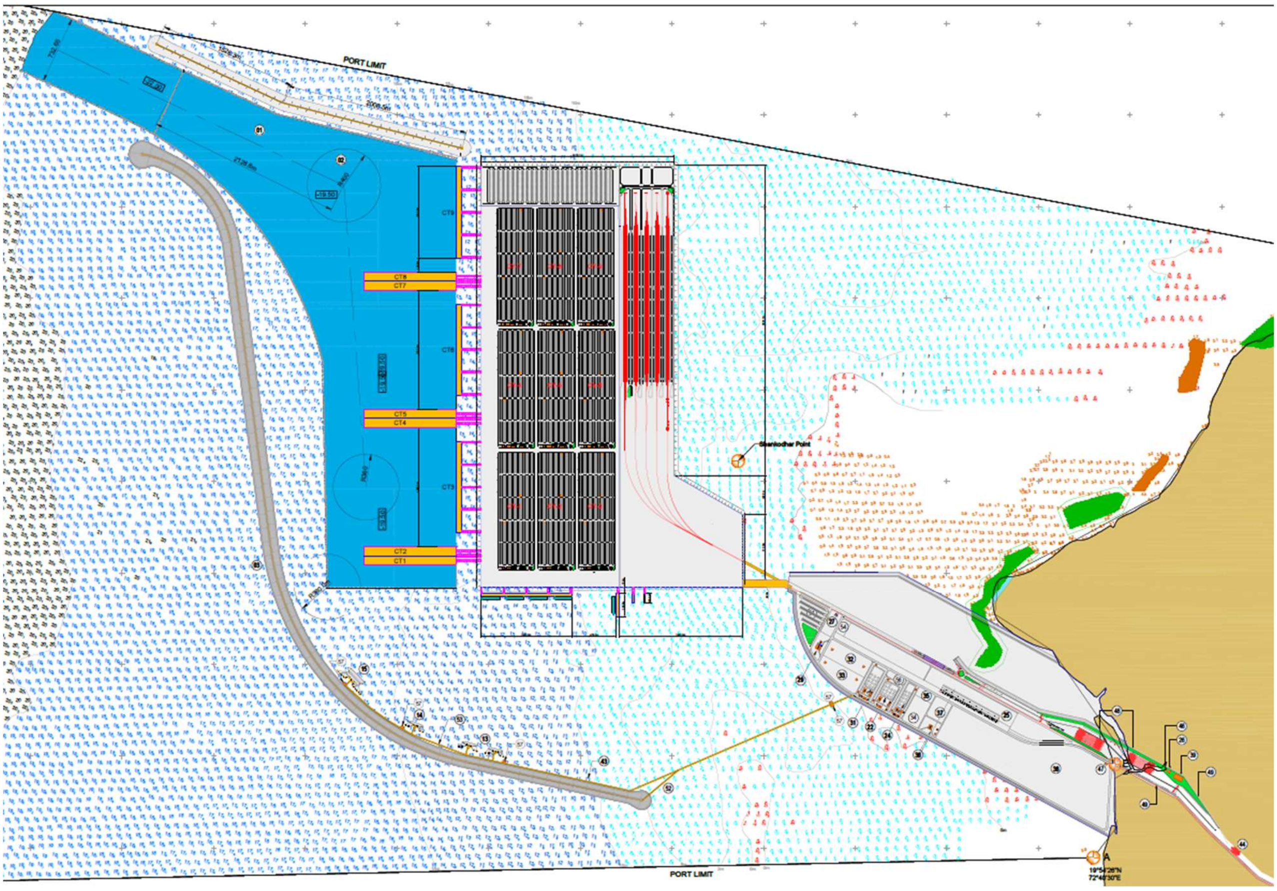
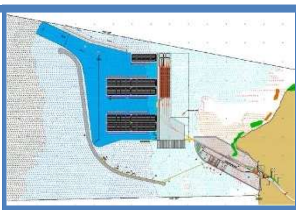


Figure 44 Master Plan Alternative 3

3.5 Evaluation of Master Plan Options

The above alternative master plan options were evaluated using Multi-criteria-analysis as presented in below table. While comparing the capital cost of the development it may be noted that for all the options the cost of breakwater, berth structure, equipment is comparable except with the reclamation, infrastructure facilities in terms of rail alignment and smooth terminal operations.

Table 46 Evaluation of Master plan options

Sl. No.	**Criteria**	 **Alternative 1**	 **Alternative 2**	 **Alternative 3**
1.	Space to accommodate types of berths required in master plan horizon	Substantial rock dredging is required to be carried to accommodate the berths	Less rock dredging compared to Alternative 1	Less rock dredging compared to Alternative 1 and 2
2.	Flexibility in implementing as staged development	The layout is very much suitable for staged expansion	The layout is very much suitable for staged expansion	The layout is very much suitable for staged expansion
3.	Rail Connectivity	Rail connectivity, away from the terminals leading to operational inefficiency and challenges	Good and efficient Rail connectivity	Same as Alternative 2
4.	Operational Flexibility	This layout provides good operational flexibility with the container terminal being contiguous and inefficient in terms of rail operations	Same as Alternative 1	This layout does not provide operational flexibility as the container terminal is not contiguous
5.	Capital Cost of Development	Moderate	High	Low
6.	Operation and Maintenance Costs of Phased Expansion	Moderate	Moderate	High

Of the above layouts, Alternative 3 was taken forward for assessment of its suitability through mathematical model studies. Model studies were carried out with the option of with and without the north breakwater

Table 47 Matrix for Alternative analysis

SN.	Criteria	Score pattern	Alternative 1	Alternative 2	Alternative 3
1.	Space to accommodate types of berths required in master plan horizon	5	2	3	4
2.	Flexibility in implementing as staged development	5	4	4	4
3.	Rail Connectivity	5	2	3	3
4.	Operational Flexibility	5	3	3	2
5.	Capital Cost of Development	5	2	3	4
6.	Operation and Maintenance Costs of Phased Expansion	5	3	3	5
7.	Reclamation required	5	1	1	1
8.	Destruction of Mangroves	5	5	5	5
9.	Impact on local fishing	5	2	2	3
10.	Displacement of Population (R&R)	5	5	5	5
11.	Impact on Marine Ecosystem	5	2	2	1
	TOTAL		**31**	**34**	**37**

Alternative-3 scores more positive points as comnpare to other two alternatives

3.6 Outcome of Model Studies

Numerical hydrodynamic and sediment transport modelling studies were carried out on the Alternative 3 layout.

The results indicated that:

- Maximum cross current at the harbour entrance of 2.5 m/s reducing to 0.3m/s at the expected ship stopping point
- Maximum current speed at the turning areas 0.3 m/s in a S-N direction
- Maximum current speed in the dredged basins between the finger piers in the range 0.15-0.30m/s. These currents are transverse to the berths since open-piled finger pier structures were modelled.

- Annual accretion rate in a limited number of areas of the harbour basin of over 2m. It was estimated that the annual siltation within the harbour would amount to some 11 million m^3.

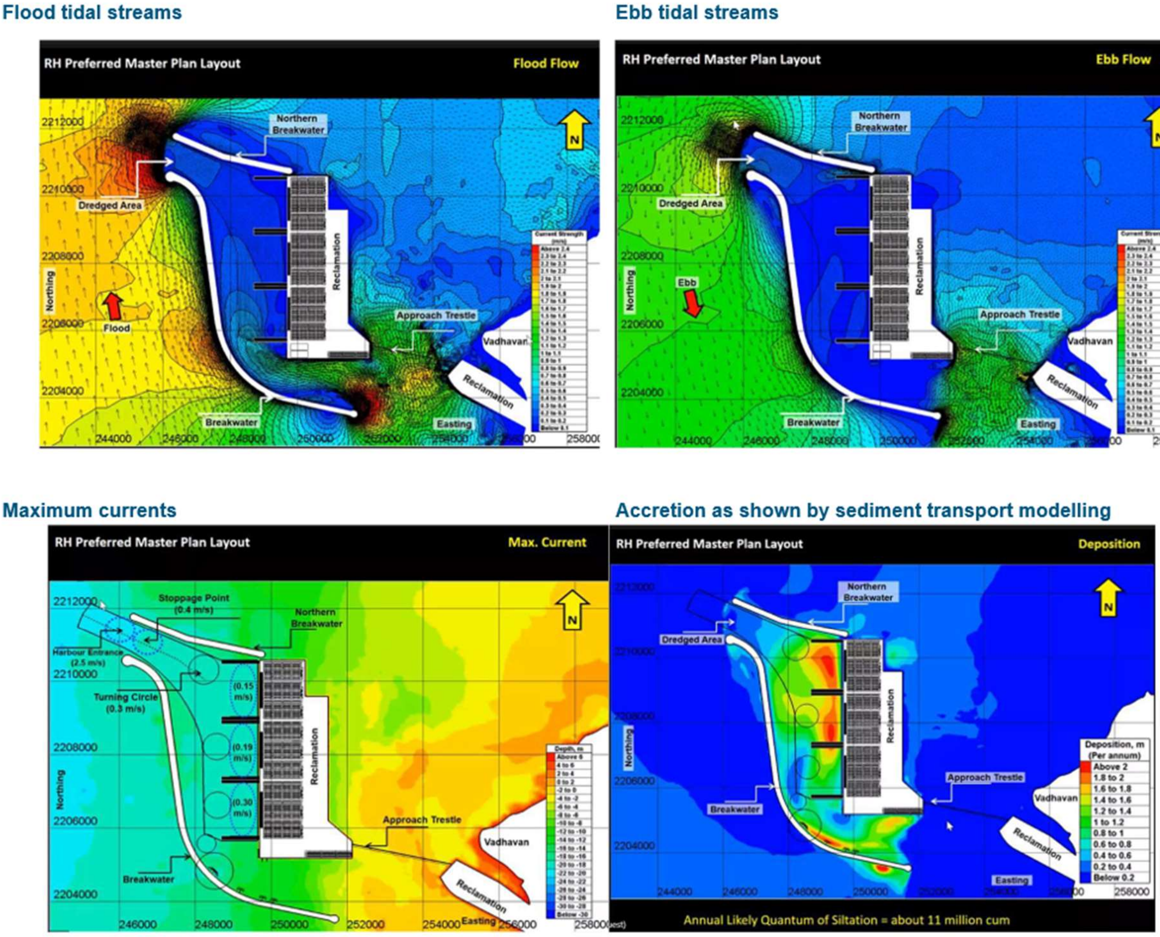


Figure 45 Alternative 3 layout (with north breakwater)- results of numerical hydrodynamic & sediment transport modelling

The same layout was also modelled without the north breakwater. The results indicated that:

- Maximum cross current at the harbour entrance of 2.7m/s reducing to 1.2m/s at the expected ship stopping point
- Maximum current speed at the turning areas 0.5m/s in a S-N direction
- Maximum current speed in the dredged basins between the finger piers in the range 0.27-0.4m/s. However, these currents are transverse to the berths since open-piled finger pier structures were modelled.

The Spring flood tide currents perpendicular to the berths are too high in either the "with" (0.15-0.30m/s) or "without" (0.27-0.45m/s) north breakwater scenarios. As a result, berthing/unberthing will be difficult, if not impossible, and excessive loads will be imposed on the mooring lines when ships are berthed alongside.

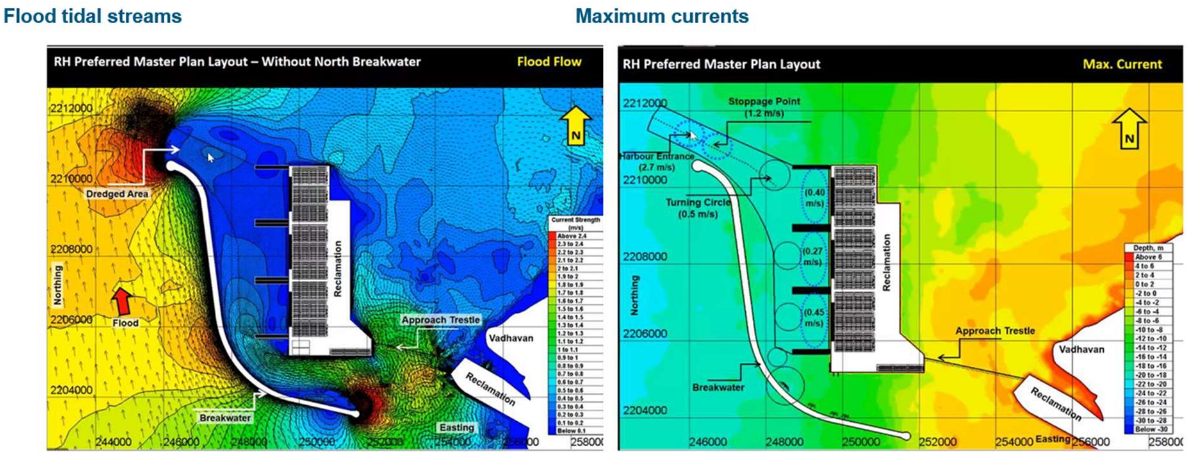


Figure 46 Alternative 3 Layout (without north breakwater)- results of numerical hydrodynamic & sediment transport modelling

Comparison of the maximum current profile at the entrance to the harbour for the “with” and “without” north breakwater scenarios indicated that, “without” the north breakwater, although the current speeds are slightly higher, the current gradient along the centreline of the entrance channel is less than “with” the breakwater. Ship navigation of the transition open sea-harbour entrance and slowing/stopping should therefore be easier in the “without” north breakwater scenario.

A layout without a north breakwater was therefore adopted.

3.7 Proposed Master Plan layout

In the proposed scheme the adoption of solid narrow finger piers will avoid currents perpendicular to the berths. However, container berths on either side of narrow finger piers with the container storage yards located some distance from the berths are undesirable from an operational point of view.

As a consequence, wide reclamation fingers were proposed with marginal container quays and container storage yards directly behind the quay apron.

However, with solid narrow or wide reclamation fingers some increase in siltation may be expected in the basin area between the fingers.

The proposed master plan layout is shown in figure below

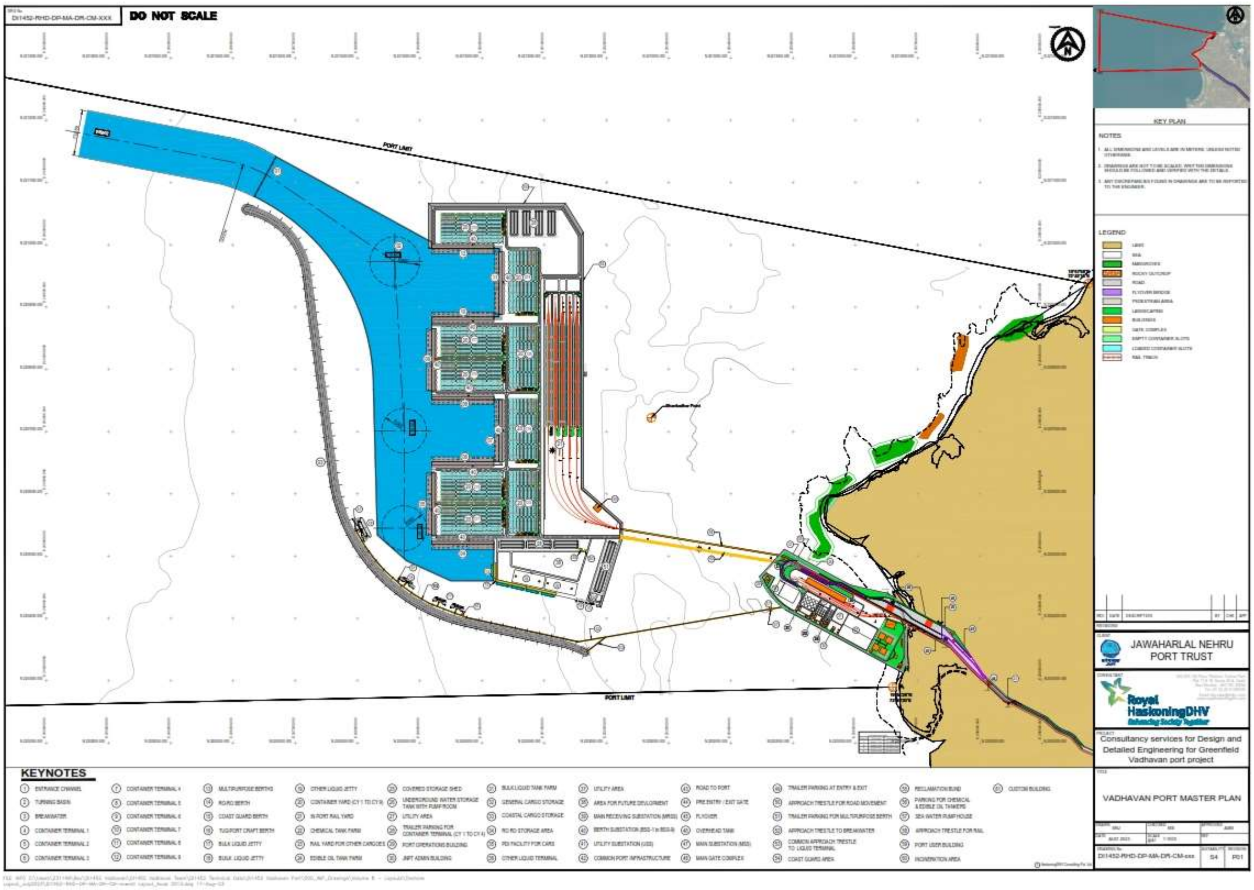


Figure 47 Proposed Master plan layout

CWPRS carried out hydrodynamic modelling of this layout. The results inicate the following:

- Maximum cross current at the harbour entrance of 2.55m/s reducing to 1.3m/s at the expected ship stopping point
- Maximum currents at the turning areas less than 0.4m/s in a S-N direction
- Currents in the dredged basins between reclamation fingers less than 0.05m/s
- Currents longitudinal to the berths at the ends of the reclamation fingers less than 0.2-0.4m/s
- The total quantum of siltation in the dredged areas will be about 9.20 M cum

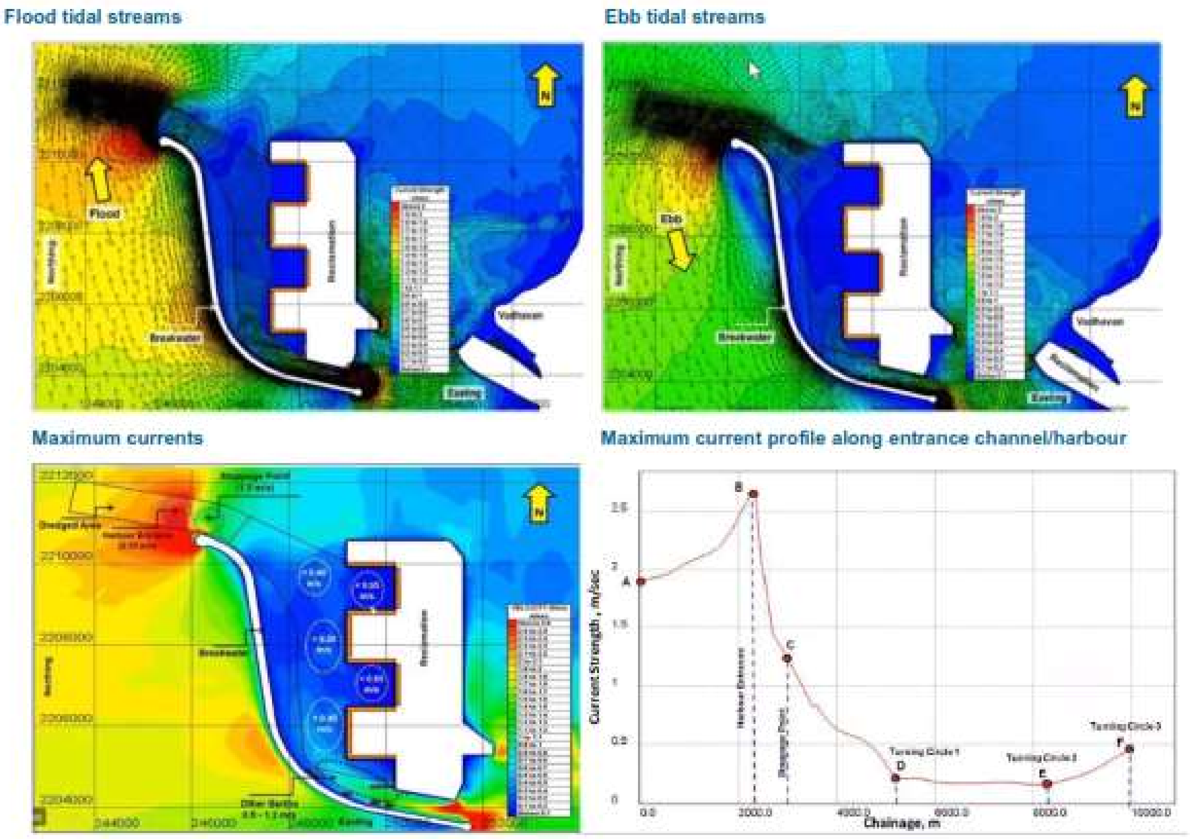


Figure 48 Recommended Vadhavan Port Master Plan Layout - results of hydrodynamic modelling

Based on the flow fields, it was observed that the tidal flow conditions are suitable at all container berths as well as in the manoeuvring area. However, the results of the numerical hydrodynamic modelling indicated that on Spring flood tides the maximum current speed between the southern end of the offshore reclamation and the southern end of the breakwater could exceed 2.5m/sec. In addition, there was indication of eddy formation at the south breakwater head

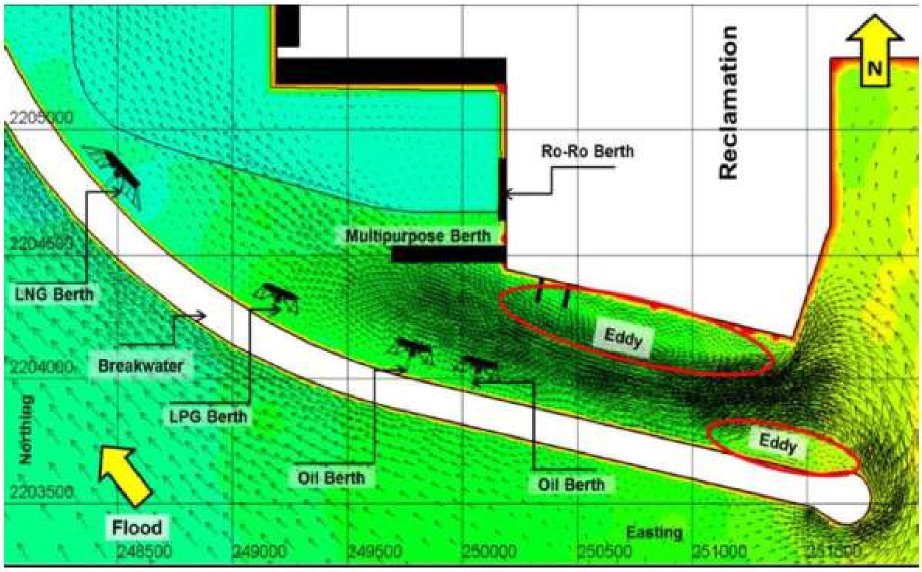
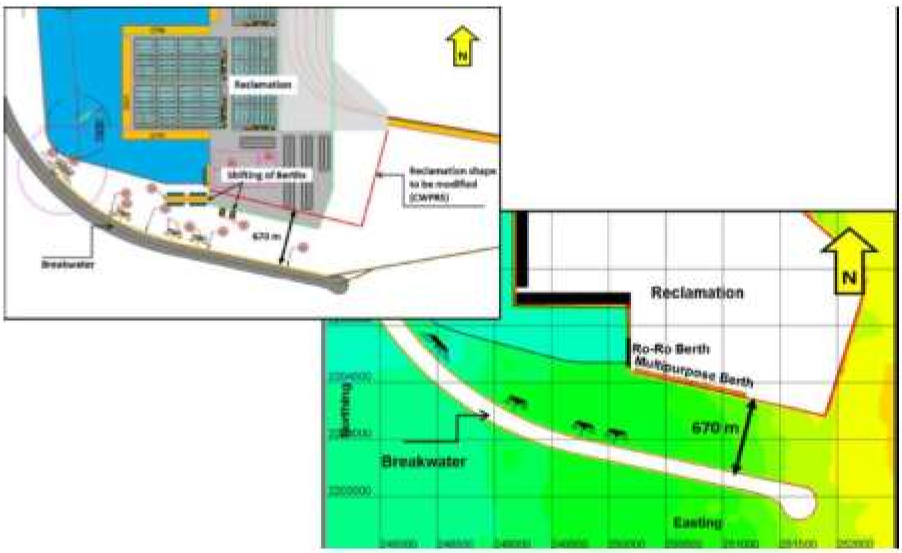


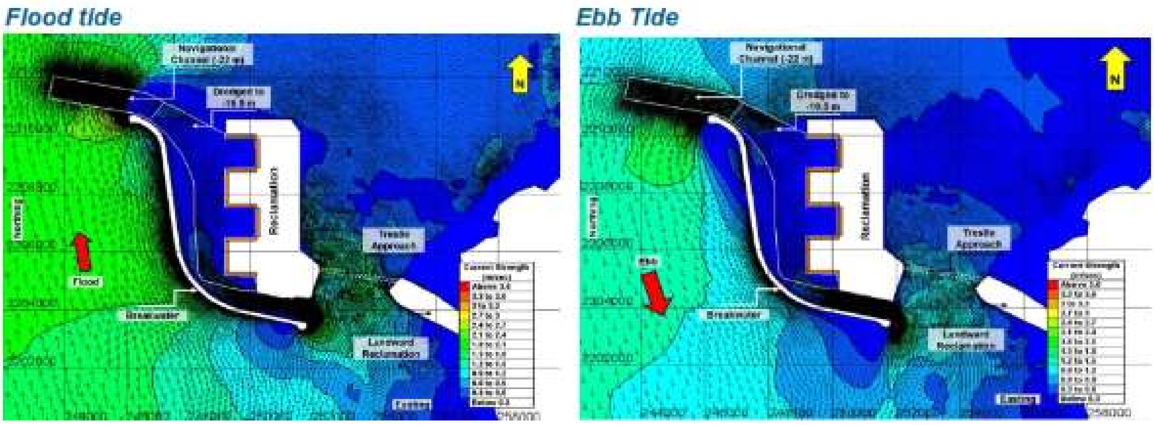
Figure 49 Maximum Spring flood tide current speeds at southern end of the reclamation

Modifications were therefore made by CWPRS to the layout in order to reduce/improve the flood tide current flows at the southern end of the harbour basin. The final port layout is shown in following Figure

Modification in the area at along the southern end of reclamation footprint and maintaining a gap of 670 m between the breakwater and the reclaimed area.



The revised reclamation arrangement facilitated the flow to align along the reclamation face during the flood as well as the ebb tide providing favourable condition for multipurpose berth along the southern end of reclamation.



Shifting of the liquid terminals 500 m along the breakwater towards north to achieve favourable flow conditions.

The quantum of likely siltation will be about 8.45 M cum per annum with the reduction of 0.75 M cum in annual siltation due to favourable tidal hydrodynamic conditions

3.8 Recommended Master Plan

The final Master Plan (also referred to as Phase 2 development) results from identifying the infrastructure needed to achieve the projected market demand over the 2040 planning horizon for the Vadhavan Port's three core commodities: containerized cargo, multipurpose and liquid. This is based on the revised traffic projections and considering the utilizable shore length of 9.5 km at Vadhavan. This infrastructure will include:

- Ability to berth fully laden two 24,000 20-foot equivalent container units (TEU) vessels in Phase 1 itself.
- Ability to handle liquid bulk carriers for chemicals and edible oil.
- Multipurpose vessels
- Container Yard on reclaimed land.
- Rail line to port and the railway yard.
- Berthing facilities for Coast Guard and Port crafts.
- Other support and ancillary facilities

The final master plan layout incorporates the following:

- 9 container terminals each with a straight 1,000m long marginal quay. 7 terminals have the container storage yard located directly behind the quay apron whilst for two of the terminals the container yard is located about 1km behind the quay.
- A total of four multi-purpose berths each 250 m long at the southern end of the reclamation
- 4 liquid cargo berths located on the leeside of the breakwater
- A Ro-Ro berth at the south-west end of the offshore reclamation with adj acent vehicle parking
- Small craft (pilot boats and tugs) and coastguard berths at the southern end of the reclamation.
- Additional berths for small craft may also be provided at the northern end of the reclamation if required.
- Rail terminal located along the eastern side of the offshore reclamation
- Onshore reclamation for liquid bulks storage and administrative facilities

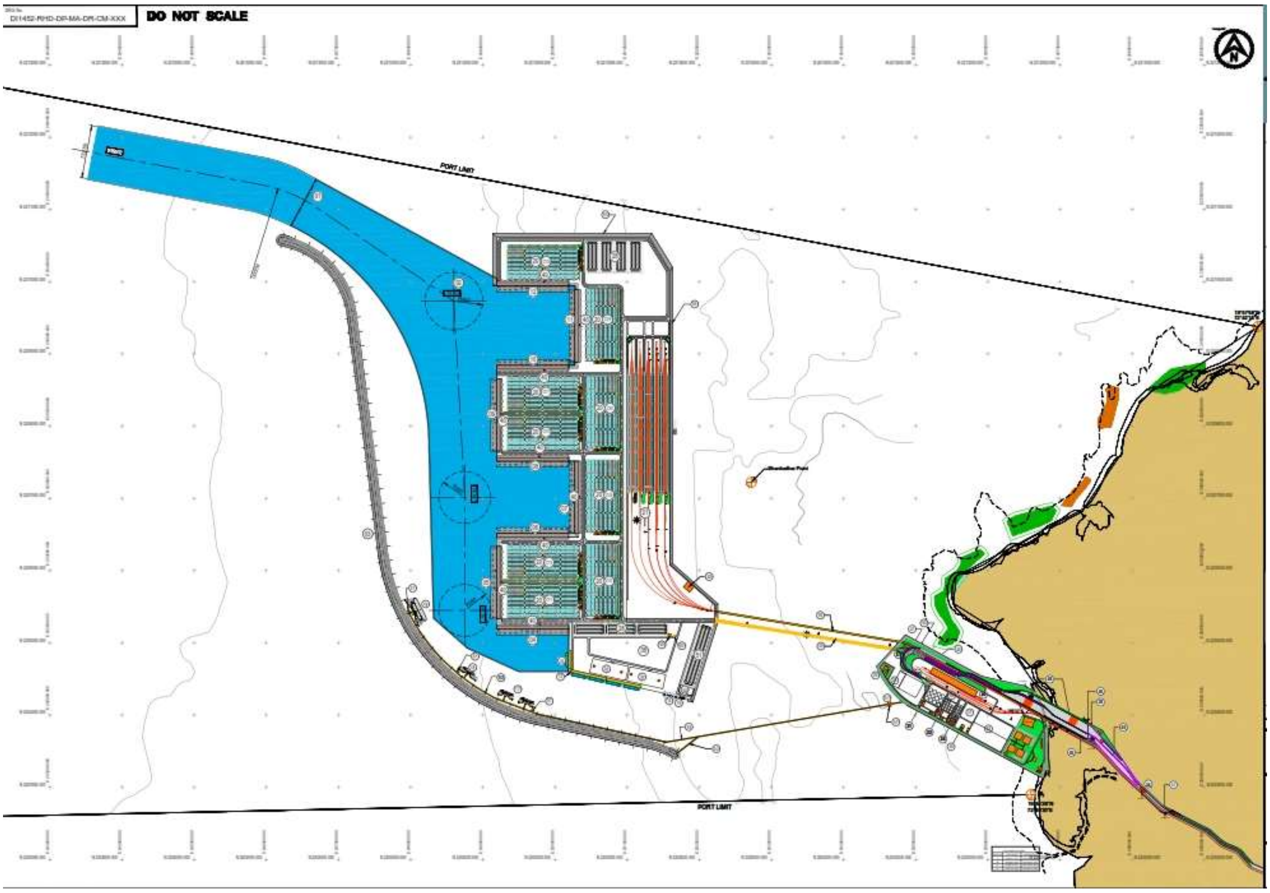


Figure 50 Final Vadhavan Port Master Plan Layout

CHAPTER 4 - DESCRIPTION OF ENVIRONMENT

4.1 General

This section of the report gives description of the existing baseline environmental conditions within the project area, to evaluate the potential impacts of the proposed port development. Natural conditions are often critical when designing and constructing infrastructure works. The assessment of baseline studies of the appropriate environmental parameters, which may be affected by the project implementation, is a pre-requisite for any Environmental Impact Assessment (EIA) study. The purpose of describing the environmental settings in the study area is:

- To assess the existing environmental quality, as well as study the environmental impacts due to the proposed project.
- To identify environmentally significant factors or geographical areas that could prelude any future development.

In order to investigate likely impacts due to commissioning of proposed project, the consultants, M/s. Ms/ Enkay Enviro Services Pvt. Ltd carried out estimation of impacts based on data generated, secondary data as well as literature studies.

This chapter outlines the information on baseline setting of the study area.

4.2 Methodology Of Conducting Studies

Field monitoring for meteorological conditions, ambient air quality, water quality, noise quality, etc. was carried out, which constitutes major portion of the baseline environmental studies.

The impact due to construction of project site on existing baseline of environment will be restricted and will be temporary in nature. These are further controlled and minimized by adopting various mitigation measures. Even during operational phase, the impact on environmental settings will be negligible and will be controlled by adopting proper Environment Management Plan (EMP). These aspects have been studied with reference to the proposed project and baseline data has been presented in this chapter.

EIA is often mandatory requirement for planning and development of infrastructure. The EIA determines the possible environmental consequences of the project, prior to construction, interprets existing baseline condition of the surrounding environment and also focuses on land use and socio-economic parameters. The entire data has been collected through actual physical surveys and observations, literature surveys, interaction with locals, government agencies and departments. This chapter describes the baseline environment settings in the area and will throw light on impact of the project on day-to-day environment.

4.3 Study Area

The study area for the baseline data collection involves 10 km (aerial distance) from the location of the proposed project. The primary and secondary baseline data was collected for the parameters viz. ambient air quality, noise, marine water and sediment quality, and ecology (flora and fauna) within 10 km radius around the proposed project site. The monitoring of these parameters was carried out in the pre monsoon period during **March 2021 to May 2021**. The primary data for socio-economic environment was collected within 10 km (aerial distance) from the location of the proposed project. As shown in Figure below;

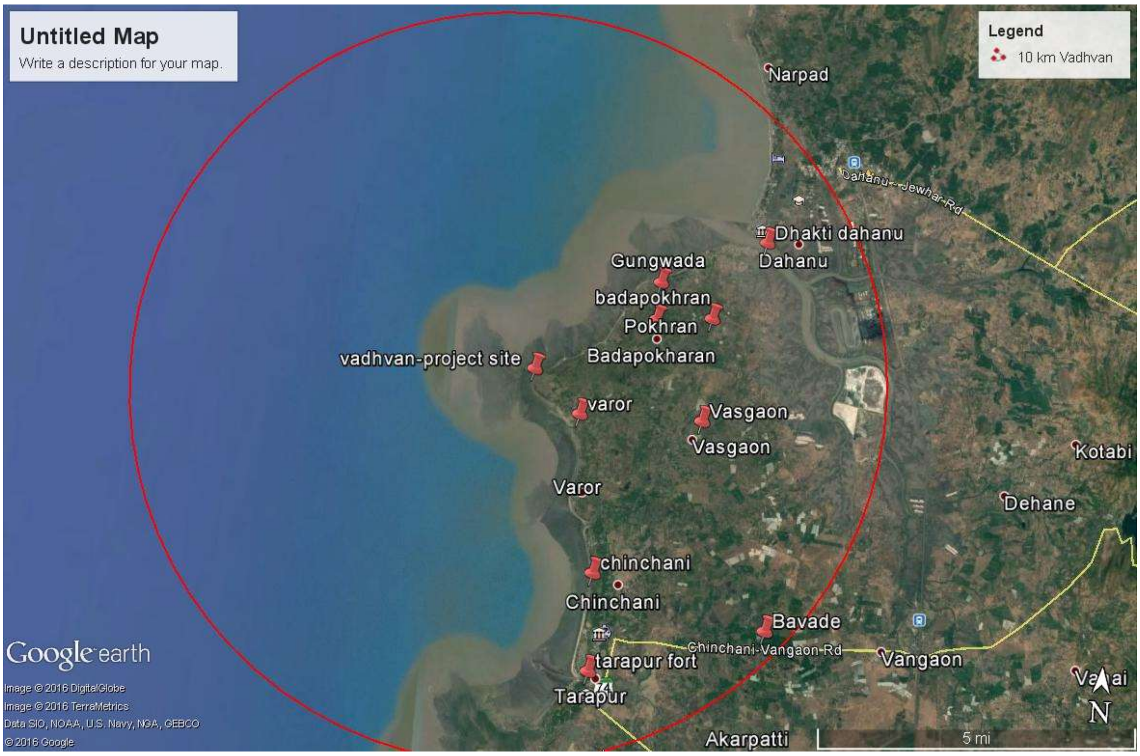


Figure 51 - Environmental Study Area for Vadhavan Port Project (10 km radius)

The various parameters studied during environmental survey are indicated in the following Table below;

Table 48 Environmental Settings

Sr. No	Parameters	
1.	Air	PM_{10}, $PM_{2.5}$, SO_X, NO_X, CO etc
2.	Water(Marine)	Salinity, Temp, pH, BOD, COD, DO, etc.
3.	Noise	Noise levels
4.	Socio-economy	Socio-economy status, population, literacy etc.

The secondary data was collected from IMD and visits to department and through literature surveys and filed study conducted by NIO, CMFRI, ZSI etc. The topography and meteorological conditions for the district has been discussed as whole while the environmental setting for air, water, noise and biodiversity studies were carried out for each part.

4.4 Land Environment

4.4.1 General

The distinctive features of the location identified are as below:

- A natural water depth of around 20.0 m below CD is available at 10 km from Vadhavan point and 15 m contour is available at a distance of 6 km which will allow safe voyage and mooring for the new generation vessels.
- A shallow inter-tidal zone between 0.0 and 2.0 m contours is available for reclamation for backyard area development which is ideal and eliminates the scope of land acquisition and rehabilitation. Thus, avoiding the R&R issues.
- As deep-water depth is available from 6 to 10 km, new generation vessels calling for deep draft can be planned without/ minimal cost on dredging.
- Connectivity to NH-48 (Mumbai-Delhi), upcoming Vadodara-Mumbai Expressway, existing Indian railways link and upcoming DFC (Dedicated Freight Corridor) is available at short distances for providing connectivity to cargo destinations centre in hinterland.
- The Road and Rail Connectivity can be availed through un-habituated areas which do not call for rehabilitation and resettlement.

4.4.2 Land

The Vadhavan port is planned to be located on reclaimed land on inter tidal zone at Vadhavan Point. The site is surrounded on the West, North and South by Arabian Sea, various villages on East with discreetly habited land. No Land Acquisition for Port is there as the land acquisition is only required for rail and road which is less than 571 ha and 30% of which is forest land and government land.

4.4.3 Topography

Topography of the intertidal zone is rocky and highly undulated. Casuarina plantations are observed along the shoreline. The bed levels in inter tidal zone are sloping west. The slope varies from 1:350 to as gentle as 1:2000 in some section. The onshore area topographic details have been extracted from various applications like Google Earth and processed through ArcGIS software. This information has been completed using the available land charts of the region.

The land close to Vadhavan site is flat and having undulations close to hilly area. The rock outcrop close to shoreline of Vadhavan can be seen and indicate rocky patches under inter-tidal area. The inter-tidal zone is wide and extends up to 1.7 km. The beach is sandy. The general terrain of the site area is largely flat with a mild slope. The following gives a general picture of the site terrain;

Figure 52 - Site Terrain near Vadhavan Port area

(Source: Detailed Project Report for Development of Greenfield Vadhavan Port by Royal Haskoning DHV Consulting Pvt. Ltd.)

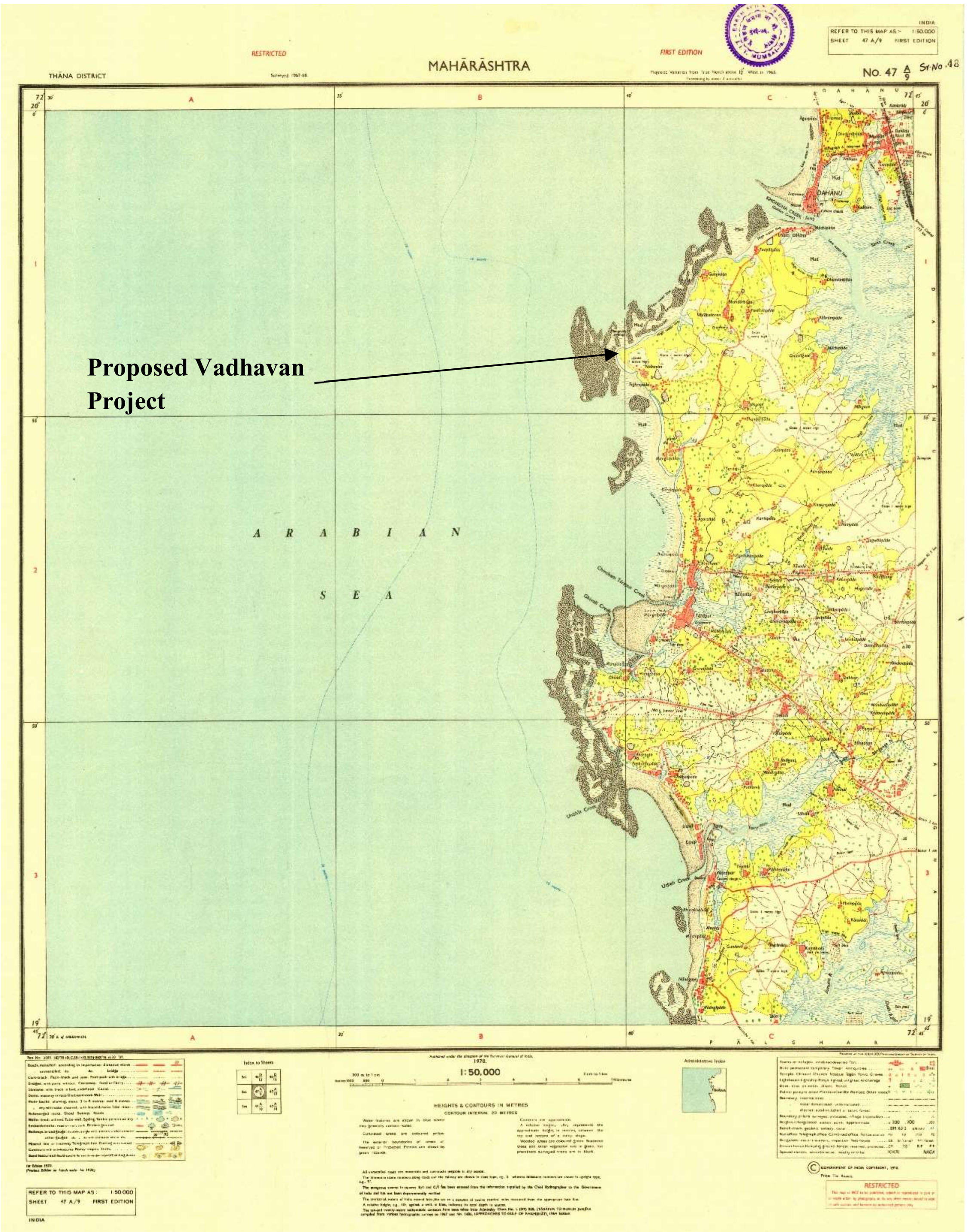


Figure 53 – Topography Map of Proposed site

4.4.4 Landuse land cover

Following image shows land use land cover of the study area

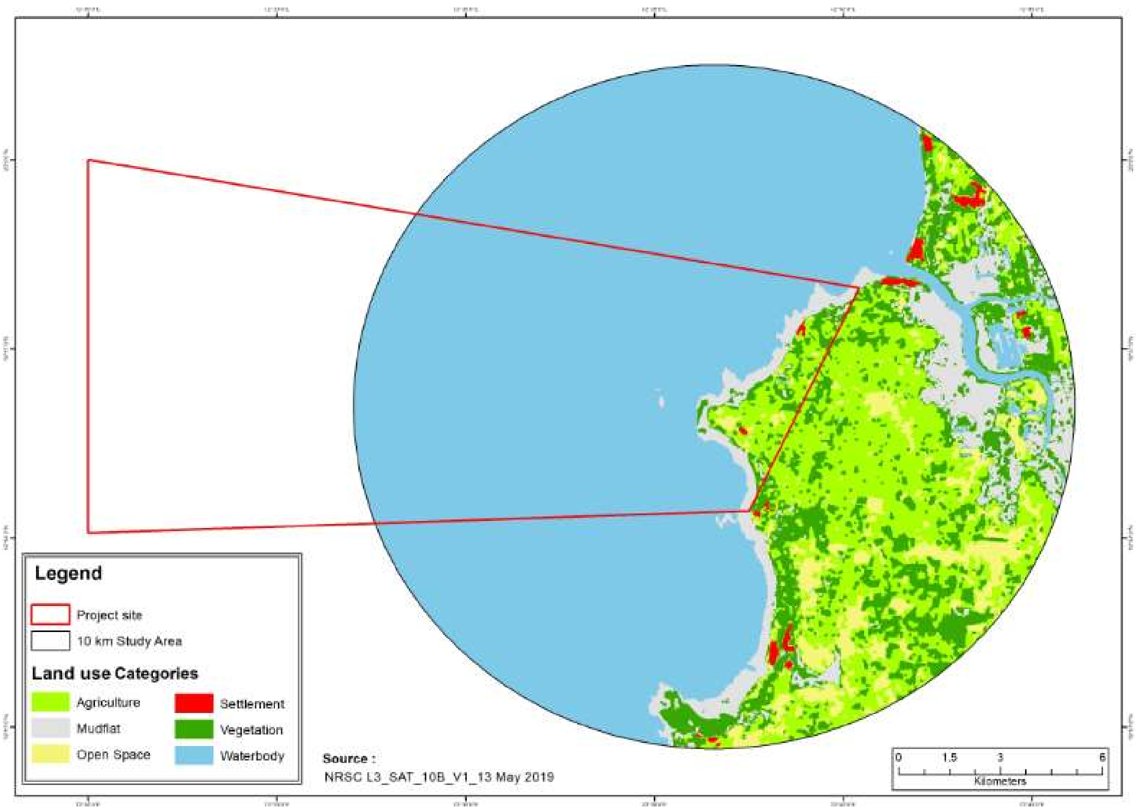


Figure 54 LULC map of the study area

The study area comprices of 13.7 % of agricultural land, 6.7 % mudflat, 4.6 % open spaces, 0.4 % settlement area, 9.8 % vegetation, and 64.7 % waterbody.

4.4.4.1 Land Use Pattern of Shortlisted Quarry Sites

Khanivade

Khanivade quarry site is located in the Palghar district, Maharashtra. This quarry site is owned by the government and is a virgin land. This quarry is in the SE direction and about 19 km from the proposed project site. The total area of the quarry site is about 7000 Ha (~18,000 acres). The quarry capacity is approximately 70+ Mcum. This quarry site is free from human settlement within a 500 m distance. The quarry site is surrounded by vegetation comprising both of natural tree cover as well as paddy fields, fruit and vegetive plantation. The equipment at this quarry includes blasting, hydraulic drilling units, backhoes, bulldozers, trailers and tractors and other smaller equipment. Quarries are reported to be operational during daytime only. The quarry material from Khanivade will be transported to the project site. The total length covered during transportation will be approximately 22 km which is inclusive of transportation from the quarrying site to the main road connecting the project site (19 km).

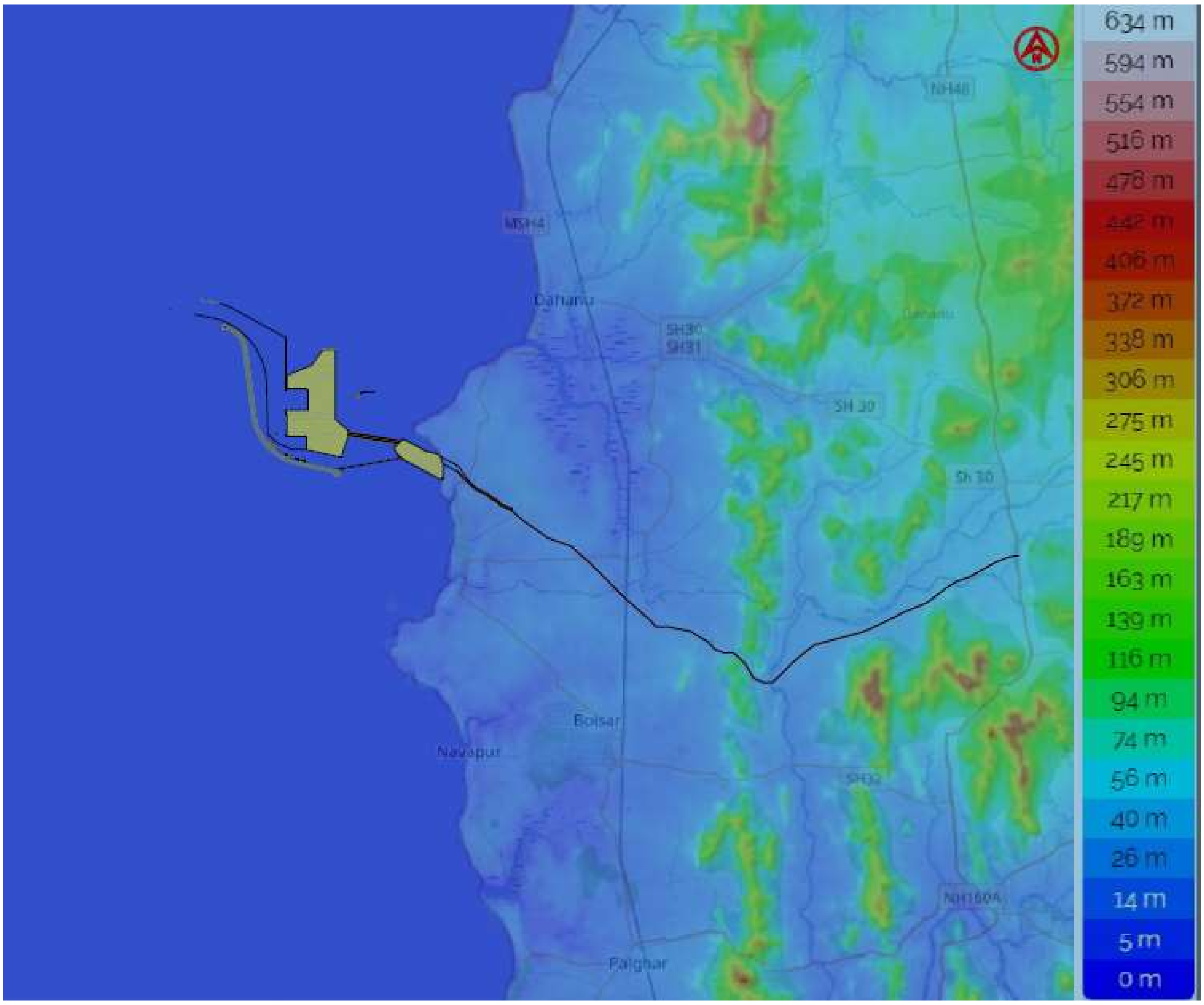


Figure 55 Digital Elevation Map of the Study Area

4.4.5 Transportation from the Proposed Quarry Site to Project Site

The transportation route of the two quarry locations are shown in figure below.

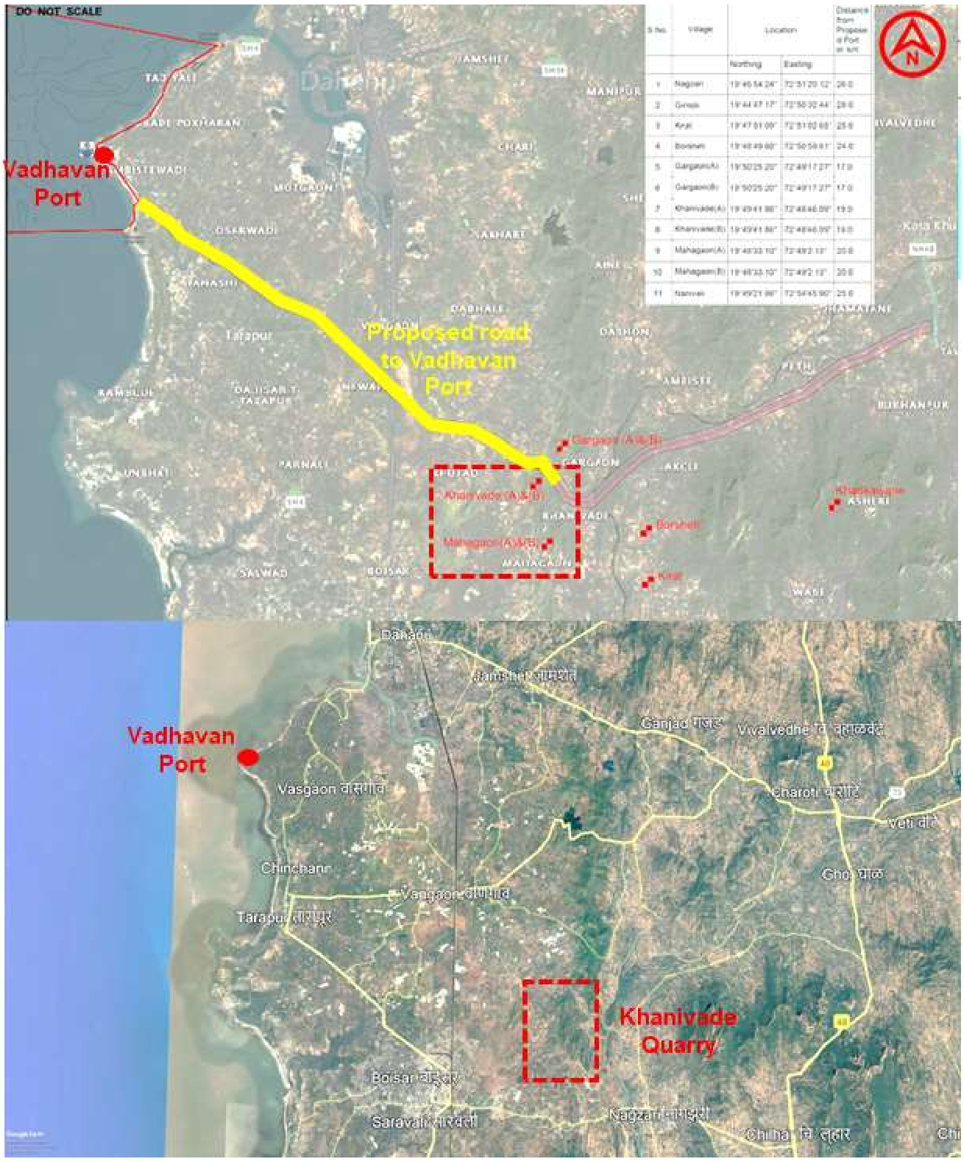


Figure 56 Khanivade Quarry Site

4.4.5.1 Traffic Survey near Quarry Sites

A traffic survey was conducted at major junctions along the various routes to understand current road traffic levels in the vicinity of the proposed port, Map the existing road network and proposed roads in the vicinity of the proposed port including identification of future bottlenecks by IIT Bombay (May 2021).

The proposed greenfield road alignment to carry port traffic directly to NH 48, takes off from port area in Vadhavan and joins NH at Tawa village. The new road is being planned as an 8-lane highway. Western railway mainline is proposed to be linked to the port through a new dedicated freight corridor to the port, taking off at Newale village, parallel to the greenfield road alignment, with a station yard also proposed at the junction.

Traffic data count was collected at 6 major intersections. These intersections are: 1) Chinchani Naka, 2) Kambale Naka, 3) Dahanu Fishmarket, 4) Ranshet 5) Dehane and 6) Ashagad. The traffic count data was collected on 19-12-2020 at these intersections for every 15 minutes time interval during morning period from 8:00 AM to 11:00 AM and during the evening period from 4:00 PM to 7:00 PM on two days. The data collection capture both morning peak and evening peak. Classified turning movements at every 15 minutes were recorded manually during both morning peak and evening peak periods. The morning peak hour volume was further used for volume to capacity analysis and develop a traffic simulation model.

The Chinchani- Vangaon section of SH 31 has 4m to 5m width (varying at places), with shoulder provisions on either side of the road. The presence of a railway crossing hinders the free movement of vehicles at Vangaon. The stoppage time due to the railway crossing (manned and gated) ranges from 10 to 15 min, and it is very frequent due to the high rail traffic on the Western mainline. However, a new dedicated road is proposed through Vangaon to the port resulting in non-interaction with the local traffic.

Vangaon is the one of the junctions near the Khanivade quarry site. This survey was conducted for 24 hours at this junction including other critical connectivity points. The results are depicted in figure 58. It is clear that the traffic flow was highest in Chinchani junction which is far from Khanivade quarry site.

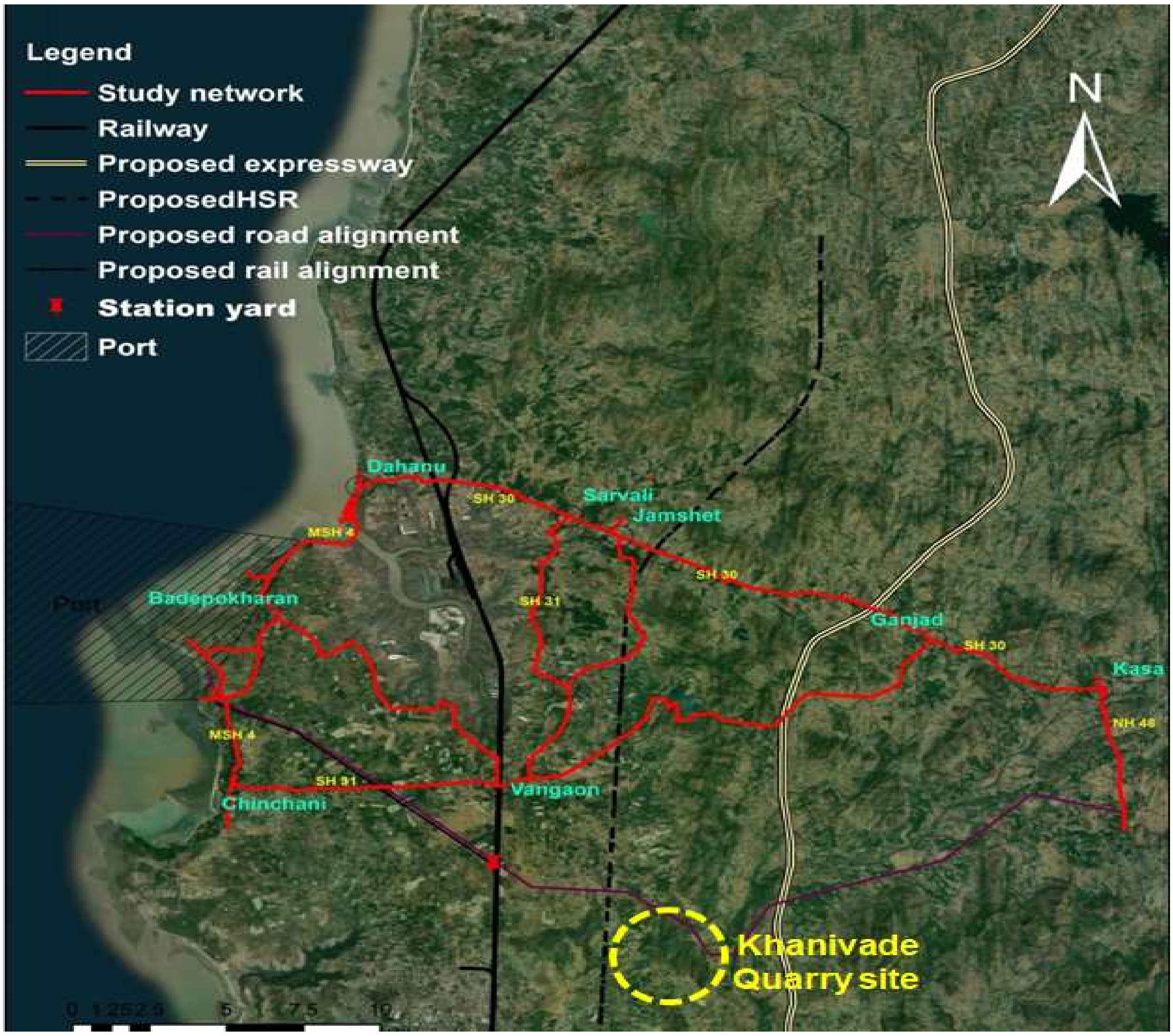


Figure 57 ***Proposed Road alignment for the Vadhavan port with reference to Khanivade Quarry***

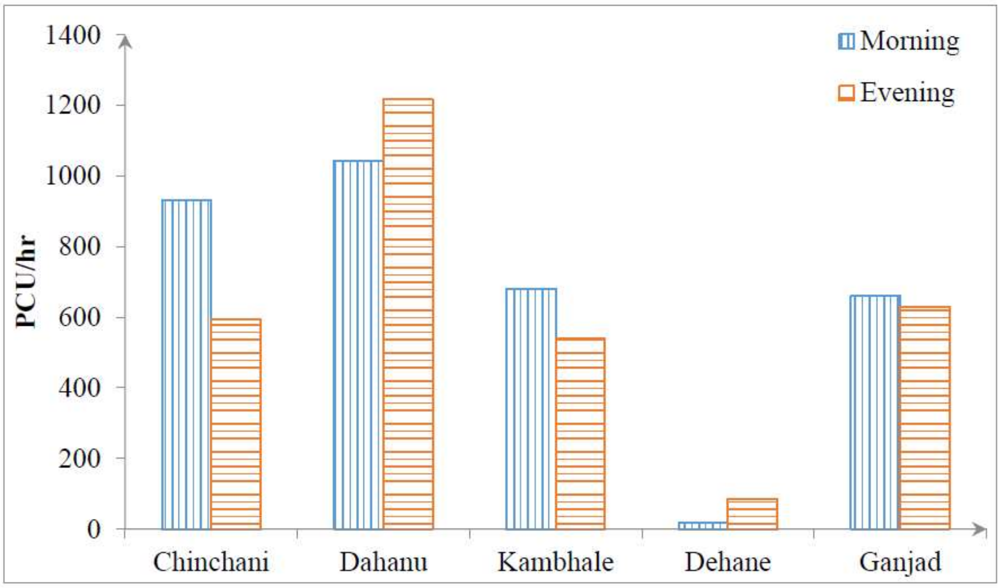


Figure 58 Traffic Survey at Major Junctions

Some of the broad observations from the study are:

1) The existing road network is sufficient to carry the present level of traffic. However, many parts of the network are under distress condition affecting the speed and capacity.

2) The road widths are not uniform. Narrow road widths for small stretches affecting the travel speed and capacity.

3) In future, the study network will require capacity additions by widening the existing roads. The simulation showed reduced speeds and increased queue lengths at some key locations. Provision must be made for sufficient fund construction and land for widening.

4) The proposed 8-lane connector for port-bound truck traffic is good enough for more than 15 years (until 2038) as per the port TEU handling estimates. The estimated freight demand beyond 2040 may create congestion.

5) With the implementation of the proposed improvements at different stages, the road network can be maintained at a low congestion level for more than 20 years.

The following suggestions are made based on the results obtained through traffic assessment analysis and simulation in the base year 2020 and by analyzing the improvements for future scenarios.

1) Resurfacing the deteriorated road stretch in the study network: This ensures safe, comfortable, and faster travel in the study network.

2) Maintaining the provision of shoulders: The authorities can ensure the provision of shoulders on both sides of the road throughout the study network

3) Road-over bridge on a railway crossing in Vangaon: The at-grade railway crossing (Western railway line) in Vangaon, can be improved with the road-over bridge. This can eliminate a bottleneck which can cause 10-15 minutes stoppage at very frequent intervals, resulting in significant queue length.

4) Four laning of Dahanu to Ashagad road: The road connecting Dahanu and Ashagad is mostly an undivided 2 lane road, which is recommended to widened to a divided 4 lane road before 2028 with uniform road width. A provision of proper shoulders should be provided on both side of the road along the stretch

5) Bhoisar-Dahuan Coastal Road: This is an important road for Bhoisar industrial area bound traffic. Presently this coastal road is of varying width from one lane to two lanes. The entire road needs to widened to uniform 2-lane before 2023 with shoulders on the both sides. This road need to widened to four-lane before 2033.

- o Two laning followed with 4 laning of Chinchani to Badepokharan: The road connecting Chinchani and Badepokharan is mostly a 1.5 intermediate lane road, which recommended to be widened to 2-lane before 2023 and then to a 4-lane road before 2033. A provision of proper shoulders should be provided on both side of the road along the stretch.

- o Four laning of Dahanu to Badepokharan: The road connecting Dahahu and Badepokhran is mostly an undivided 2 lane road, which is suggested to be widened to a divided 4 lane road before 2033 with uniform road width.

6) Widening of Chinchani to Vangaon followed by 4 laning in 2043: The road connecting Chinchani and Vangaon is mostly a 1.5 intermediate lane road, which needs to be widened to undivided 2 lane road before 2023 with uniform road width. A provision of proper shoulders should be provided on both side of the road along the stretch. Further before 2043 the section is proposed to be widened to 4 lanes to cater for the increasing travel demand.

7) Four-laning of Ashagad to Ganjad: The road connecting Ashagad and Ganjad is mostly an undivided 2 lane road, which needs to be expanded to an undivided 4 lane road before 2033 with uniform road width. A provision of proper shoulders should be provided on both side of the road along the stretch.

8) Four-laning of Ganjad to Vangaon: The road connecting Vangaon in SH 31 to Ganjad junction in SH 30, which was 2-lane undivided, is recommended to be expanded to 4 lanes before 2043. A provision of proper shoulders should be provided on both side of the road along the stretch.

4.4.6 Land Use Land Cover

4.4.6.1 Land Availability

All the port facilities are proposed to be developed entirely on reclaimed land whereas all the infrastructure facilities like back up areas, terminal areas, administrative buildings, etc. are planned to be developed on the landward side of the reclaimed area of 221 Ha.. The port facilities which are planned to develop on reclaimed land comprises an area of approximately

1448 Ha. The total area required for development of port and associated facilities will be 16,967.54 Ha (including the water area inside the port).

4.4.6.2 Land Use Pattern in Study Area

A land use land cover map for the project area is presented in Figure 45. The quarry material transport route from Khanivade to Vadhavan port site is presented in Figure 57 above..

4.4.7 Geology

The data pertaining to geology and geomorphology of the Palghar district in general and Vadhavan in specific has been assimilated by reviewing published literature and documents, especially from the Publication of Dsitrict Mining Plan Palghar district, 2019.

Also, site specific geotechnical investigations are taken into consideration to understand the geology of the project area.

A major part of the district is covered with basalt i.e., lava flows generally called as Deccan Trap. This volcanic activity was confined mainly to Lower Eocene to Upper Cretaceous age. Between two eruptions there was a time gap and during this period upper surface of flow subject to denudation and weathering. This time gap is marked by formation of red bole and Ash beds. The upper surface of lava flows has generally vesicular struches caused by the escape of the gases and steams from molten lava. During the sudden cooling at the surface, joints and other openings developed. The upper surface of each flow therefore has a rough texture. Based on the megascopic structures and physical properties, basalts of the district can be classified into l) compact, Massive Basalt. 2) vesicular Zeolitic Basalt 3) porphyritic Basalt 4) Fractured and Jointed Basalt.

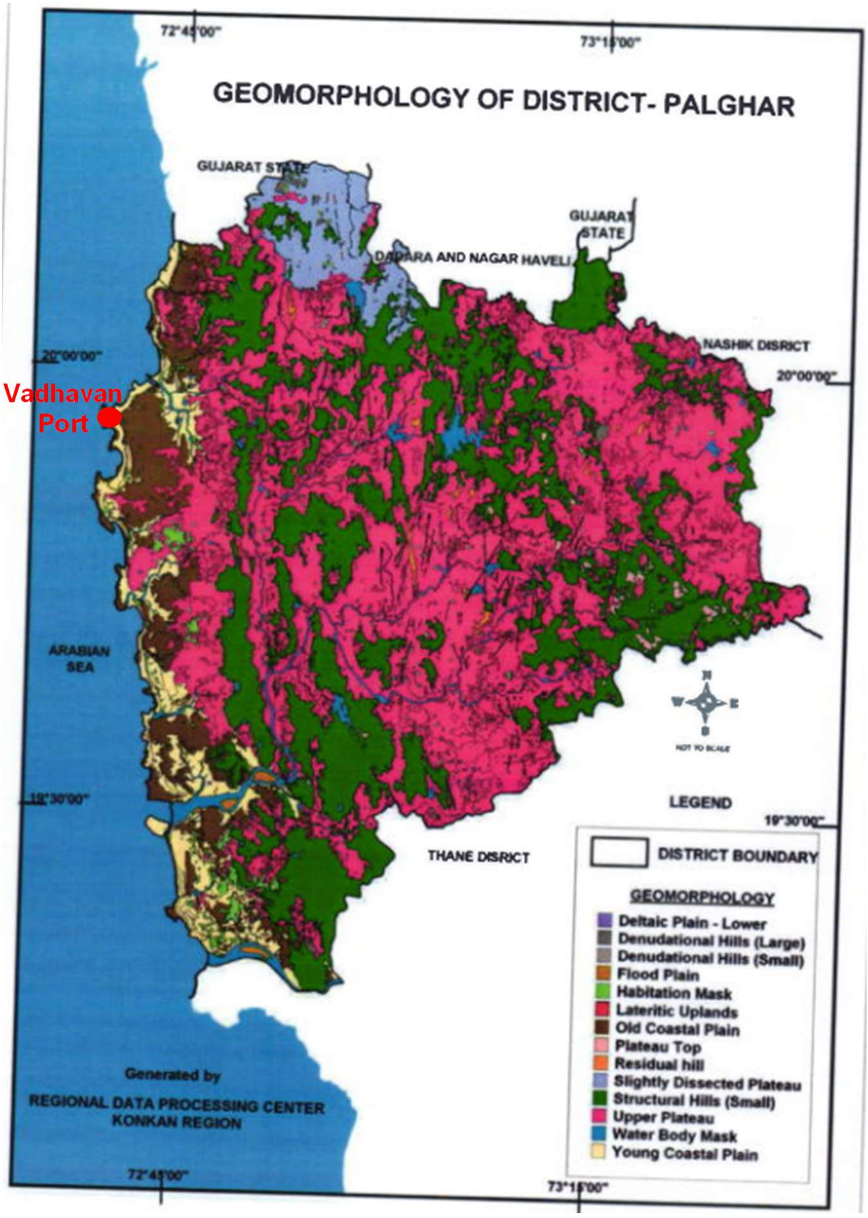


Figure 59 Geology Map of Palghar District

Source:- District Mining Plan Plaghar District, July 2019

The thickness of compact & Massive flows varies between 15 m to 20 m thickness of Fractured and Jointed flows vary between 5 to 8 m. The thickness of vesicular zeoritic flows vary between 3 to 6 m and porphyritic flows having thickness vary between l0 to 20 m. (Source: An appraisal of Hydrological Condition of Thane district) Stratigraphic sequences of the georogical formation in the district is shown as below:

Table 49 Stratigraphic sequences of the georogical formation in the district

Formation	Age	Lithology
Alluvium	Recent	Clay, silt and Sand

Formation	Age	Lithology
Beach Sand	Recent	Sand and silt
Laterite	Pleistocene	Laterite
Dykes	--	Basic intrusion
Deccan Trap Basalt	Lower Eocene to upper cretaceous	Basalt

The Deccan trap flows in the district are classified into 'Pahoehoe' and 'aa' and are normally aphyric to feldspar phyric. At places some of the feldspar phyric flows are highly porphyritic containing giant sized plagioclase feldspar. These megacryst flows are quite extensive and serve as reliable regional markers for grouping the flows into various formations. Three different Megacryst horizons viz. (M1, M2, M3) have been identified and on the basis of these marker horizons the lava pile has been divided into six formations. The lowermost selher formation comprises 11 aphyric flows. Upper Ratangarh formation comprising six aphync to felsic 'aa' flows appear next in the sequence. The uppermost Karla formation comprises of three compound Pahoehoe flows of aphyric in nature.

The basaltic pile of the area is profusely intruded by rocks of Borivali formation which includes dolerite and basaltic dykes, tuffs and agglomerates. The frequency of dye much more north-westem part where the N-S trending dykes is very conspicuous. Dykes trending in NW-SE' NE-sw & E-w are also observed. Frequency of dyke relatively less in Southeastern part.

Alluviums developed in the western part of the area along the coast and river courses and are lacustrine in nature' Along the coast, alluvium consists of clayey and mud deposits. The quality of water is slightly brackish and pumping from this formation has to be restricted to prevent ingression of seawater. The alluvium constitutes the potential aquifer in the area.

Most of the rock at Vadhavan Point and off comprises rock of basaltic composition. The basaltic rock is dark grey, black and hard, tough and compact. The rock is susceptible to superficial weathering. Most part of the hard rock under the sea is weathered and degree of weathering varies from exposed rock to subsurface rock with subsurface rock more weathered than the exposed one.

4.4.8 Seismicity

Vadhavan Port site is in Zone III of Indian Map of Seismic zones (IS-1893 Part-1 2002) which is a moderate risk seismic intensity zone. The zoning map as per Geological Survey of India is as shown in Figure below.

However, considering the Palghar earthquake sequence, whose largest magnitude was 4.5 till now and considering the project of national importance and vital installations, it was advised by CSIR – National Geophysical Research Institute to consider the seismic zone IV in design parameters.

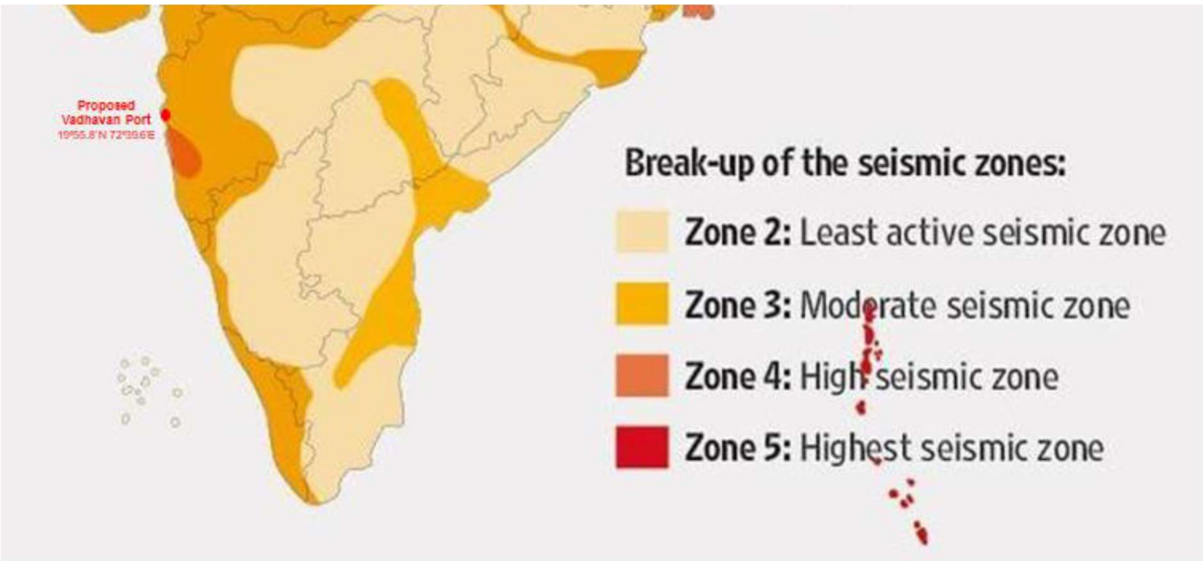


Figure 60 - Seismic Zoning Map as per Geological Survey of India (GSI)

The seismo-tectonic faults and earthquake zonation is shown in Figure 61. From the map it is evident that no major/regional seismically active faults, thrusts or trenches are present in the project area. Few exiting fault lines from map can be observed which are located about few 100kms away from the site. It is also evident that the project area did not experience any major earthquake in the past few years. The seismic scenario of Maharashtra is monitored by National Center for Seismology which maintains National Seismological Network of 115 stations each having state of art equipment and spreading all across the country. The seismic history of Palghar district collected from National Center for Seismology. The Palghar region of Maharashtra is seismically active which lies in seismic zone III; witnessed 21 earthquakes during the month September 2020 in the magnitude range 2.0-4.0. The largest event of M4.0 occurred on 04th September 2020 (18:11:54 UTC), this was followed by M3.8 on 08th September 2020 (04:20:42). Six events in magnitude range 3.0 - 3.6 and 13 events of magnitude range 2.0-2.9 occurred during this month. For the event of 04th Sep2020 (M:4.0), 11 felt responses were reported through website (seismo.gov.in) and App (RISEQ) within the radius of about 200 km from the epicentre.

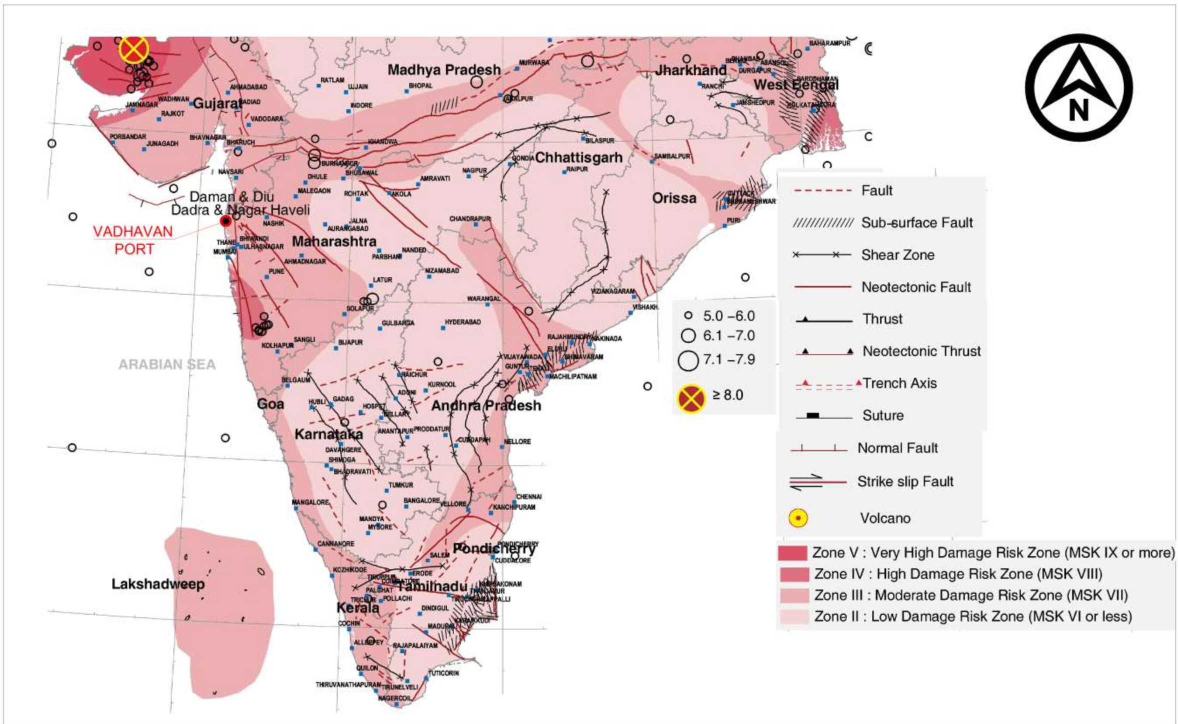


Figure 61 -Seismic and Earthquake Zones and Regional Faults in Maharashtra (Building Materials and Technology Promotion Council (BMTPC), 2012)

4.4.9 Soil Quality

The Palghar district forms part of western slope of Sahayadri hill range. This hill range passes through the eastern part of the district. Major part of the district constitutes rugged and uneven topography, characterized by high hills and steep valleys. Physiographically, district can be divided into two broad divisions-Undulating Hilly Tract and Coastal Plain in western part. Most of the soils in the district can be considered as being derived from trap (Basaltic) rocks. The soil has been classified into three broad categories based on the characteristics and relationship with topographic set up. (1) Soil of Coastal Lands with Residual Hills - These soils are slightly deep, poorly drained, fine soils on gentle sloping land and very fine soil on sloping land. These soils are calcareous and occur along the coast of Vasai, Palgarh and Dahanu (2) Lighter Colored soils - These soils are occurring on the undulating, elongated hills and intervening valleys. These are medium to deep grayish in color, poor in fertility, clayey to loamy in nature, shallow in depth and coarse in texture. These soils are known as Varkas and are suitable for rice. These soils occur on the eastern part of the district. (3) Black Colored Soil- These soils occur on plains in the middle and eastern part of the district along the valleys.

Soil quality monitoring was carried out within 10 km radius of project area. The physico-chemical and fertility characteristics of the soils within the study area were examined by obtaining soil samples from selected points and subsequent analysis of the same. Total 3 Soil samples collected from the nearest locations of project area and the samples were analysed for various parameters to check the Quality of soil.

The soil sampling locations are given in Table below.

Table 50 The soil sampling locations

Code	Location
Sample-1	At Vadhavan Village
Sample 2	At Badapokharan

A number of parameters, which are indicative of physical, chemical characteristics and fertility of the soil, were determined. Sampling and analysis were conducted as per established standard methods and procedures prescribed in IS:2720, Central Pollution Control Board (CPCB) and United States Environment Protection Agency (USEPA). The respective methods used for the analysis of soil samples and their minimum detection limit are given in following table

Table 51 Analytical Method and its Detection Limit for Soil Quality Monitoring Parameters

Parameters	Unit	Method	Detection Limit
Organic content	% by mass	IS: 2720 Part-22	0.01
Moisture content	%	IS:2720 (Part21):1977, Reaffirmed:2015Oven Drying Method	0.1
Chemical Parameters (aqueous Extract)			
pH of 10% solution	--	Electrometric method	0.1
Conductivity of 10% solution	mS/cm	Conductometry	0.001
Chloride as Cl	mg/kg	Argentometric Method based on APHA 22nd Ed. 2012, 4500 Cl- B	1
Sulphate as SO^4	mg/kg	Turbidimetric Method based on APHA 22nd Ed. 2012, 4500 SO42- E	1

Parameters	Unit	Method	Detection Limit
Borone as B		Azomethine-H Method based on Methods Manual for Soil Testing, DAC-MOA, GOI, New Delhi, Ed.2011, Page No. 115-118	
Calcium as Ca	mg/kg	EDTA Titration Method based on Methods Manual for Soil Testing, DAC-MOA, GOI, New Delhi, Ed.2011, Page No. 102-105	1
Magnesium as Mg	mg/kg	EDTA Titration Method based on APHA 22nd Ed. 2012, 3500 Mg B	1
Sodium as Na	mg/kg	Based on Laboratory Test Procedure For Soil & Water Sample Analysis, Water Resource Department, Directorate of Irrigation Research & Development, Pune, 2009, Page No. 61-70	1
Potassium as K	mg/kg	Based on Laboratory Test Procedure For Soil & Water Sample Analysis, Water Resource Department, Directorate of Irrigation Research & Development, Pune, 2009, Page No. 61-70	1
Specific parameter			
Total Phosphate as PO^4	mg/kg	Turbidimetric Method based on APHA 22nd Ed. 2012, 4500 SO42- E	1
Total Kjeldahis Nitrogen, TKN	mg/kg	CPCB/P.K.Behra, P-105	1
Sodium Adsorption Ratio, SAR	(meq/kg)0.5	Calculation Method based on Exchangeable Cations Measurements	1
Water retaining capacity	%	Based on Methods Manual for Soil Testing, DAC-MOA, GOI, New Delhi, Ed.2011, Page No. 76-77	0.1
Heavy metals (Extraction fluid)			
Copper as Cu	Mg/kg	Based on USEPA SW-846, Update V, July 2014 Method 3050B & 7000B (FLAA)	5

Parameters	Unit	Method	Detection Limit
Nickel as Ni	Mg/kg	Based on USEPA SW-846, Update V, July 2014 Method 3050B & 7000B (FLAA)	5
Zink as Zn	Mg/kg	Based on USEPA SW-846, Update V, July 2014 Method 3050B & 7000B (FLAA)	2
Chromium as Cr	Mg/kg	Based on USEPA SW-846, Update V, July 2014 Method 3050B & 7000B (FLAA)	5
Cadmium as Cd	Mg/kg	Based on USEPA SW-846, Update V, July 2014 Method 3050B & 7000B (FLAA)	2
Lead as Pb	Mg/kg	Based on USEPA SW-846, Update V, July 2014 Method 3050B & 7000B (FLAA)	5
Mercury as Hg	Mg/kg	Based on USEPA SW-846, Update V, July 2014 Method 7471B Cold Vapour Atomic Absorption Spectrometry	2

Table 52 Soil Analysis report

Parameters	Sample-1	Sample 2	Units
Organic content	3.56	3.19	%
Moisture content	7.81	7.70	%
Soil Classification			
Textural Class	Sandy	Sandy	%
Chemical Parameters (aqueous Extract)			
pH of 10% solution	7.55	7.31	--
Conductivity of 10% solution	3480	668	µs/cm
Chloride as Cl	7901	7000	mg/kg
Sulphate as SO^4	1400	1058	mg/kg
Borone as B	8.39	808	mg/kg
Calcium as Ca	525	386	mg/kg
Magnecium as Mg	664	645	mg/kg
Sodium as Na	550	527	mg/kg
Potassium as K	222	198	mg/kg
Specific parameter			

Parameters	Sample-1	Sample 2	Units
Total Phosphate as PO^4	0.261	0.239	%
Total Kjeldahis Nitrogen, TKN	0.023	0.02	%
Sodium Adsorption Ratio, SAR	3.74	3.79	--
Water retaining capacity	21.8	21.7	%
Heavy metals (Extraction fluid)			
Copper as Cu	<0.50	<0.50	mg/kg
Nickel as Ni	0.944	0.624	mg/kg
Zink as Zn	1.6	1.49	mg/kg
Chromium as Cr	<0.50	<0.50	mg/kg
Cadmium as Cd	<0.50	<0.50	mg/kg
Lead as Pb	<0.50	<0.50	mg/kg
Mercury as Hg	<0.50	<0.50	mg/kg

4.5 Water Environment

Kawadas pick up weir which is the main source of water for Dahanu and Boisar is located approximately 15km away from Vadhavan site in East direction. The dam has the storage capacity of 4.07 M cum of water.

- During construction (1st 4 years) 0.4 MLD
- Short term needs (subsequent 4 years) – Phase 1 (upto 2030) 6.8 MLD
- Long term needs (subsequent years) – Master Plan 13.3 MLD

For the analysis of water environment near the project site the surface water and ground water monitoring was carried out at different locations in the month of May 2021 (Analysis date 19-05-2021). 10 km area (aerial distance) from the project site was covered for the selection of monitoring locations. Following Table shows Standards for Drinking Water (BIS: IS: 10500, 1991).

Table 53 Standards For Drinking Water (BIS: IS: 10500, 1991)

Sr. No.	Parameters	Prescribed limits	
		Desirable	Permissible
1	COLOUR (HAZEN UNIT)	5	25
2	ODOUR	Essentially free	

Sr. No.	Parameters	Prescribed limits	
		Desirable	Permissible
3	TASTE	Agreeable	
4	TURBIDITY (NTU)	5	10
5	pH	6.5	8.5
6	HARDNESS, as $CaCO_3$, mg/l	300	600
7	IRON, as Fe , mg/l	0.30	1.00
8	CHLORIDE, as Cl , mg/l	250	1000
9	RESIDUAL CHLORINE, only when Water is chlorinated	0.20	-
10	TOTAL DISSOLVED SOLIDS, mg/l	500	2000
11	CALCIUM, as Ca, mg/l	75	200
12	MAGNESIUM, as Mg, mg/l	30	100
13	COPPER, as Cu, mg/l	0.05	1.50
14	SULPHATE, as SO_4, mg/l	200	400
15	NITRATE, as N, mg/l	45	100
16	FLUORIDE, as F, mg/l	1.00	1.50
17	CADMIUM, as Cd, mg/l	0.01	No relaxation
18	LEAD, as Pb, mg/l	0.05	No relaxation
19	ZINC, as Zn , mg/l	5	15
20	CHROMIUM, as Cr, mg/l	0.05	No relaxation
21	ARSENIC, as As, mg/l	0.05	No relaxation
22	ANTIMONY, as Sb, mg/l	0.006	No relaxation
23	ALUMINIUM, as Al, mg/l	0.030	0.200
24	BARIUM, as Ba, mg/l	2	No relaxation
25	BERYLLIUM, as Be, mg/l	nil	0.0002
26	CYANIDE, as CN, mg/l	0.05	No relaxation
27	MERCURY, as Hg, mg/l	0.001	No relaxation
28	MANGANESE, as Mn, mg/l	0.10	0.30
29	SELENIUM, as Se, mg/l	0.01	No relaxation

Sr. No.	Parameters	Prescribed limits	
		Desirable	Permissible
30	BORON, as B, mg/l	1.00	5.00
31	ALKALINITY, as $CaCO_3$, mg/l	200	600
32	PESTICIDES, ug/l	nil	0.001
33	PHOSPHATE, as PO_4, mg/l	No guideline	
34	SODIUM, as Na, mg/l	No guideline	
35	POTASSIUM, as K, mg/l	No guideline	
36	NICKEL, as Ni , mg/l	No guideline	
37	PATHOGENS a)TOTAL COLIFORM No/dl b)FAECAL COLIFORM No/dl	1	10
38	RADIOACTIVITY: -BETA PARTICLES -ALPHA PARTICLES -RADIUM	0-4 millirem/year 0-15 picocuries/year 0-05 icocuries/year	

4.5.1 Surface Water

The area is drained by innumerable streams and tributaries of Vaitarna and Ulhas River. The four main tributaries of river Vaitarna are Surya, Tansa, Deharaja and Pinjal Rivers. Ulhas River is the other important river in the district.

The study area exhibits more or less a dendritic drainage pattern dipping towards the coast and towards the east. The hillock separate the area sloping towards the east as well as towards the west. As evident from the figure that, there is one main river with four tributaries in the Project stretch, which flows towards the east. There are creeks formed along the local depression (low lying area), through which water during monsoon season are drained into the sea.

Figure 62- Drainage Pattern of Palghar/ Thane District

Source:- District Mining Plan Plaghar District, July 2019

Surface water monitoring was carried out within 10 km radius of project area in the month of May 2021 (Analysis date 19-05-2021). Total 3 Water samples collected from the nearest locations of project area and the samples were analyzed for various parameters to check the Quality of water. The Surface water monitoring locations are shown in Figure below.

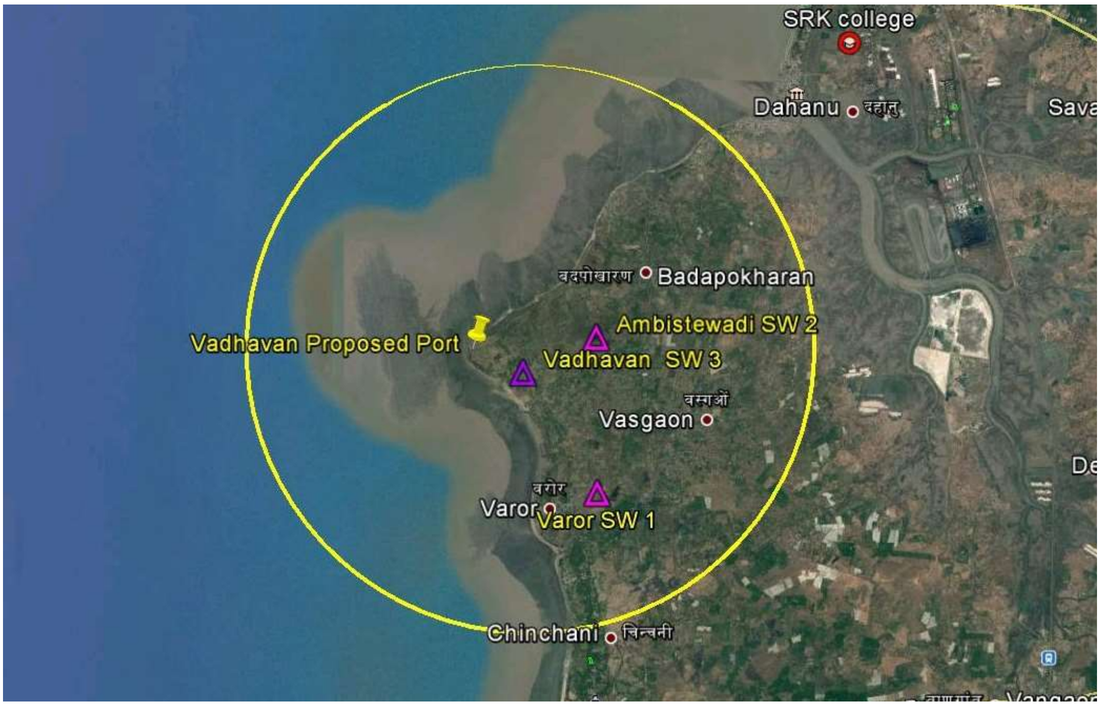


Figure 63 - Surface Water Sampling Sites

Table 54 Surface Water quality

Sr. No.	Parameters	Water Sample - Station – W1	Water Sample - Station – W2	Water Sample - Station – W3	Unit
Physical parameters					
1	Temperature	33.3	34.1	31	^{O}C
Chemical temperature					
2	Aluminum	0.35	0.18	0.24	mg/l
3	Total carbon	38.19	39.33	38.24	mg/l
4	Free ammonia as N	4.12	4.0	4.0	mg/l
5	Boron	2.94	2.94	3.01	mg/l
6	Silicon as SiO_2	7.16	6.36	6.57	%
7	Sodium absorption rate	3.9	4.96	3.8	--
8	pH	7.68	7.97	7.84	--

Sr. No.	Parameters	Water Sample - Station – W1	Water Sample - Station – W2	Water Sample - Station – W3	Unit
9	Total suspended Solid	130	110	125	mg/l
10	Conductivity	4877.0	4207.4	4732.5	µs/cm
11	Nitrite as NO_2	0.088	0.04	0.052	mg/l
12	Oil &Grease	<0.5	<0.5	<0.5	mg/l
13	Colour	1	1	1	Hazen
14	Turbidity	5.5	5.9	5.2	NTU
15	Total Dissolved Solids (TDS)	2902.4	2807.6	2765.9	mg/l
16	Total hardness as $CaCO_3$	808.5	756.0	789.2	mg/l
17	Sulphate as SO_4	189	180	178	mg/l
18	Fluoride as F	1.2	1.0	1.1	mg/l
19	Nitrate as NO_3	8.22	7.9	8.3	mg/l
20	Iron as Fe	0.12	0.06	0.8	mg/l
21	Manganese as Mn	<0.01	<0.01	<0.01	mg/l
22	Zinc as Zn	<0.01	<0.01	<0.01	mg/l
23	Mercury as Hg	<0.001	<0.001	<0.001	mg/l
24	Cadmium as Cd	<0.002	<0.002	<0.002	mg/l
25	Phosphate as a PO_4	30.1	27.3	29.24	mg/l
26	Biochemical Oxygen Demand, BOD (27^{o}C, 3 days)	48	28	36	mg/l
27	Chemical Oxygen Demand	136	87	124	mg/l
28	Dissolved oxygen	4.12	4	4.01	mg/l
29	Ammonical Nitrogen as NH_3-N	5	4.4	4.7	mg/l

Sr. No.	Parameters	Water Sample - Station – W1	Water Sample - Station – W2	Water Sample - Station – W3	Unit
30	Chloride as Cl	198.02	188.10	192.04	mg/l
Microbiological parameters					
31	Coliform count	<2	<2	<2	MPN/100 m
32	Faecal coliform	Absent	Absent	Absent	/100ml

Surface water monitoring was again conducted for post-monsoon season for one month in the October 2023, as earlier figures were found to be on higher side.

Table 54a 55 Surface Water quality (October 2023)

Sr. No.	Parameters	Water Sample - Station – W1	Water Sample - Station – W2	Water Sample - Station – W3	Unit
Physical parameters					
1	Temperature	32.3	33.1	32.1	^{O}C
Chemical temperature					
2	Aluminum	0.32	0.15	0.26	mg/l
3	Total carbon	39.15	40.34	39.25	mg/l
4	Free ammonia as N	3.12	3.5	3.7	mg/l
5	Boron	2.54	2.54	2.91	mg/l
6	Silicon as SiO_2	6.5	6.6	6.7	%
7	Sodium absorption rate	4.9	4.6	3.9	--
8	pH	7.6	7.9	7.8	--
9	Total suspended Solid	120	100	105	mg/l
10	Conductivity	1640	1661	1754	µs/cm

Sr. No.	Parameters	Water Sample - Station – W1	Water Sample - Station – W2	Water Sample - Station – W3	Unit
11	Nitrite as NO_2	0.08	0.05	0.05	mg/l
12	Oil &Grease	<0.5	<0.5	<0.5	mg/l
13	Colour	1	1	1	Hazen
14	Turbidity	5.7	5.8	5.3	NTU
15	Total Dissolved Solids (TDS)	902.7	914.5	965.9	mg/l
16	Total hardness as $CaCO_3$	150.6	160.0	192.2	mg/l
17	Sulphate as SO_4	180	183	180	mg/l
18	Fluoride as F	1.1	1.0	1.1	mg/l
19	Nitrate as NO_3	8.1	8.0	8.2	mg/l
20	Iron as Fe	0.1	0.06	0.08	mg/l
21	Manganese as Mn	<0.01	<0.01	<0.01	mg/l
22	Zinc as Zn	<0.01	<0.01	<0.01	mg/l
23	Mercury as Hg	<0.001	<0.001	<0.001	mg/l
24	Cadmium as Cd	<0.002	<0.002	<0.002	mg/l
25	Phosphate as a PO_4	27.1	26.3	28.4	mg/l
26	Biochemical Oxygen Demand, BOD (27ºC, 3 days)	40	29	33	mg/l
27	Chemical Oxygen Demand	133	85	110	mg/l
28	Dissolved oxygen	4.2	4.0	4.1	mg/l
29	Ammonical Nitrogen as NH_3-N	4.8	4.1	4.5	mg/l
30	Chloride as Cl	205	225	210	mg/l
Microbiological parameters					

Sr. No.	Parameters	Water Sample - Station – W1	Water Sample - Station – W2	Water Sample - Station – W3	Unit
31	Coliform count	<2	<2	<2	MPN/100 m
32	Faecal coliform	Absent	Absent	Absent	/100ml

Observation – Conductivity or electrical conductivity (EC) and total dissolved solids (TDS) are frequently used as water quality parameters, especially in the coastal area. These two parameters are indicators of salinity level which make them very useful as one way in studying seawater intrusion. Detailed relationship between these two parameters was published by "*Walton N R G 1989, Desalination 72 275–292".* TDS concentration describes the present of inorganic salts and small amounts of organic matter in water and EC is the measure of water capacity to conduct electrical current. The sources of material in TDS and EC can come from nature, i.e. geological condition and seawater, and from human activities.

TDS has been classified into four types: type I is freshwater with TDS < 1,000 mg/L; type II is brackish water with TDS between 1,000 and 10,000 mg/L; type III is saline water with TDS from 10,000 till 100,000 mg/L; and type IV is brine water with TDS > 100,000 mg/L.

The total dissolved solids (TDS) ranges from 900mg/l to 965 mg/l. Conductivity ranges from 1640 to 1754 µs/cm. The value of EC and TDS are correlated to the ratio of 0.55, which depicts the water is freshwater in nature and suitable for agricultural activities.

Chlorides values are less than 400mg/l. The proposed project is not anticipated to have any impact on the surface water quality except increase in turbidity temporarily during construction.

4.5.2 Ground Water

The hydro-geological map of Palghar district is given in Figure 64, it can be inferred that the area around the project site consists of both hilly area and hard rock terrain. The northern and eastern part of site is made up of hilly terrain and the southern part is underlined by hard rock.

The groundwater levels in the project area during pre-monsoon and post-monsoon seasons are shown in Figure 66. From the figures it is evident that the groundwater table is recharged during monsoon.

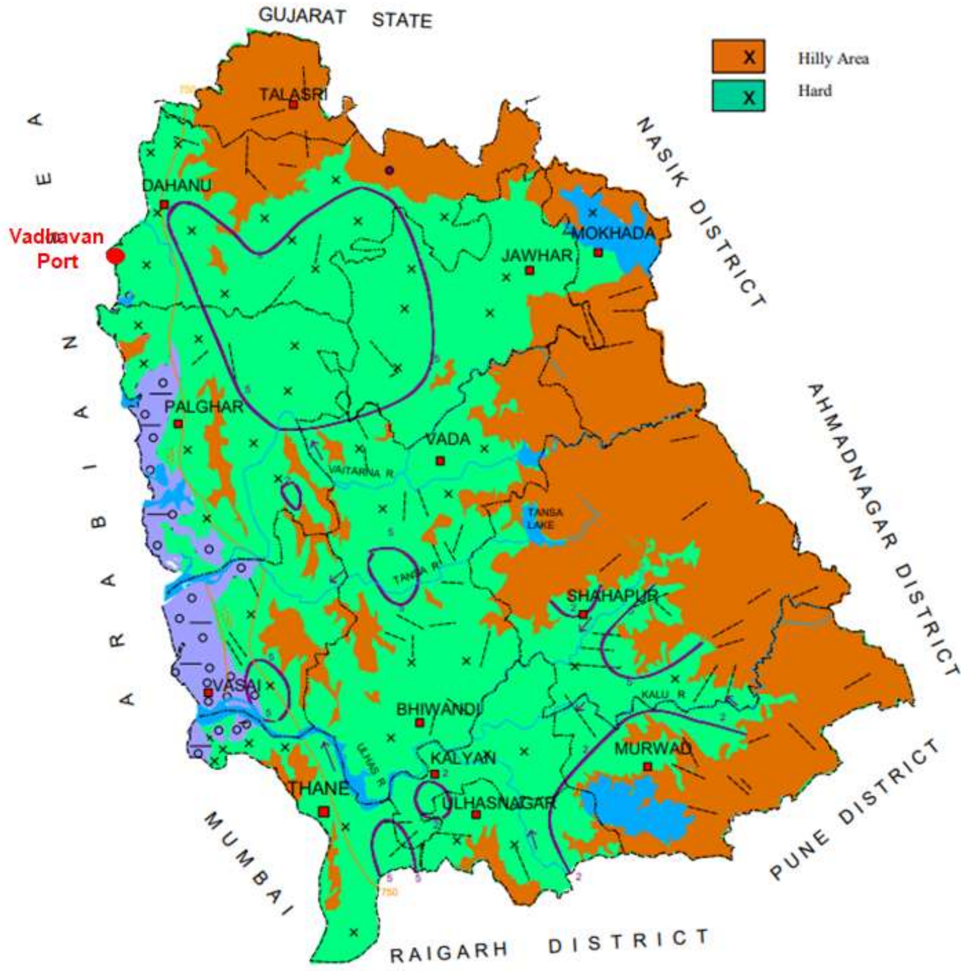


Figure 64 Hydrogeological Map of Palghar District

Source: Ministry of Water Resources Central Ground Water Board

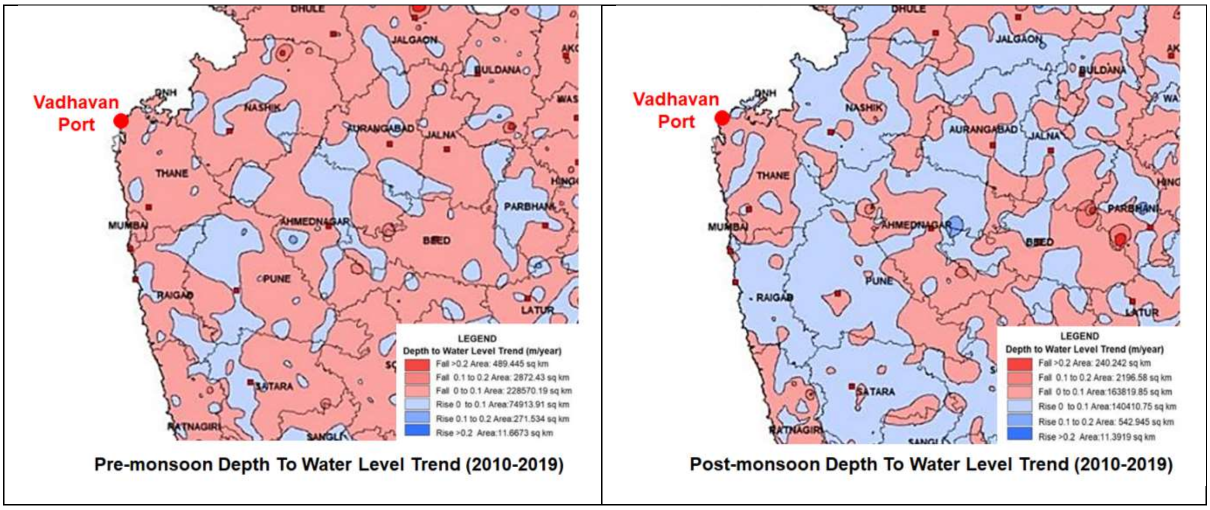


Figure 65 Premonsoon and Post monsoon Depth to Water level

Source: Ministry of Water Resources Central Ground Water Board

For the Ground water quality analysis, the various locations within 10 km of radius of project area were selected. Samples were collected from 3 different locations and various parameters were analyzed to check the quality of water. The descriptions of the Ground water monitoring locations are shown in Figure below and the Ground water analysis results are given in the Following Table.

Figure 66 - Ground Water Sampling Sites

Table 56 Ground Water Quality (March to May 2021)

Sr. No.	Parameters	Water Sample - Station – W1	Water Sample - Station – W2	Water Sample - Station – W3	Unit
Physical parameters					
1	Temperature	33.3	32.6	31.1	^{O}C
Chemical temperature					
2	Aluminum	0.18	0.19	0.18	Mg/l
3	Total carbon	39.33	40.21	41.6	Mg/l
4	Free ammonia as N	4.0	3.9	4.1	Mg/l
5	Boron	2.94	3.2	2.84	Mg/l
6	Silicon as SiO_2	6.36	6.40	5.98	%
7	Sodium absorption rate	4.96	4.5	4.87	--
8	pH	7.97	7.65	7.1	--
9	Total suspended Solid	110	135	105	Mg/l
10	Conductivity	4207.4	4245.6	4198.5	µs/cm
11	Nitrite as NO_2	0.04	0.04	0.03	Mg/l

Sr. No.	Parameters	Water Sample - Station – W1	Water Sample - Station – W2	Water Sample - Station – W3	Unit
12	Oil &Grease	<0.05	<0.05	<0.05	Mg/l
13	Color	1	1	1	Hazen
14	Turbidity	35.9	34.23	33.24	NTU
15	Total Dissolved Solids (TDS)	2807.6	2804.7	2789.5	Mg/l
16	Total hardness as $CaCO_3$	756.0	749.2	741.6	Mg/l
17	Sulphate as SO_4	180	182	179	Mg/l
18	Fluoride as F	2.0	2.0	1.9	Mg/l
19	Nitrate as NO_3	7.9	7.8	7.5	Mg/l
20	Iron as Fe	0.06	0.06	0.05	Mg/l
21	Manganese as Mn	<0.01	<0.01	<0.01	Mg/l
22	Zinc s Zn	<0.01	<0.01	<0.01	Mg/l
23	Mercury as Hg	<0.001	<0.001	<0.001	Mg/l
24	Cadmium as Cd	<0.002	<0.002	<0.002	Mg/l
25	Phosphate as a PO_4	27.3	30.2	29.4	Mg/l
26	Biochemical Oxygen Demand, BOD (27°C, 3 days)	28	35	31	Mg/l
27	Chemical Oxygen Demand (COD)	87	102	98	Mg/l
28	Dissolved oxygen	4	4.2	4.1	Mg/l
29	Ammonical Nitrogen as NH_3-N	4.4	4	4.2	Mg/l
30	Chloride as Cl	188.10	176.45	187.54	Mg/l
Microbiological parameters					
31	Coliform count	<2	<2	<2	MPN/100 ml
32	Faecal coliform	Absent	Absent	Absent	/100ml

Observations – The baseline monitoring was conducted in pre-monsoon season, hence, the COD and BOD values are high. The quality of ground water is generally alkaline and is good for domestic except high nitrate concentration in wells. For irrigation point of view the ground water falls in medium to high salinity and it should be used for irrigation with proper soil and crop management practices. The quality of ground water in basaltic lava flows is comparatively better than in alluvial sediments. Localized nitrate contamination is observed in rural areas.

Ground water monitoring was again conducted for post-monsoon season for one month in the October 2023, as earlier figures were found to be on higher side. Sampling was carried out as per the standard procedure IS 3025 Part I & IS 1622:1981 (Reaff. 2009)

Table 57 Ground Water Quality (October 2023)

Sr. No.	Parameters	Water Sample - Station – W1	Water Sample - Station – W2	Water Sample - Station – W3	Unit
Physical parameters					
1	Temperature	31.1	30.5	30.1	^{O}C
Chemical temperature					
2	Aluminum	0.15	0.16	0.17	mg/l
3	Total carbon	40.33	41.21	41.44	ppm
4	Free ammonia as N	4.0	3.9	4.1	mg/l
5	Boron	2.94	3.2	2.84	mg/l
6	Silicon as SiO_2	5.36	5.40	5.50	%
7	Sodium absorption rate	4.96	4.5	4.87	--
8	pH	7.57	7.68	7.34	--
9	Total suspended Solid	110	130	105	mg/l
10	Conductivity	827.3	812.7	822.1	µs/cm
11	Nitrite as NO_2	0.04	0.08	0.03	mg/l
12	Oil &Grease	<0.05	<0.05	<0.05	mg/l
13	Color	1	1	1	Hazen
14	Turbidity	34.9	37.23	35.24	NTU
15	Total Dissolved Solids (TDS)	455	447	485	mg/l
16	Total hardness as $CaCO_3$	230	235	210	mg/l
17	Sulphate as SO_4	175	185	180	mg/l
18	Fluoride as F	1.8	1.9	1.5	mg/l
19	Nitrate as NO_3	7.5	7.7	7.0	mg/l
20	Iron as Fe	0.06	0.06	0.05	mg/l
21	Manganese as Mn	<0.01	<0.01	<0.01	mg/l
22	Zinc s Zn	<0.01	<0.01	<0.01	mg/l
23	Mercury as Hg	<0.001	<0.001	<0.001	mg/l
24	Cadmium as Cd	<0.002	<0.002	<0.002	mg/l
25	Phosphate as a PO_4	26.4	29.6	27.5	mg/l
26	Biochemical Oxygen Demand, BOD (27°C, 3 days)	5.2	5.5	4.5	mg/l
27	Chemical Oxygen Demand (COD)	15.6	18	13	mg/l
28	Dissolved oxygen	1.8	1.9	1.7	mg/l

Sr. No.	Parameters	Water Sample - Station – W1	Water Sample - Station – W2	Water Sample - Station – W3	Unit
29	Ammonical Nitrogen as NH_3-N	4.1	4.0	4.2	mg/l
30	Chloride as Cl	180.5	175	183.5	mg/l
Microbiological parameters					
31	Coliform count	<2	<2	<2	MPN/100 ml
32	Faecal coliform	Absent	Absent	Absent	/100ml

Observations – It is observed that all the values are in range and without any organic contamination. Also, values of Ammonical Nitrogen are less, hence there is no possibility of sewage contamination. All other parameters are within the limit.

The quality of ground water is generally alkaline and is good for domestic except high nitrate concentration in wells. For irrigation point of view the ground water falls in low to medium salinity and it should be used for irrigation with proper soil and crop management practices. The quality of ground water in basaltic lava flows is comparatively better than in alluvial sediments.

4.6 Coastal Hydrology/ Geomorphology

Bathymetry

The seabed is smooth on regional scale with a light gradient towards west. The contours have a general trend in NE-SW direction. Water depths within survey area range between a minimum of 0.0 m recorded in the Eastern end and maximum of 25.3 m at Northwest corner of the survey area. Rock outcrops appear in some places as high as 3 to 4 m above the adjoining seabed levels in the area.

The ‘0’ m contour is about 2.1 km from the shoreline at the NE corner, curving outwards for up to 4.9 km and then inwards. This contour tends to follow the general trend of the coast. The inter-tidal zone is thus observed to be about 2 km wide, between the shoreline and 0 m contour. 2 m contour starts about 2.5 km towards offshore from NE corner of the survey area and follows the general trend of the coast. 5 m contour lies at about 3.5 km west of Vadhavan point.10 m contour starts on the north side from about 4.5 km west of Vadhavan point and runs towards south. At its nearest point, the 15 m contour lies 1.5 km west of 10 m contour on the northern side, running in the S-SE direction. 20 m contour lies at about 10 km from Vadhavan point.

Waves

Wave climate in the area is dominated during SW monsoon period (June to September). High waves with comparatively shorter periods occur during the monsoon period and the sea appears to be calm in non-monsoon period except for the cyclonic events.

Site specific wave data collection was carried out by M/s. Seageo Surveys Pvt. Ltd. Acoustic Doppler Current Profiler (ADCP) for measuring waves and currents was deployed at 11.5 km off Dahanu, in the Arabian Sea for period of one month i.e., from 10th Jan. 2017 to 10th Feb. 2017 covering one full cycle of neap and spring tides. The location of ADCP is as shown in following figure

Figure 67 Location of Acoustic Doppler Current Profiler (ADCP) deployed

[Source: CWRPS Technical Report - 5583, March 2018]

The wave parameters that were recorded during the measurements included - Significant wave height (Hs), Peak Wave Period (Tp), Peak Wave Direction (Dp), Water Depth (WL), $H_{1/10}$, Mean Wave Period (Tmean) and Mean Wave Direction (Dmean).

The maximum significant wave height observed in the entire period is 1.19 m and the minimum of 0.14 m. In general, the amplitude of the wave height shows considerable variation changing from highs to lows with changing spring and neap tides. The variation of peak wave period is between a minimum of 2.0 sec to 16.90 sec and is dominant at around 4.0 sec. During spring tide, the peak wave period surges to highs of 17 sec and then consequently settling down to around 14 sec during transition from spring to neap. The wave direction is dominant in between directions 247.5° (West) and 360.0° (North - waves from Arabian Sea) during the observed period which is generally the post monsoon period. The peak wave direction perfectly matches with the location of observation i.e., with the coastline of Dahanu. The magnitude of significant wave is observed to be less from WSW and W when compared to NW and N.

The maximum and minimum significant wave height with the corresponding peak wave period and the occurrence time is given here below:

Table 58 Significant wave height

Wave Height (Hs)	Wave Period (Tp)	Wave direction
1.19	5.40	351°
0.14	14.90	244°

The Percentage of Occurrence of Significant Wave Height (Hs) and Peak Direction (Dp) is as indicated below:

Table 59 Occurrence Significant Wave Height (Hs) and Direction (Dp)

Hs (m)	Wave Direction from True North							
	N	NE	E	SE	S	SW	W	NW
0.0 – 0.2	1	0	0	0	1	8	15	2
0.2 – 0.4	11	0	0	1	0	34	73	37
0.4 – 0.6	10	0	0	0	0	0	18	53
0.6 – 0.8	12	0	0	0	0	0	7	38
0.8 – 1.0	7	0	0	0	0	0	6	8
1.0 – 1.2	5	0	0	0	0	0	3	0
Percentage Occurrence	7.29%	0	0	0.16%	0.16%	6.66%	19.33%	21.87%

Wave rose diagram indicating the significant wave height, wave direction and peak wave period during the investigation is as shown in Figure 68. The dominant direction is between 315.0° and 337.5° with wave height up to 1.51 m.

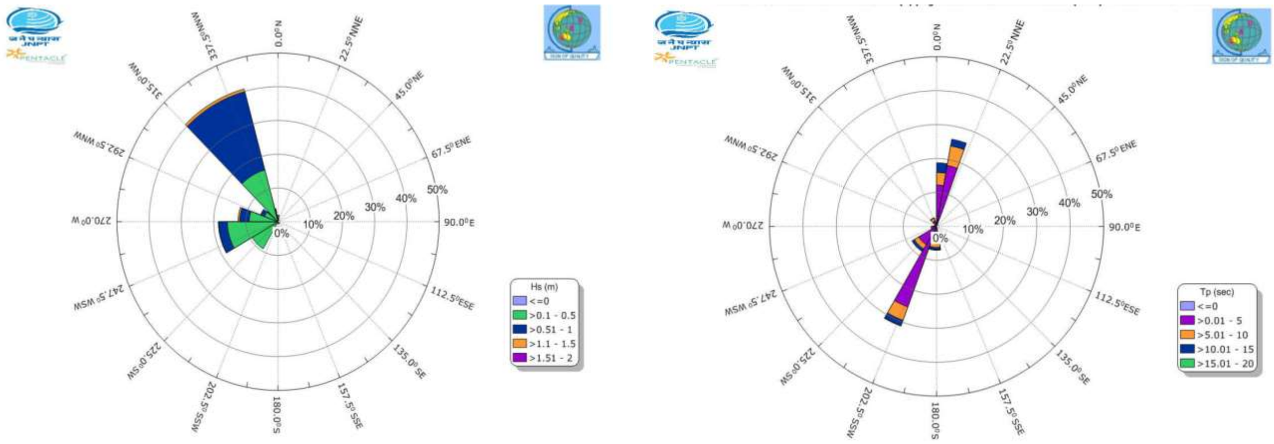


Figure 68 Wave rose plot of significant wave height, direction and peak wave period

[Source: Progen-Pentacle Detailed Project Report, 2018]

The above wave rose is only for one-month period of investigation, whereas the historical data represents pre-monsoon, monsoon and post-monsoon periods over an entire year.

Currents

Currents are significant in the project area and primarily forced by tide and wind components. The vertical variation of currents measurements was carried out at the location using ADCP instrument. ADCP data for currents were collected in the project area for the period of 27 days. The current speeds in general are observed within the range of 0.00 knots to 2.60 knots with the dominant speeds observed in the range of 0.20 knots to 1.60 knots. The current directions in general are observed in the entire range from 000.0° to 360° degrees with the dominant directions observed in the range of 348.75° to 033.75° during flooding and 191.26° to 236.25° during ebbing. The roll and pitch of the ADCP during the observation period remains relatively stable. The observations at different depths are summarised as below:

Table 60 Summary of Current Measurements

Location	Level of current above seabed (m)	Current Speed during flooding (Knots)		Current Speed during ebbing (Knots)	
		Min.	Max.	Min.	Max.
Surface	13.61	0.066	2.268	0.049	1.594
Near surface	12.61	0.075	2.550	0.037	1.816
Mid	8.11	0.008	2.439	0.023	1.757
Seabed	2.61	0.031	2.043	0.008	1.456

[Source: Progen-Pentacle Detailed Project Report, 2018]

The observed current data indicates that the flood and ebb flows do not follow a reversal in direction. The general flooding direction is between 000.00° to 022.50° (N-NNE), whereas the general ebbing direction is between 202.50° to 225.00° (SSW-SW). It is observed that the land abutting south of Dahanu bay juts out, obstructing the path of ebbing flow of currents straight along. Hence, the ebbing currents take an unobstructed direction towards SSW-SW.

Tides

The tides in the region are of the semi-diurnal type i.e. characterized by occurrence of two High and two Low Waters every day. Duration of each tidal cycle is between 5 to 7 hours (theoretically 6 hours and 12 minutes). There is a marked inequality in the levels of the two low waters in a day. Tide levels in the Vadhavan Port region as per the NHO Chart No. 210 Umargam to Satpati are summarised below.

Table 61 Tide levels in Vadhavan (NHO Chart No. 210)

Description	Tide Levels (m CD)
Mean High Water Spring	+4.7
Mean High Water Neap	+3.7
Mean Sea Level	+2.8
Mean Low Water Neap	+2.0
Mean Low Water Level Spring	+1.2

Site specific tide measurements were carried out for the proposed development. The tidal observations were carried out using the Auto Tide Gauges The recording of the data was carried out for a period of one month covering one full cycle of the neap and spring tides. The period of observation started from near spring tide covering near neap tide from 10th January to 10th February 2017. Tide gauge was set up and levelled to the Survey of India benchmark at Dahanu lighthouse, which is 7.81 m above chart datum, using RTK survey heights of tide were recorded continuously at this location, and used to reduce observed depths to Chart Datum. The observed tidal range was about 3.5 m during spring tide and 1.7 m during neap tide.

Seabed type and Features

The 61 marine boreholes were examined for geotechnical information. A side scan sonar survey was also performed to identify possible underwater rock outcrops. The investigation carried out for port area included drilling marine boreholes up to maximum depth of 20 m and drilling landside boreholes upto maximum 15 m depth, in-situ testing and laboratory test of selected samples.

The table below shows the relevant boreholes in the proximity of the structures in the Phase 1 development.

Table 62 Borehole details with respect to proposed port structures

S. No.	Proposed Structure/Area	Seabed level as per Bathymetry	Relevant Boreholes
1.	Port craft/ Tug berth of 200 m (2 berths of 100 m each).	-3.9 m CD to -5.3 m CD	MBH-56, Profile between MBH-22 to MBH-54
2.	Total Reclamation area inside the port 1448 ha. with 1162 ha. in Phase 1	-3.2m CD to -17.9 m CD	MBH-17, MBH-25, MBH-47, MBH-49, MBH-50, MBH-51, MBH-52, MBH-53, MBH-54, MBH-55
3.	In port rail yard/ IRC railway area	-4.6 m CD to -10 m CD	Profile between MBH-41, MBH-49
4.	Utility area, Port operation building, bulk liquid tank farm, Chemical tank form, Edible oil tank farm, Other liquid terminal, Main substation, Admin building	-0.4 m CD to +4.8 m CD	MBH-02, MBH-48
5.	Container terminals (each of 1,000 m length) capable of handling upto current largest 24,000 TEU container vessels. (CT1, CT2, CT3, CT4)	-11.6 m CD to -17.9 m CD	Profile between MBH-43, MBH-47, MBH-50, & MBH-52 considered.
6.	Multipurpose berths	-8.3 m CD to -12.7 m CD	MBH-54
7.	Bulk liquid jetties	-12.5mCD to -13.4mCD	MBH 58, profile between MBH-60 & MBH-56 considered.
8.	1 Other liquid jetty	-12.9mCD to -13.6	MBH 57 and MBH-60
9.	Provisional liquid jetty	-17.6mCD to -18.7mCD	No immediate nearby borehole (Profile between MBH-14 and MBH-57 can be considered)
10.	Approach trestle for liquid terminals and breakwater	-0.4 m CD to -7.6 m CD	Profile between MBH-24, MBH-11, MBH-09, MBH-06 and MBH-02 can be referred
11.	Road and Rail approach trestle to offshore terminal	-0.3 m CD to -3.2 m CD	MBH-17 at leeward side, No immediate borehole along remaining length of the trestle
12.	Offshore Breakwater	-12.4mCD to 18.8mCD	MBH-40, MBH-42, MBH-44, MBH-45, MBH-46, MBH-21, MBH-19, MBH-14, MBH-59, MBH-57, MBH-60, MBH-58, MBH-24

The following sequences of deposits/ solid geology were encountered during the ground investigation as shown on the borehole logs.

Table 63 sequences of deposits/ solid geology were encountered during the ground investigation

Unit	Soil / Rock Description	Thickness (m)
Soil Unit 1	Silty Sand	1.6 to 11.27
Soil Unit 2	Silty Clay	1.6 to 9.0
Rock Unit 1 and Rock Unit 2	Weathered sandstone	8.0 to 17.6

The rock level is found to vary with the deepest level of -26 m CD seen near MBH-21. Shallowest rock level of -13 m CD can be observed near MBH-24 at the southern side of the main breakwater.

A detailed and recent geophysical survey of the seabed in the Project area was conducted by M/s Seageo Surveys in 2017. The seabed features were identified using sonar reflectivity. During the survey, three different types of seabed reflectivity were observed on the side scan sonar records, they are:

- Unit A: Silty clay/sand
- Unit B: Weathered bedrock

Most of the rocks in and around comprise of basaltic composition. Unit A is recorded as the surficial layer in survey corridor in depths of more than 15 m and is interpreted as comprising silty clay/sand. Maximum thickness of Unit-A surficial layer recorded up to 10.0 m below the seabed overlying the bedrock. Unit B is recorded all along the survey route within the survey corridor and is interpreted as comprising weathered bedrock.

This layer is seen to be present all along the survey area near to coast and seen as outcrops at certain places. This layer is seen to be sloping from 1 m at the eastern side of the area to about 13 m at the end of the survey area on the West as the depths increase.

The survey reveals predominant rocky seabed with buried channel comprising of soft clay over sand/gravel or highly weathered rock.

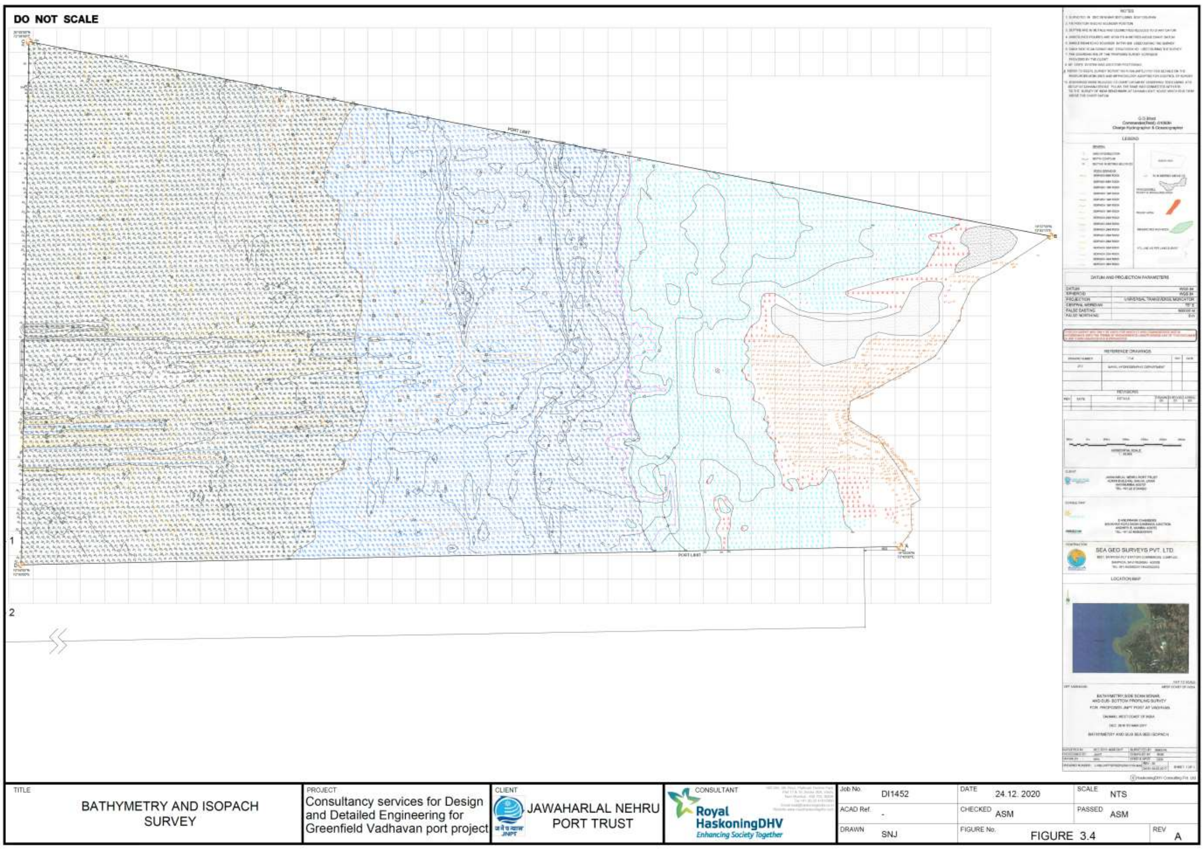


Figure 69 Coastal Geomorphology of the Project Area with Rock Outcrops in Dark Brown (Source: M/s Seageo Surveys, 2017)

No evidence of any cables and other submarine facilities were recorded in the survey area. The seafloor appeared to be clear of any debris other objects which are likely to be hazardous or otherwise obstruct anchoring and operations in the port.

4.7 Marine Environment

Sediment Quality

The information available from the boreholes have been presented in following table based on their relevance to the areas where dredging is envisaged.

Table 64 Relevant boreholes along the dredged area

Area	Dredge level (m CD)	Relevant Boreholes
Entrance channel	-20.0	MBH-35, MBH-37, MBH-40
Basin area	-17.5	MBH-14, MBH-19, MBH-35, MBH-37, MBH-40, MBH-42, MBH-44, MBH-45, MBH-50, MBH-52, MBH-54, MBH-55, MBH-57, MBH-58
Container berth terminals	-19.5	MBH-14, MBH-19, MBH-47, MBH-50, MBH-52, MBH-55, MBH-58

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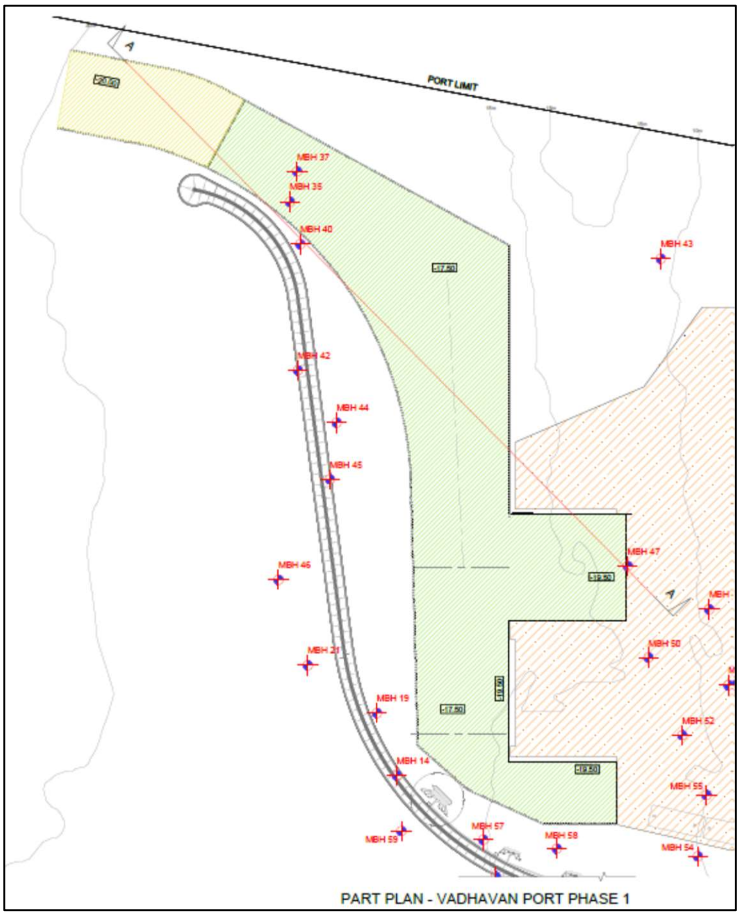


Figure 70 Location of Boreholes in dredging area

Based on the general geology in the area, weathered basalt is anticipated to be encountered with rock strength varying from 8 to 48 MPa. Core recovery values for the weathered rock generally varies from 2 to 40% above dredge level and corresponding RQD values varies from Nil to 12%.

Based on the above, the rock level encountered in the different areas are summarised in following.

Table 65 Summary of rock level and strength encountered in different areas

Dredging area	Soil/rock type	Rock level
Outer channel	Silty Sand/Silty Clay/Weathered Basalt	-19.7
Basin area	Silty Sand/ Silty Clay/Weathered Basalt	-16
Container berth terminals.	Silty Sand/ Silty Clay/Weathered Basalt	-16.5

The sediment quality of the port region was assessed by analyzing sediment samples collected from sea and creek. Marine sediment quality was assessed in the months of March – 2021 for six different locations selected within Arabian Sea and Dahanu Creek. Google image for marine sediment quality monitoring locations are presented in the following Figure and the monitoring results are given in the following Table.

Figure 71 Marine Sediment & Water Quality Monitoring Locations

Table 66 Marine Sediment Quality Results

Parameter	Units	CR-1	Stn- 1	Stn- 2	Stn- 3	Stn-4
Chemical parameter						
Sodium absorption ratio		0.409	1.425	1.69	1.67	1.66
Physical parameter						
Organic content	%	0.057	10.4	19	18.9	25.2
Texture	%	Semisolid	Semisolid	Semisolid	Semisolid	Semisolid
moisture content	%	24.1	65.6	67.9	65.6	66
Chemical parameter (Aqueous Extract)						
pH of 10% solution	--	7.76	8.01	8.09	8.12	8.13
Chloride as Cl	mg/kg	6508	15774	16431	15452	16168
Sulphate as SO4	mg/kg	867	1585	1865	1854	1312
Lead as pb	mg/kg	0.686	0.937	<0.50	<0.51	1.03
Calcium as Ca	mg/kg	54468	5496	5532	6904	5451

Parameter	Units	CR-1	Stn- 1	Stn- 2	Stn- 3	Stn-4
Magnecium as Mg	mg/kg	11068	7504	6630	7984	6080
Sodium as Na	mg/kg	402	695	793	866	755
Potassium as K	mg/kg	676	1035	990	1340	822
Boron as B	mg/kg	6.6	7.59	10.7	6.51	7.9
Coper as Cu	mg/kg	<0.50	0.539	<0.52	<0.52	<0.52
Nikel as Ni	mg/kg	<0.51	<0.52	<0.52	<0.52	<0.52
Zink as Zn	mg/kg	0.688	1.28	1.32	1.38	1.58
Chromium as Cr.	mg/kg	<0.51	<0.51	<0.51	<0.52	<0.52
Cadmium as Cd	mg/kg	<0.51	<0.51	<0.51	<0.52	<0.52
Mercury as Hg	mg/kg	<0.51	<0.51	<0.51	<0.52	<0.52
Specific parameter						
Water retaining capacity	%	18	14	16	14	14
Electrical conductivity	µS/cm	2110	4270	4310	4310	4330
Phosphate as PO4	%	0.14	0.114	0.099	0.099	0.084
Total kjeldahls Nitrogen, TKN	%	0.083	0.094	0.085	0.084	0.074

Observations & Conclusion

Marine sediment samples were taken from 5 locations. Out of them 1 was taken from creek area and other 4 were taken from sea at different location within 10 km radius. Marine sediment quality indicates that it is free from any significant pollution.

Marine Water Quality

The marine water quality of the port region was assessed by analyzing water samples collected from sea and creek. Marine water quality was assessed in the months of March – 2021 for six different locations selected within Arabian Sea and Dahanu Creek. Google image for marine water quality monitoring locations are presented in the Figure 71 and the monitoring results are given in the following Table.

Table 67 Marine Water Quality

Parameters	Unit	CR-1	CR-2	Stn- 1	Stn- 2	Stn- 3	Stn-4
Physical parameters							
Temperature	^{O}C	30.5	30.5	30.8	30.7	30.8	32.7

Parameters	Unit	CR-1	CR-2	Stn- 1	Stn- 2	Stn- 3	Stn-4
Chemical temperature							
Boron	mg/l	4.3	4.47	4.44	4.38	4.5	5.13
Silicon as SiO_2	%	0.17	0.16	<0.1	<0.1	<0.1	<0.1
Sodium absorption rate	--	9.13	8.64	11.2	11.3	7.68	9.89
Aluminium	mg/l	0.068	0.045	0.068	0.079	0.02	0.023
Total carbon	mg/l	43.7	38.7	41.3	41.6	36.5	39.4
Free ammonia	mg/l	<1	<1	<1	<1	<1	<1
Electrical conductivity	mS/cm	76.9	72.65	73.6	72.4	76.3	70.2
pH	--	7.51	8.02	7.45	7.96	8.3	8.31
Total suspended Solid	mg/l	32	48	22	58	7	5
Nitrite as NO2	µmol/l	0.08	0.06	0.02	0.02	0.01	0.07
Oil &Grease	mg/l	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Colour	Hazen	1	1	1	1	1	1
Turbidity	NTU	38.8	69.3	36.4	99.9	9.94	2.49
Total Dissolved Solids (TDS)	mg/l	47900	47160	47870	46930	47920	46890
Total hardness as CaCO3	mg/l	7918	8346	7704	7383	9095	7704
Sulphate as SO4	mg/l	3644	3519	41841	4556	2322	2329
Fluoride as F	mg/l	2.08	1.95	1.82	2.02	1.94	1.91

Observations & Conclusion

Marine water samples were taken from 6 locations. Out of them 2 were taken from creek area and other 4 were taken from sea at different location within 10 km radius. Marine Water quality indicates that it is free from any significant pollution.

Shoreline Erosion

The project area is characterised by different coastal geomorphological features like pocket beaches, rocky coasts, headlands, bays, medium and low cliffs. The shoreline is not a fixed line and its position is dynamic as the change in the shoreline is a natural phenomenon because of the suspension of sediment and transportation of the same due to current (littoral drift) during the monsoon season and deposition in calm non-monsoon season. If this natural cycle is disturbed by anthropogenic intervention, an unbalanced sediment transport cycle will occur, which may lead to an unusual and irreversible shoreline behaviour.

Various studies conducted on the shoreline erosion of the State have been reviewed and historical satellite images were analysed to assess the shoreline condition of the project area over the years. Documents reviewed are listed below:

- Project specific shoreline Changes assessment report titled “mathematical Model Studies for Shoreline Changes for the Development of Proposed Port at Vadhavan, Maharashtra” by (CWPRS), in 2018.
- Report prepared on National Assessment on Shoreline Changes along Indian Coast by Ministry of Earth Sciences National Centre for Coastal Research Chennai, July 2018
- Study report on the Shoreline Changes Atlas of Indian Coast (Volume II) Maharashtra and Goa, by Space Application Center, ISRO Ahmedbad, August 2021.

Coastal length of the state is estimated to be approximately 740 km from 2016 satellite imagery. Shoreline change analysis carried out along the 740 km of coast from 1990-2016 elucidates that around 24% of the coast is eroding, 12% is accreting and 64% remains in stable condition. The north of Thane creek, from Mumbai to northern end of the state in Thane/ Palghar district, erosion is evident. Coastal protection measures taken in the form of ripraps, seawall etc., can be observed along the districts of Palghar, Thane and Mumbai (Ministry of Earth Science, NCCR, 2018).

A comparison of erosion, accretion, and stable coast in various coastal district of Maharashtra is given in table below, shows that the percentage of shoreline erosion is comparatively low higher in proposed project district. The district has the low percentage of erosion, when compared to other districts. The geological formation and rocky outcrop might be the reason of lowest percentage of erosion in the district, which made it safer than the rest of the districts of the State.

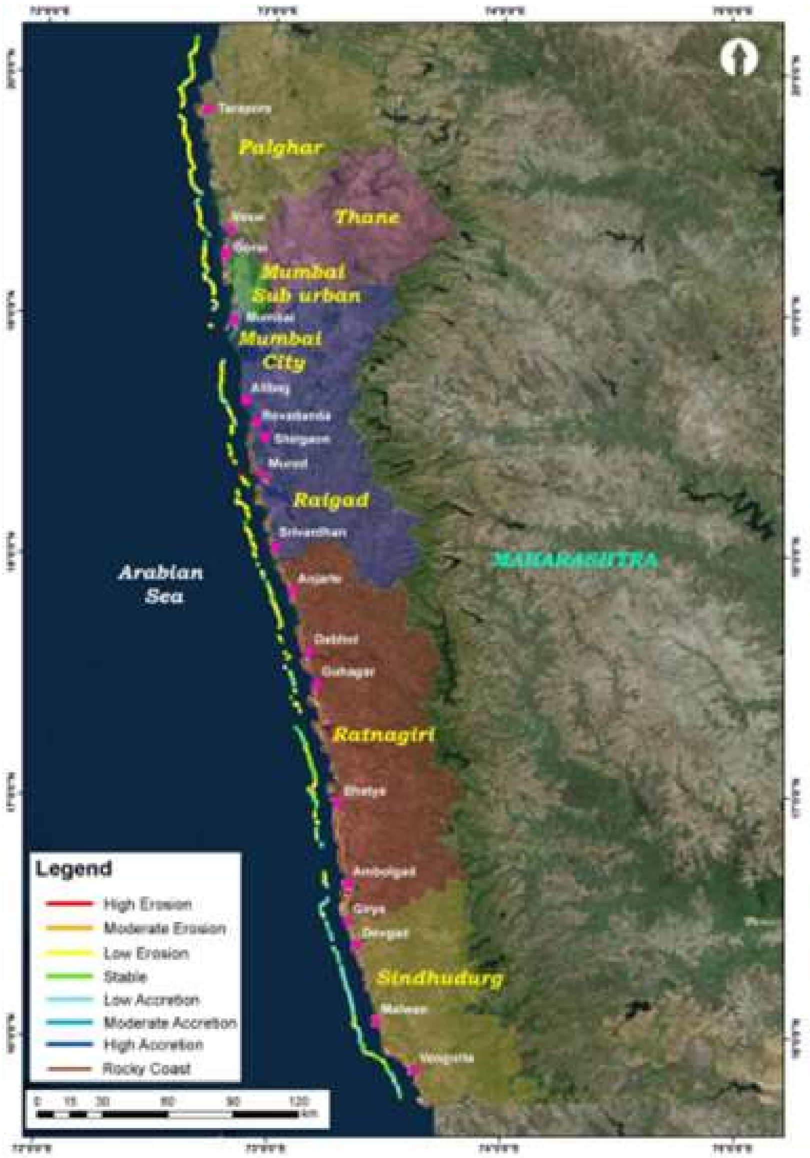


Figure 72 Shoreline Change Map of Maharashtra Coast (1990-2016)

Table 68 Erosion-Stable-accretion status of Maharashtra coastal districts

SL No	District	Coast Length (in km)	Coast length (in km)						
			High Erosion	Moderate Erosion	Low Erosion	Stable	Low Accretion	Moderate Accretion	High Accretion
1	Sindhudurg	137.02	0.04	0.20	6.50	82.00	46.88	1.02	0.38
2	Ratnagiri	258.93	0.78	1.08	36.32	203.39	15.80	0.82	0.74
3	Raigad	134.83	0.58	2.90	42.98	81.73	5.16	0.70	0.78
4	Mumbai city	41.02	0.00	0.00	1.34	38.36	1.32	0.00	0.00
5	Mumbai suburban	41.15	0.02	0.22	17.54	18.77	2.78	0.58	1.24
6	Palghar &Thane	126.64	1.12	4.98	61.66	48.44	6.28	2.26	1.90
	TOTAL	**739.57**	**2.54**	**9.38**	**166.34**	**472.67**	**78.22**	**5.38**	**5.04**

Figure 73 Coastline Erosion of Palghar Dirtrict

With respect to the proposed project location, the study was conducted to assess the impact of the port on the 20 km long shoreline between Dahanu and Tarapur.

SHORELINE CHANGE ANALYSIS BY NCCR

Shoreline change analysis is carried out for long term (1973 to 2023) using Landsat-MSS (60 m), Landsat-TM (30 m), ResourceSat-I LISS-III (23.5 m), CartoSat-1 PAN (2.5 m), ResourceSat-II LISS-IV (5.8 m) and Sentinel-2A (10 m) satellite images.

Table 69 Details of satellite data used (1973 to 2023) for shoreline change analysis

Year	No. of data	Satellite data	Resolution (in meters)
1973	1	Landsat-MSS	30
1990	1	Landsat-TM	30
2001	1	Landsat-TM	30
2006	1	Cartosat-1 (PAN)	2.5
2008	1	RS-1 (LISS-III)	23.5
2012	1	RS-2 (LISS-IV)	5.8
2013	1	RS-2 (LISS-IV)	5.8
2014	1	RS-2 (LISS-IV)	5.8
2015	1	RS-2 (LISS-IV)	5.8
2016	1	RS-2 (LISS-IV)	5.8
2017	1	RS-2 (LISS-IV)	5.8
2018	1	RS-2 (LISS-IV)	5.8
2019	1	Sentinel-2A	10
2020	1	Sentinel-2A	10
2021	1	Sentinel-2A	10
2022	1	Sentinel-2A	10
2023	1	Sentinel-2A	10

The baseline layer was generated with a buffer distance of 300 m landward from the oldest shoreline, and seaward transects (perpendicular lines) were generated at every 20 m interval along the coastline. Shoreline change statistics is evaluated using the approaches in Digital Shoreline Analysis System v.4.0 (Thieler et al. 2009): Long-term (1973 to 2023) analysis calculated using the weighted linear regression (WLR) method which considers the uncertainty field to calculate the rates of shoreline change. A shoreline change assessment was carried out for long term (1973–2023) period to understand the changes on the shoreline. The rate of shoreline changes from 1973-2023, signifies that among the study area of 10 km, 2.06 km (20%) of the coast and, 0.34 km (4%) were observed to have moderate and high erosion during the 1973-2023 period.

Table 70 Estimation of Shoreline Change Analysis for 1973-2023

Shoreline Change Analysis (1973-2023)		
Status	Long term	
	Length (in km)	%
High Accretion	0	0
Moderate Accretion	0	0
Low Accretion	0.12	1.2
Stable	1.2	12
Low Erosion	6.36	63
Moderate Erosion	2.06	20
High Erosion	0.34	4
Total	**10**	**100**

Figure 74 Shoreline Change Analysis of long term (1973 - 2023)

The existing reports on wave tranquillity, hydrodynamics, shoreline change assessment, and shoreline morphology study were analyzed and shoreline change analysis was carried out by NCCR. The following were the outcomes of the study:

1. The maximum significant wave height in the port basin is 1.0m in the Final Master Plan Layout as compared to 2.5 m height offshore. Due to the presence of offshore breakwater, blockage of sediments along the coast is not anticipated. However, there could be a possibility of the formation of a salient behind the proposed port, which needs to be monitored.

2. The Tidal Hydrodynamic and Siltation study finalized the Master Plan Layout for favorable operation and maneuvering conditions with minimum effect on the morphology. The maximum current strengths at container terminals are within 0.15 m/s and flow approaches at an angle varying between 4° and 7° along oil berths and Other Liquid terminals. These hydrodynamic conditions allow the bypassing of sediments towards the North of the port area.

3. The shoreline morphology study reveals that a net transport of about 0.07 Mm^3 is transported just North of the proposed port area. Although Northerly transport is not fully hindered, maintenance dredging of the port can be utilized for nourishment in the North of the port. A

minimum of 0.15 Mm^3 of sand shall be used for nourishment of the North which will be dredged from the port basin as a part of maintenance dredging.

4. The littoral drift and shoreline evolution comparing the original shoreline and proposed port indicates an insignificant effect on the adjacent shoreline.

5. The shoreline change analysis by NCCR suggests that a stretch of 2.4 km of the study area is in a moderate to high erosion state for long-term analysis. The construction of the port breakwater is likely to reduce erosion in the south.

4.8 Air Environment

Climate and Meteorology

The climate of Maharashtra is mainly governed by the Arabian Sea and the Western Ghats (range of mountain spread over the Western side of India), which acts as a shield and protects the State from the dry winds blowing North to South. Also, the Ghats play a significant role in the onset of the monsoon. Presence of the sea also plays a significant role in the diurnal variation of climatic condition. The landward sea breeze in the evening keeps the temperature at a pleasant range. The seasons of Maharashtra are generally divided into Winter, Summer and South-West Monsoon.

The seasonal variation in the meteorological data is discussed below:

Winter (Mid November to mid February): This season has a maximum temperature of 35.1 °C and minimum temperature of 12.9°C. Winter season witnesses the lowest rainfall 18 . Accordingly, the relative humidity varies in the range of 67-71%.

Summer (End of February to May): The highest maximum temperature and lowest minimum temperature of this season is 36°C and 16.9°C respectively. The temperature is relatively low, as the Western Ghats acts as a shield to Maharashtra and protect it from the hot and dry winds blowing towards the south. Also, the sea breeze originating from the Arabian Sea decreases the temperature. The rainfall during this season is about 527mm, with a relative humidity in the range of 77% to 66%.

South-West Monsoon (June to September): The season starts in June with the outset of the south-west monsoon. About 80 - 85% of the total rainfall of Maharashtra is received in this season. The average rainfall of this season was 1593mm. The maximum temperature of this season was recorded 35°C and the minimum temperature was 22.5°C. The relative humidity was in the range of 79% to 89%.

Wind and Cyclone

Based on the wind data from India Meteorological Department (IMD) for a period of 30 years from 1976 to 2005 for the grid covering Lat. 18° – 20° N and Long 71° – 73° E, it may be seen that west is the predominant wind direction and that the wind speed is less than 10 m/s for 88% of the time.

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.

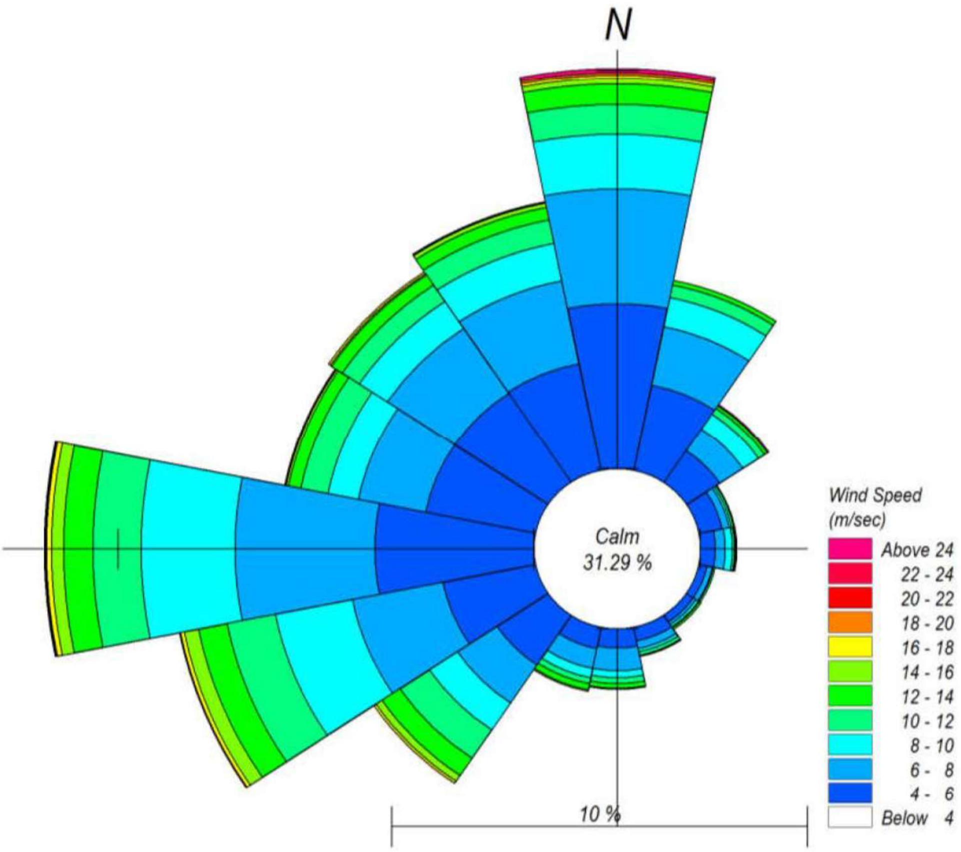


Figure 75 - Wind Rose Diagram IMD, 1976 – 2005

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.

Wind rose plot for the month of March 2021 is shown below, as per which pre-dominant wind speed is NE-NW.

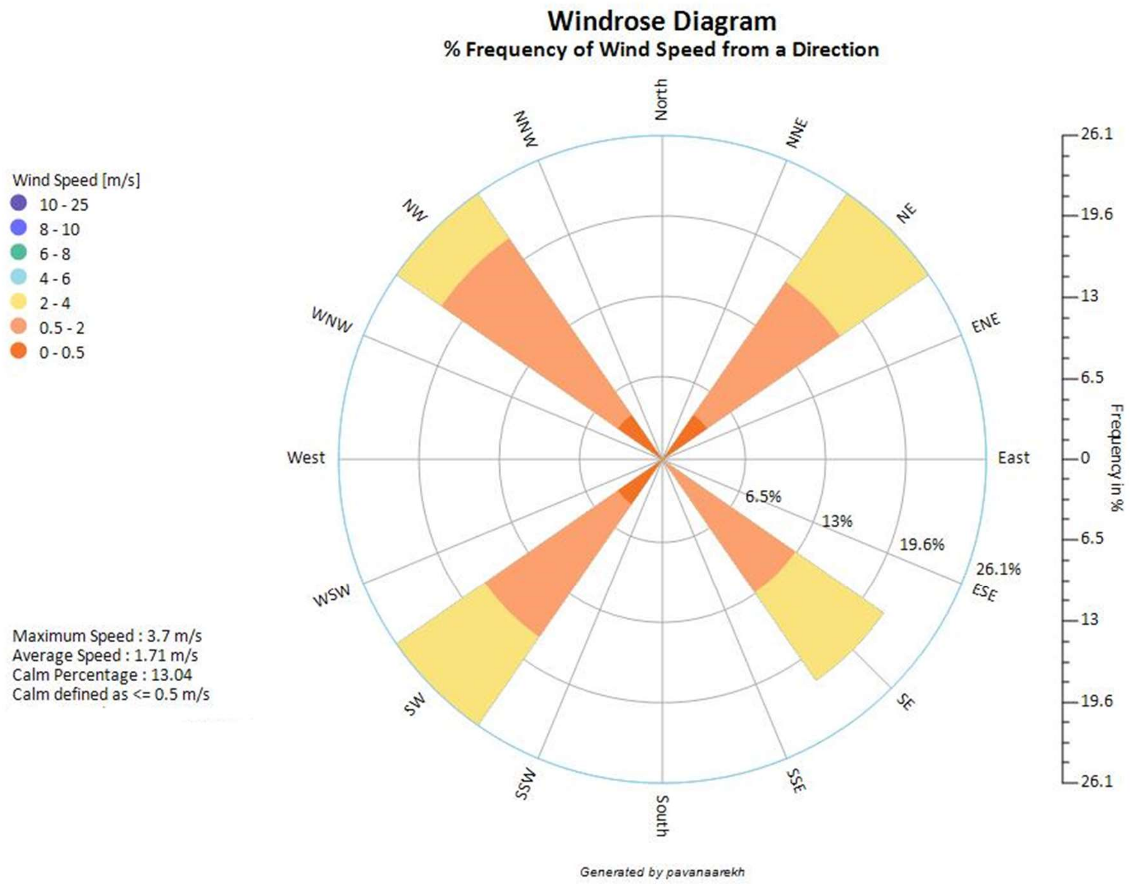


Figure 76 Measured Wind Rose Diagram at Vadhavan Port, March 2021

The coastal area of Maharashtra comes under the moderate damage risk zone as per the Wind hazard map prepared by the Building Materials and Technology Promotion Council (BMTPC). The wind hazard map and cyclone occurrence map are given in Figure 78. Figure 79 show the cyclonic tracks along the Maharashtra coast. The distribution of different types of storm events off Vadhavan Port. It is observed that almost all the storms which are of significance for Vadhavan have occurred during the months of May to November.

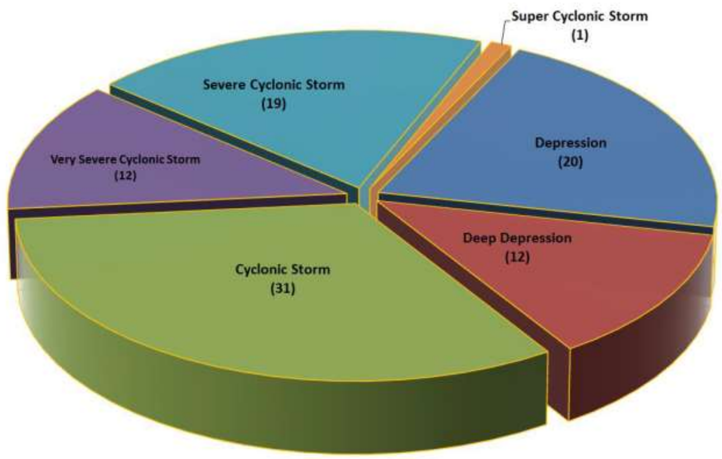


Figure 77 Distribution of Different Types of Storm Events off Vadhavan Port (1946-2015)

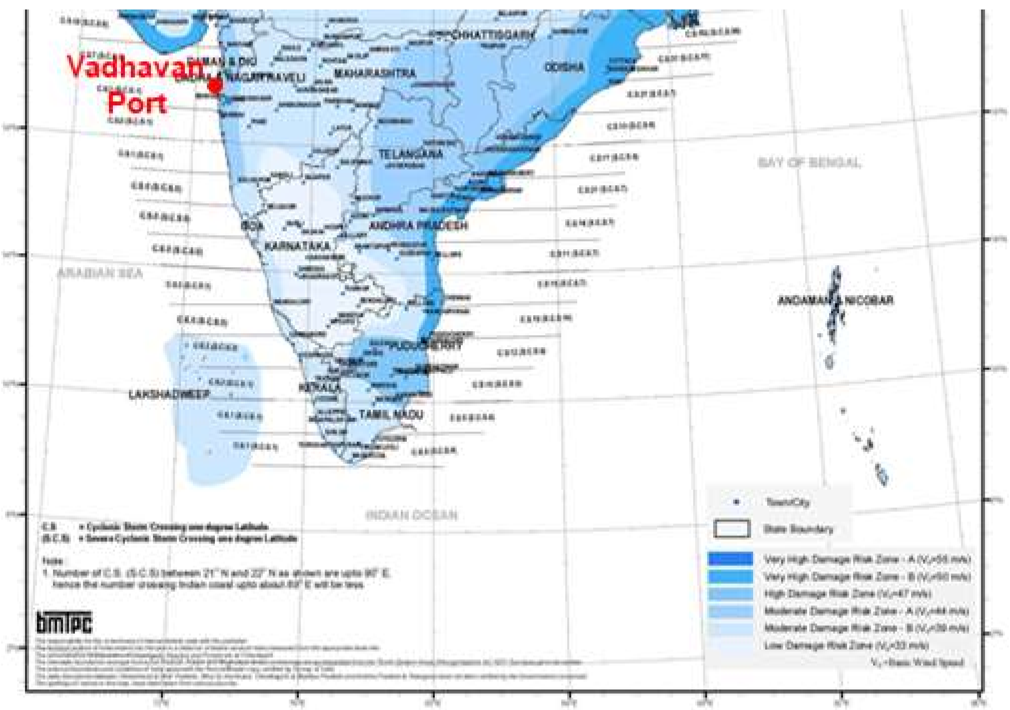


Figure 78 Wind hazard map of Maharashtra

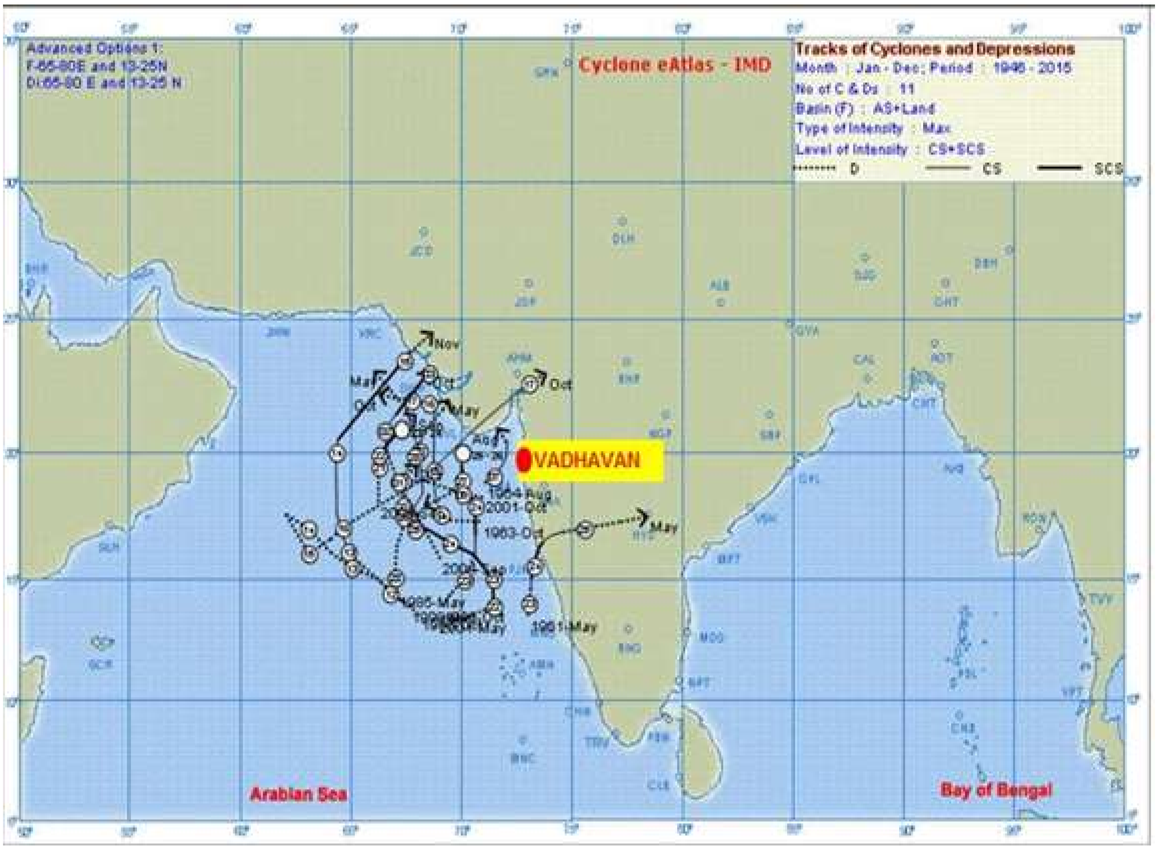


Figure 79 Cyclone tracks along Maharashtra Coast

Flood

The flood hazard map of India is given in Figure 80. As per the map, the Palghar district is not a flood prone and has a probable maximum surge height of 5.0 m. Flood in Maharashtra are highly localised due to undulating terrain features except sandy plan coastal areas. Land ward side of the project area is highly unduklating with hills and valleys. Generally, the low-lying areas get flooded during the southwest monsoon season.

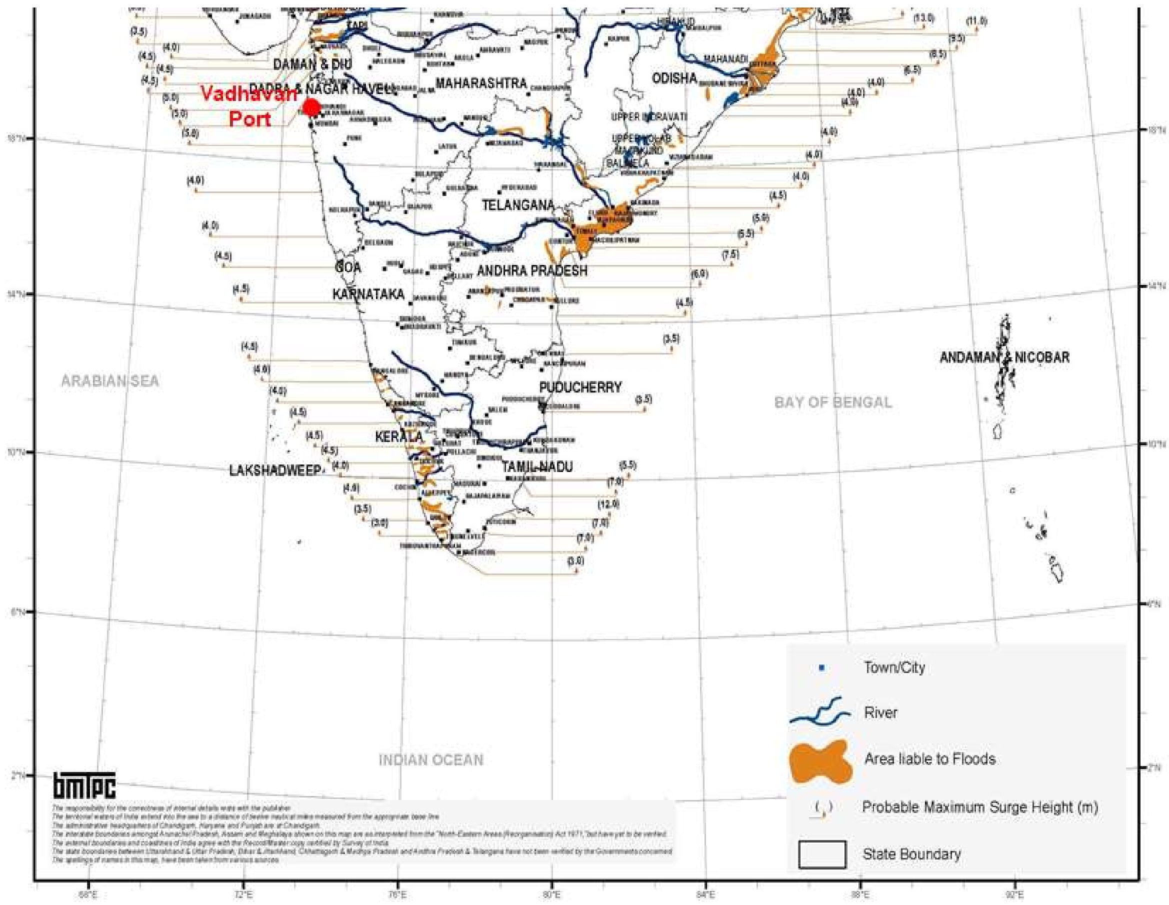


Figure 80 Flood Hazard Map of Maharashtra

Air quality

Methodology for Studies Undertaken

a) Selection of Monitoring Stations

The locations for the monitoring were selected considering the distance of the location from the site.

b) Monitoring Methodology

Monitoring of ambient air quality was carried out as per CPCB guidelines. The techniques used for measurement of pollutants may be summarized as under:

Table 71 Monitoring Methodology

Sr.	Pollutant	Code Of Practice	Methods Of Measurement	Minimum Detectable Limit
1	Sulphur Dioxide (SO_2)	IS-5182 (Part-II):2001 & CPCB Guidelines	Improved West and Geake	3 µg/m^3

Sr.	Pollutant	Code Of Practice	Methods Of Measurement	Minimum Detectable Limit
2	Nitrogen Dioxide (NO_2)	IS-5182 (Part-VI): 2006 & CPCB Guidelines	Modified Jacob & Hochheiser (Na-Arsenite)	3 µg/m^3
3	Particulate Matter (size less than 10 µm) or PM_{10}	IS-5182 (PART-23):2006 & CPCB Guidelines	Gravimetric	4 µg/m^3
4	Particulate Matter (size less than 2.5 µm) or $PM_{2.5}$			4 µg/m^3
5	Ozone (O_3)	IS-5182 (Part-IX):1974 & CPCB Guidelines	Spectrophotometric Method	1 µg/m^3
6	Carbon Monoxide (CO)	IS: 5182 (Part-X) & CPCB Guidelines	Non Dispersive Infra-Red (NDIR) spectroscopy	0.01 mg/m^3
7	Ammonia (NH_3)	APHA, (Method-401) & CPCB Guidelines	Indophenol blue method	6 µg/m^3
8	Benzene (C_6H_6)	IS-5182 (Part-XI):2006 & CPCB Guidelines	Gas Chromatography	0.5 µg/m^3
9	Benzo (a) Pyrene (BaP) – particulate phase only,	IS-5182 (Part-XII):2004 & CPCB Guidelines	Solvent extraction followed by HPLC analysis	0.5 ng/m^3
10	Lead (Pb)	USEPA/625/R-96/0109/IO-3.1& 3.2 & CPCB Guidelines	AAS method	0.01 µg/m^3
11	Arsenic (As)			1 ng/m^3
12	Nickel (Ni)			1 ng/m^3

Ambient Air Quality Standards stipulated by CPCB are presented in **Table below.**

Table 72 National Ambient Air Quality Standards (CPCB)

Pollutant	Time Weighted Average	Concentration in Ambient Air	
		Industrial, Residential, Rural and other areas	Ecologically Sensitive areas notified by Central Government
Sulphur Dioxide (SO_2) ($\mu g/m^3$)	Annual Average* 24 hours**	50 80	20 80
Oxides of Nitrogen (NOx) ($\mu g/m^3$)	Annual Average* 24 hours**	40 80	30 80
Particulate Matter (PM_{10}) ($\mu g/m^3$)	Annual Average* 24 hours**	60 100	60 100
Particulate Matter ($PM_{2.5}$) ($\mu g/m^3$)	Annual Average* 24 hours**	40 60	40 60
Carbon Monoxide (CO) (mg/m^3)	8 hours** 1 hour	02 04	02 04
Lead (Pb) ($\mu g/m^3$)	Annual Average* 24 hours**	0.50 1.0	0.50 1.0
Ozone (O_3) $\mu g/m^3$	8 hours** 1 hour**	100 180	100 180
Ammonia (NH3) $\mu g/m^3$	Annual* 24 hours**	100 400	100 400
Benzene (C_6H_6) $\mu g/m^3$	Annual*	05	05
Benzo(a)Pyrene (BaP) – particulate phase only, ng/m^3	Annual*	01	01
Arsenic (As) ng/m^3	Annual*	06	06
Nickel (Ni), ng/m^3	Annual*	20	20

Ambient Air Quality

The study on baseline ambient air quality status in the project area is an essential and primary requirement for assessing the impacts on air environment due to any proposed developmental activity. The baseline studies on air environment include identification of specific air pollution parameters expected to have significant impacts and assessing their existing levels in ambient air within the impact zone. To assess the baseline status of ambient air quality in the study area monitoring is undertaken to ascertain the baseline pollutant concentrations in ambient air in the month of March to April 2021.

Ambient Air Quality Monitoring locations were monitored on 24 hourly average bases as per guidelines of Central Pollution Control Board (CPCB) and National Ambient Air Quality Standards (NAAQS) within 10 km radius (aerial distance) from the proposed project site at 8 different locations. Table 136 & Figure 80 shows the air monitoring stations selected near the project area. Ambient Air Quality Standards stipulated by CPCB are presented in Table 134. Various parameters like PM_{10}, $PM_{2.5}$, SO_2, NOx, CO, O_3, Pb, NH_3 were monitored at these locations. The minimum, maximum and the average of the monitoring results are presented in this section. The air monitoring analysis results for the proposed Vadhavan port is summarized in Tables below.

Table 73 Air Quality Monitoring Locations

Site	Study Location	Direction
1	Near Bada-Pokharan Grampanchayat	NEE
2	Barade Babasaheb Ambedkar	SE
3	Dahanu Khadi Bridge	NE
4	Z.P. School Matgaon	SE
5	Vadhavan (Near Project Site)	NW
6	Near Datta Mandir, Vasgaon	SE
7	Near PHC Tarapur	SE
8	SRK College Dahanu	NE

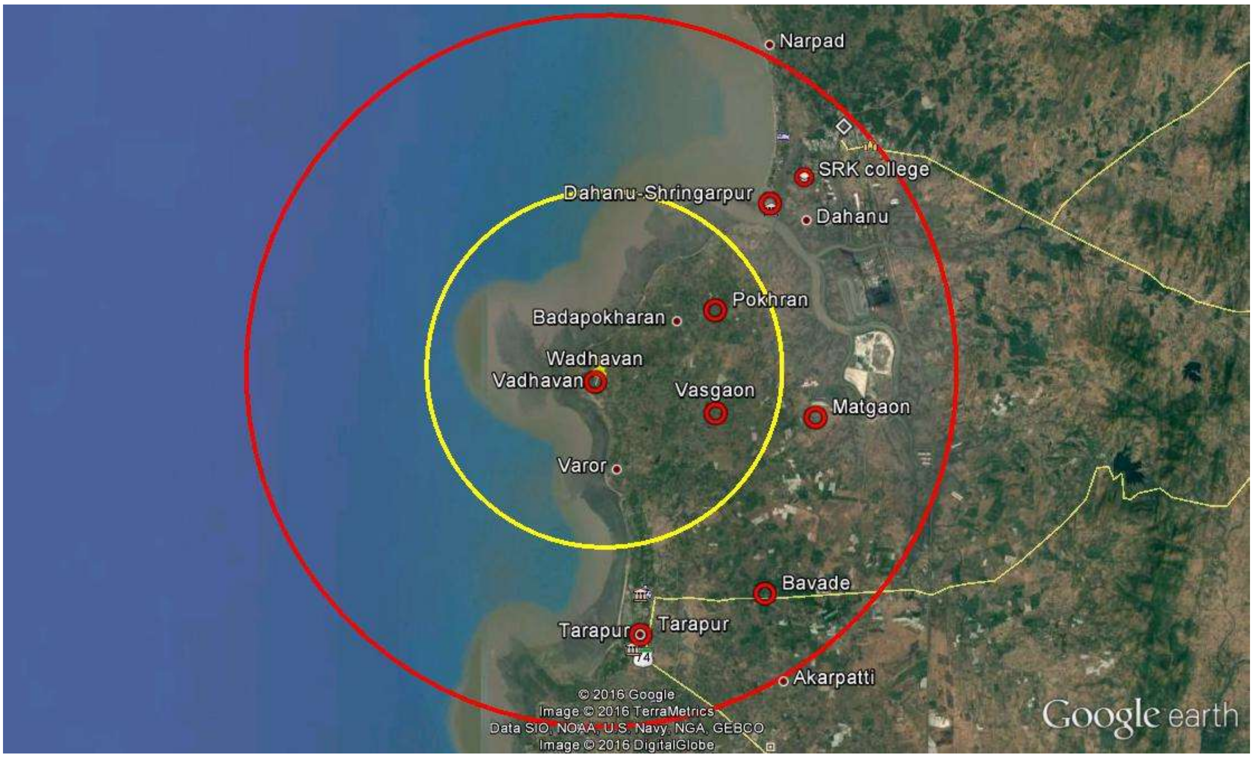


Figure 81 - Air Monitoring Locations

Table 74 Result Of Air Pollutant Concentration at Various Stations for March 2021 (Monitoring Dates : 13-14/03/2021)

Station	Relative Humidity	PM_{10}	$PM_{2.5}$	NOx	SO_2	NH_3	O_3	Ni	As	Pb	C_6H_6	CO	BaP	AQI
Unit	*%*	*µg/m³*	*µg/m³*	*µg/m³*	*µg/m³*	*µg/m³*	*µg/m³*	*ng/m³*	*ng/m³*	*µg/m³*	*µg/m³*	*mg/m³*	*ng/m³*	--
Standards	--	***100***	***60***	***80***	***80***	***400***	***100***	***20.0***	***6.0***	***1.0***	***5.0***	***2.0***	***1.0***	--
Near Bada-Pokharan Grampanchayat	Min.: 70 Max.: 75	70.8	48.8	22.0	16.0	84.0	26.0	3.0	BDL	BDL	BDL	BDL	BDL	81
Barade Babasaheb Ambedkar	Min.: 70 Max.: 75	68.7	31.3	26.0	18.0	94.0	27.0	8.0	BDL	BDL	BDL	BDL	BDL	69
Dahanu Khadi Bridge	Min.: 70 Max.: 75	87.1	54.5	24.0	19.0	89.0	27.0	4.0	BDL	BDL	BDL	BDL	BDL	91
Z.P. School Matgaon	Min.: 70 Max.: 75	77.0	34.0	19.0	16.0	87.0	27.0	2.0	BDL	BDL	BDL	BDL	BDL	77
Vadhavan (Near Project Site)	Min.: 70 Max.: 75	70.8	40.9	28.0	16.0	BDL	25.0	BDL	BDL	BDL	BDL	BDL	BDL	71
Near Datta Mandir, Vasgaon	Min.: 70 Max.: 75	69.6	34.8	22.7	18.0	80.0	21.0	5.0	BDL	BDL	BDL	BDL	BDL	70
Near PHC Tarapur	Min.: 70 Max.: 75	75.6	38.7	23.0	15.0	94.0	23.0	6.0	BDL	BDL	BDL	BDL	BDL	76
SRK College Dahanu	Min.: 70 Max.: 75	77.1	38.5	26.0	18.0	BDL	25.0	BDL	BDL	BDL	BDL	BDL	BDL	77
Minimum	**70**	**68.7**	**31.3**	**19.0**	**15.0**	**BDL**	**21.0**	**BDL**	**BDL**	**BDL**	**BDL**	**BDL**	**BDL**	**69**
Maximum	**75**	**77.1**	**54.5**	**26.0**	**19.0**	**94.0**	**27.0**	**8.0**	**BDL**	**BDL**	**BDL**	**BDL**	**BDL**	**81**
Average	--	**74.6**	**40.2**	**23.8**	**17.0**	**66.0**	**25.1**	**3.5**	**BDL**	**BDL**	**BDL**	**BDL**	**BDL**	**76.5**

Table 75 Result of Air Pollutant Concentration at Various Stations for April 2021 (Monitoring Dates : 13-14/04/2021)

Station	Relative Humidity	PM_{10}	$PM_{2.5}$	NOx	SO_2	NH_3	O_3	Ni	As	Pb	C_6H_6	CO	BaP	AQI
Unit	*%*	*µg/m³*	*µg/m³*	*µg/m³*	*µg/m³*	*µg/m³*	*µg/m³*	*ng/m³*	*ng/m³*	*µg/m³*	*µg/m³*	*mg/m³*	*ng/m³*	
Standards	**--**	***100***	***60***	***80***	***80***	***400***	***100***	***20.0***	***6.0***	***1.0***	***5.0***	***2.0***	***1.0***	
Near Bada-Pokharan Grampanchayat	40	44.0	16.5	30.0	31.1	18.0	14.0	<0.007	BDL	BDL	BDL	0.007	BDL	44
Bavade, Near Babasaheb Ambedkar Chowk	40	48.0	14.0	30.3	23.0	19.0	15.0	<0.003	BDL	BDL	BDL	0.008	BDL	48
Dahanu Khadi Bridge, Near Ganesh Mandir	40	48.0	16.1	32.4	28.0	23.0	14.0	<0.006	BDL	BDL	BDL	0.007	BDL	48
Near Z.P. School, Matgaon	40	50.1	18.0	34.1	25.2	20.0	12.0	<0.03	BDL	BDL	BDL	0.07	BDL	50
Vadhavan (Near Project Site)	40	42.3	14.0	30.0	28.5	20.0	15.0	<0.006	BDL	BDL	BDL	0.007	BDL	42
Near Datta Mandir, Vasgaon	40	48.2	13.0	28.1	26.0	20.0	12.0	<0.05	BDL	BDL	BDL	0.08	BDL	40
Near PHC, Tarapur	40	46.8	18.1	30.0	29.1	17.0	15.0	<0.06	BDL	BDL	BDL	0.06	BDL	47
SRK College, Dahanu	40	46.1	14.4	32.5	26.1	22.1	11.0	<0.06	BDL	BDL	BDL	0.06	BDL	46
Minimum	**--**	**42.3**	**13.0**	**28.1**	**23.0**	**17.0**	**11.0**	**<0.006**	**BDL**	**BDL**	**BDL**	**0.007**	**BDL**	**40**
Maximum	**--**	**50.1**	**18.1**	**34.1**	**31.1**	**23.0**	**15.0**	**<0.06**	**BDL**	**BDL**	**BDL**	**0.08**	**BDL**	**50**
Average	**40**	**46.7**	**15.5**	**30.9**	**27.1**	**19.9**	**13.5**	**<0.03**	**BDL**	**BDL**	**BDL**	**0.04**	**BDL**	**45.6**

Table 76 Result of Air Pollutant Concentration at Various Stations for May 2021 (Monitoring Dates : 16-17/05/2021)

Station	Relative Humidity	PM_{10}	$PM_{2.5}$	NOx	SO_2	NH_3	O_3	Ni	As	Pb	C_6H_6	CO	BaP	AQI
Unit	*%*	*µg/m³*	*µg/m³*	*µg/m³*	*µg/m³*	*µg/m³*	*µg/m³*	*ng/m³*	*ng/m³*	*µg/m³*	*µg/m³*	*mg/m³*	*ng/m³*	
Standards	--	*100*	*60*	*80*	*80*	*400*	*100*	*20.0*	*6.0*	*1.0*	*5.0*	*2.0*	*1.0*	
Near Bada-Pokharan Grampanchayat	50	42.0	15.3	30.0	28.0	16.0	13.0	<0.006	BDL	BDL	BDL	0.006	BDL	42
Bavade, Near Babasaheb Ambedkar Chowk	50	50.1	16.1	28.2	26.0	17.0	14.0	<0.004	BDL	BDL	BDL	0.06	BDL	50
Dahanu Khadi Bridge, Near Ganesh Mandir	50	50.0	18.1	34.1	29.0	21.0	13.0	<0.005	BDL	BDL	BDL	0.06	BDL	50
Near Z.P. School, Matgaon	50	48.0	20.1	34.1	28.3	21.0	11.0	<0.04	BDL	BDL	BDL	0.06	BDL	48
Vadhavan (Near Project Site)	50	44.2	16.0	28.0	26.4	18.0	13.0	<0.005	BDL	BDL	BDL	0.06	BDL	44
Near Datta Mandir, Vasgaon	50	47.2	14.0	24.0	26.2	18.0	11.0	<0.03	BDL	BDL	BDL	0.04	BDL	47
Near PHC, Tarapur	50	44.6	19.2	29.0	27.1	16.0	14.0	<0.04	BDL	BDL	BDL	0.05	BDL	45
SRK College, Dahanu	50	48.0	15.0	30.3	28.1	20.0	10.0	<0.05	BDL	BDL	BDL	0.05	BDL	48
Minimum	--	**42.0**	**14.0**	**24.0**	**26.0**	**16.0**	**11.0**	**<0.006**	**BDL**	**BDL**	**BDL**	**0.006**	**BDL**	**42**
Maximum	--	**50.1**	**20.1**	**34.1**	**28.3**	**21.0**	**14.0**	**<0.05**	**BDL**	**BDL**	**BDL**	**0.05**	**BDL**	**50**
Average	**50**	**46.8**	**16.7**	**29.7**	**27.4**	**18.4**	**12.4**	**<0.02**	**BDL**	**BDL**	**BDL**	**0.05**	**BDL**	**46.7**

Table 77 Average Results of Air Pollutant Concentration at Various Stations (March to May 2021)

Station	Relative Humidity	PM_{10}	$PM_{2.5}$	NOx	SO_2	NH_3	O_3	Ni	As	Pb	C_6H_6	CO	BaP
Unit	*%*	*µg/m³*	*µg/m³*	*µg/m³*	*µg/m³*	*µg/m³*	*µg/m³*	*ng/m³*	*ng/m³*	*µg/m³*	*µg/m³*	*mg/m³*	*ng/m³*
Standards	**--**	***100***	***60***	***80***	***80***	***400***	***100***	***20.0***	***6.0***	***1.0***	***5.0***	***2.0***	***1.0***
Near Bada-Pokharan Grampanchayat	Min.: 70 Max.: 75	52.3	26.9	27.3	25.3	39.3	17.7	1.0	BDL	BDL	BDL	0.004	BDL
Bavade, Near Babasaheb Ambedkar Chowk	Min.: 70 Max.: 75	55.6	20.5	28.2	22.3	43.3	18.7	2.7	BDL	BDL	BDL	0.02	BDL
Dahanu Khadi Bridge, Near Ganesh Mandir	Min.: 70 Max.: 75	61.7	29.6	30.2	25.3	44.3	18.0	1.3	BDL	BDL	BDL	0.02	BDL
Near Z.P. School, Matgaon	Min.: 70 Max.: 75	58.4	24.0	29.1	23.2	42.7	16.7	0.7	BDL	BDL	BDL	0.04	BDL
Vadhavan (Near Project Site)	Min.: 70 Max.: 75	52.4	23.6	28.7	23.6	12.7	17.7	0.003	BDL	BDL	BDL	0.02	BDL
Near Datta Mandir, Vasgaon	Min.: 70 Max.: 75	55.0	20.6	24.9	23.4	39.3	14.7	1.6	BDL	BDL	BDL	0.04	BDL
Near PHC, Tarapur	Min.: 70 Max.: 75	55.7	25.3	27.3	23.7	42.3	17.3	2.0	BDL	BDL	BDL	0.04	BDL
SRK College, Dahanu	Min.: 70 Max.: 75	57.1	24.1	29.6	24.1	14.0	15.3	0.03	BDL	BDL	BDL	0.04	BDL
Minimum	**70**	**52.3**	**20.5**	**27.3**	**22.3**	**12.7**	**14.7**	**0.003**	**BDL**	**BDL**	**BDL**	**0.02**	**BDL**
Maximum	**75**	**61.7**	**29.6**	**30.2**	**25.3**	**44.3**	**18.7**	**2.7**	**BDL**	**BDL**	**BDL**	**0.04**	**BDL**

Good (0–50)	Minimal Impact	**Poor (201–300)**	Breathing discomfort to people on prolonged exposure
Satisfactory (51–100)	Minor breathing discomfort to sensitive people	**Very Poor (301–400)**	Respiratory illness to the people on prolonged exposure
Moderate (101–200)	Breathing discomfort to the people with lung, heart disease, children and older adults	**Severe (>401)**	Respiratory effects even on healthy people

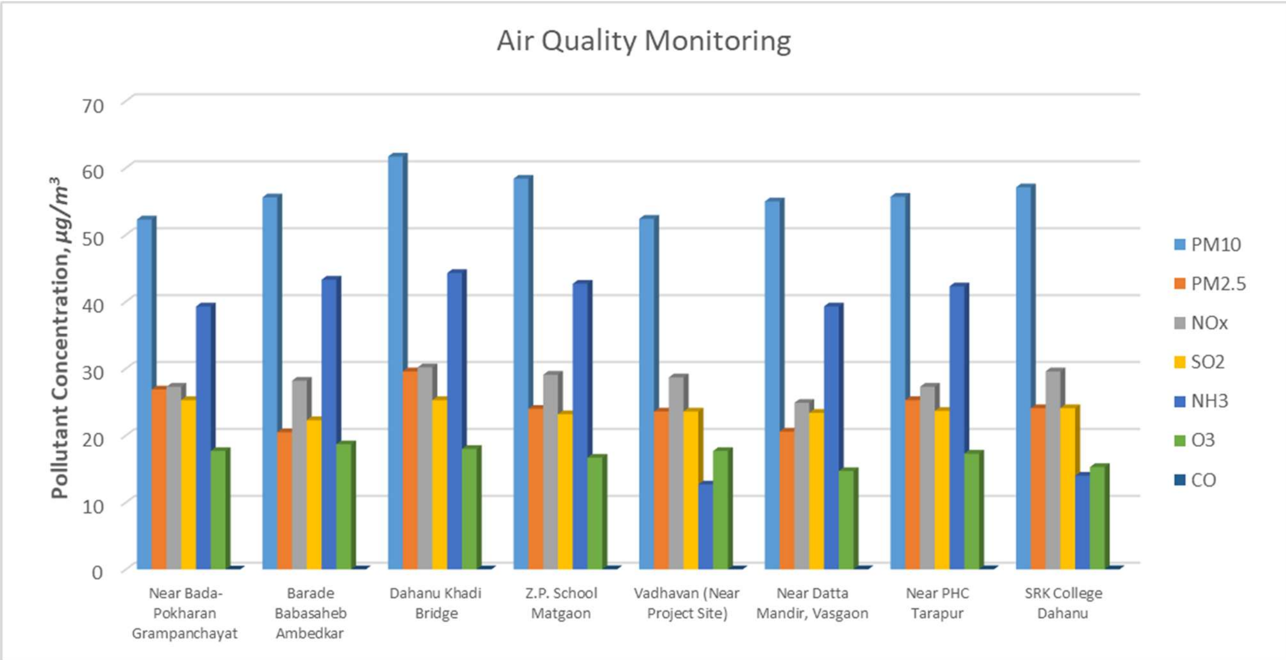


Figure 82 – Ambient Air Quality Monitoring Results (Average)

Observation and Conclusion

The status of the ambient air quality in the study area was established by carrying out monitoring for air quality parameters like $PM_{2.5}$, PM_{10}, SO_2 NO_X, O_3, Pb, etc. at 8 locations in the study area. The data presented is average for 24 hours.

- **Observation on Ambient PM_{10} levels**

The Average PM_{10} levels at various stations covered under the ambient air quality monitoring survey ranged from 52.3 to 61.7 µg/m^3 which is well below the permissible limits (100 µg/m^3) specified for industrial areas by CPCB/ MoEF.

The suspended particulate matter (PM_{10}) is average minimum as 52.3 µg/m^3 near Bada Pokharan Grampanchayat and average maximum of 61.7 µg/m^3 at Dahanu Khadi Bridge, Near Ganesh Mandir.

- **Observation on Ambient $PM_{2.5}$ levels**

The Average $PM_{2.5}$ levels at various stations covered under the ambient air quality monitoring survey ranged from 20.5 to 29.6 µg/m^3 which is well below the permissible limits (60 µg/m^3) specified for industrial areas by CPCB/ MoEF.

The respiratory suspended particulate matter ($PM_{2.5}$), the average highest value was 29.6µg/m^3 at Dahanu Khadi Bridge, Near Ganesh Mandir and average minimum of 20.5µg/m^3 near Bavade, Near Babasaheb Ambedkar Chowk.

- **Observation on Ambient SO_2 levels**

The Average SO_2 levels at various stations covered under the ambient air quality monitoring survey ranged from 22.3 to 25.3 µg/m^3 which is well below the permissible limits (80 µg/m^3) specified for industrial areas by CPCB/ MoEF.

The Sulphur Dioxide (SO_2) the average highest value was 25.3 µg/m^3 at Dahanu Khadi Bridge, Near Ganesh Mandir and average minimum of 22.3 µg/m^3 near Bavade, Near Babasaheb Ambedkar Chowk.

- **Observation on Ambient NOx levels**

The Average NOx levels at various stations covered under the ambient air quality monitoring survey ranged from 27.3 to 30.2 µg/m^3 which is well within the permissible industrial area (80 µg/m^3) as specified by CPCB.

The Nitrogen Dioxide (NO_2), the average highest value was 30.2 µg/m^3 at Dahanu Khadi Bridge, Near Ganesh Mandir and average minimum of 27.3 µg/m^3 at Near Bada-Pokharan Grampanchayat and near PHC, Tarapur.

- **Observations on Carbon Monoxide (CO)**

The CO values recorded at all the locations is <0.4 mg/m^3.

- **Observations on other parameters**

It is observed that Lead, Benzene, Benzo-Pyrene, Ammonia and Ozone were found to be below the detectable limits during the field survey

4.9 Noise Environment

The noise quality of the port region was assessed by monitoring the sound level at different sites in the region. Noise quality was assessed in the months of March – 2021 to May 2021 for eight different locations selected within the study area. The noise monitoring was done within 10 km distance from the proposed project location. Google image for noise monitoring locations are presented in the Figure 82 and the noise monitoring results are given in the Tables below.

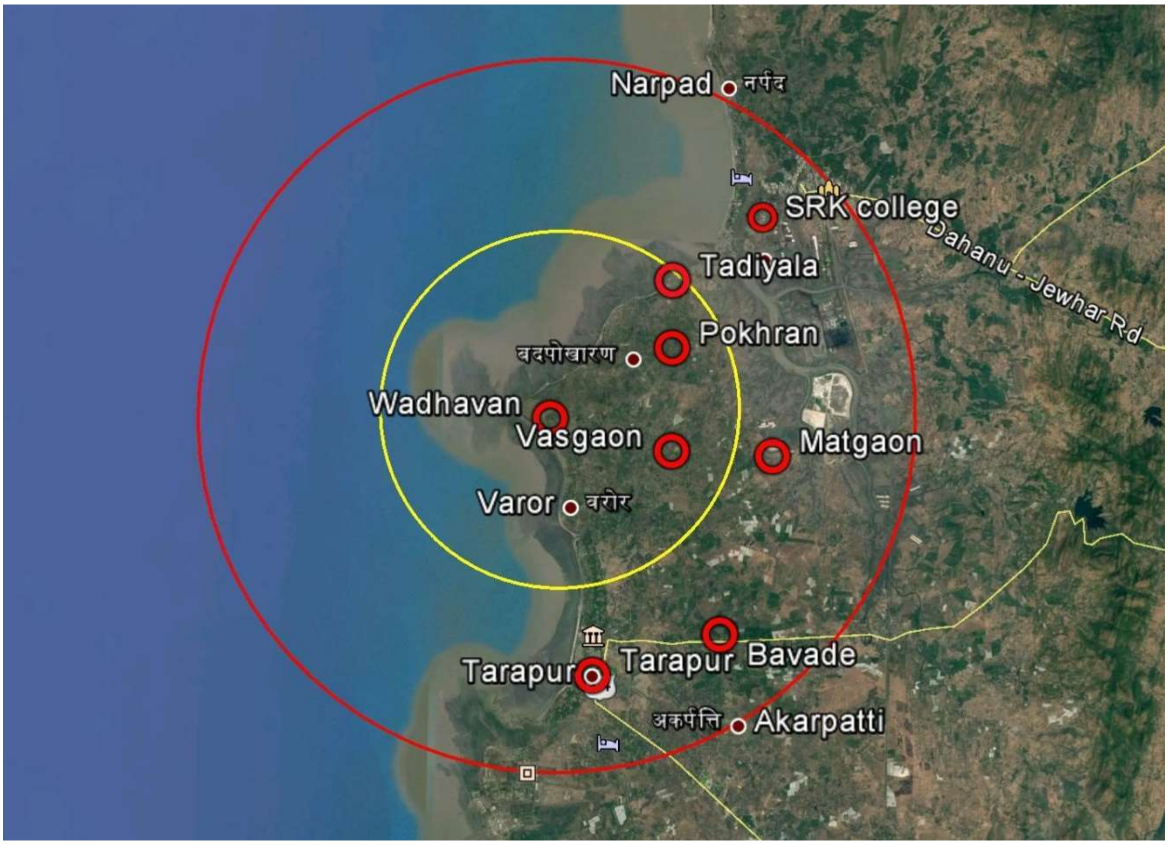


Figure 83 - Google image Showing Noise Monitoring Locations

The main objective of Noise Pollution Impact Assessment in the study area is to assess the impact of the total noise generated by the existing activity on the human settlements. The main objectives of the study conducted are:

- Assessment of background noise levels.
- Identification and monitoring the major noise sources of the existing activity.
- To assess the impact of noise of general population

At each ambient noise monitoring station, Leq. Noise level has been recorded at hourly intervals for 24 hours.

Table 78 Permissible Noise Level (CPCB STANDARDS)

Area	Category of Area	Permissible Limit	
		L_{eq} Day time	L_{eq} 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 AM and 9 PM

2. Night time is 9 PM and 6 AM

3. Silence zone is defined as areas up to 100 m 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 Gazettee notification, Government of India, date 14.2.2000.

Table 79 Result of Noise Levels at Various Stations for March 2021(Monitoring Dates : 13-14/03/2021)

Station Code	Noise Monitoring Location	Average noise levels in dB		CPCB Limits in dB (A)	
		Leq (day)	Leq (night)	Day	Night
N1	Near Bada-Pokharan Grampanchayat	63.9	54.8	65	55
N2	Bavade, Near Babasaheb Ambedkar Chowk	58.5	43.7	65	55
N3	Dahanu Khadi Bridge, Near Ganesh Mandir	61.5	47.2	65	55
N4	Near Z.P. School, Matgaon	54.3	38.5	65	55
N5	Vadhavan (Near Project Site)	57.8	39.4	75	70
N6	Near Datta Mandir, Vasgaon	59.3	42.1	65	55
N7	Near PHC, Tarapur	64.8	50.1	75	70
N8	SRK College, Dahanu	62.9	48.3	65	55

Table 80 Result of Noise Levels at Various Stations for April 2021 (Monitoring Dates : 13-14/04/2021)

Station Code	Noise Monitoring Location	Average noise levels in dB		CPCB Limits in dB (A)	
		Leq (day)	Leq (night)	Day	Night
N1	Near Bada-Pokharan Grampanchayat	64.1	48.9	65	55
N2	Bavade, Near Babasaheb Ambedkar Chowk	60.9	50.1	65	55
N3	Dahanu Khadi Bridge, Near Ganesh Mandir	62.5	53.1	65	55

Station Code	Noise Monitoring Location	Average noise levels in dB		CPCB Limits in dB (A)	
		Leq (day)	Leq (night)	Day	Night
N4	Near Z.P. School, Matgaon	61.9	46.3	65	55
N5	Vadhavan (Near Project Site)	61.7	46.1	75	70
N6	Near Datta Mandir, Vasgaon	60.1	46.2	65	55
N7	Near PHC, Tarapur	63.1	52.7	75	70
N8	SRK College, Dahanu	60.9	48.3	65	55

Table 81: Result of Noise Levels at Various Stations for May 2021 (Monitoring Dates : 16-17/05/2021)

Station Code	Noise Monitoring Location	Average noise levels in dB		CPCB Limits in dB (A)	
		Leq (day)	**Leq (night)**	**Day**	**Night**
N1	Near Bada-Pokharan Grampanchayat	63.8	49.0	65	55
N2	Bavade, Near Babasaheb Ambedkar Chowk	60.3	49.1	65	55
N3	Dahanu Khadi Bridge, Near Ganesh Mandir	61.6	52.9	65	55
N4	Near Z.P. School, Matgaon	62.2	47.5	65	55
N5	Vadhavan (Near Project Site)	62.4	47.4	75	70
N6	Near Datta Mandir, Vasgaon	60.9	48.6	65	55
N7	Near PHC, Tarapur	62.7	52.5	75	70
N8	SRK College, Dahanu	60.8	47.8	65	55

Table 82: Average Result of Noise Levels at Various Stations (March to May 2021)

Station Code	Noise Monitoring Location	Average noise levels in dB		CPCB Limits in dB (A)	
		Leq (day)	Leq (night)	Day	Night
N1	Near Bada-Pokharan Grampanchayat	63.9	50.9	65	55
N2	Bavade, Near Babasaheb Ambedkar Chowk	59.9	47.6	65	55
N3	Dahanu Khadi Bridge, Near Ganesh Mandir	61.9	51.1	65	55

Station Code	Noise Monitoring Location	Average noise levels in dB		CPCB Limits in dB (A)	
		Leq (day)	Leq (night)	Day	Night
N4	Near Z.P. School, Matgaon	59.5	44.1	65	55
N5	Vadhavan (Near Project Site)	60.6	44.3	75	70
N6	Near Datta Mandir, Vasgaon	60.1	45.6	65	55
N7	Near PHC, Tarapur	63.5	51.8	75	70
N8	SRK College, Dahanu	61.5	48.1	65	55

Observation & Conclusion

The monitoring for noise level was carried out for 72 hours using a portable sound level meter. Noise levels were recorded at a 1 hour interval. The L equivalent (Leq) was Calculated for the day and night time readings. The noise monitoring was carried out for eight different locations and the results obtained were compared to the standards prescribed by the Noise Pollution (Regulation and Control) Rules, (Year 2000).

The noise level around project area is a minimum of 59.5 dB(A) at Near Z.P. School, Matgaon and maximum 63.9 dB(A) near Near Bada-Pokharan Grampanchayat during day time & a minimum of 44.1 dB(A) at Near Z.P. School, Matgaon and maximum 51.8 dB(A) near Near PHC, Tarapur during Night time.

All the noise monitoring results were found to be within the acceptable limits for all the locations.

4.10 Socio-economic Environment

Social Impact Assessment Report for Vadhavan Port is conducted by Southern Enviro Engineers Pvt. Ltd., Hyderabad (March 2022). Report enclosed as Annexure 14

4.10.1 Demography and Socio-Economics

The growth of infrastructure developments for mining and industrial sectors in and around the agriculture dominant areas, villages and towns is bound to create its impact on the socio-economic aspects of the local population of the area experiencing development. The impacts may be positive or negative depending upon the developmental activity. To assess the anticipated impacts of the infrastructural industrial growth on the socio-economic aspects of people, it is necessary to study the existing socio-economic status of the local population, which will be helpful for making efforts to further improve the quality of life in the area under study. For assessing the prevailing socio-economic aspects of people in the study area around the port project, the required data has been collected from primary and various secondary sources and analyzed.

4.10.2 Scope of the Study

As a consequence of developing Vadhavan Port would acquire a 17471 ha. of land which includes waterfront, intertidal zone, private governmental waste and forest land. This would have serious implications on the lives of the people, as they will be losing their land, means of livelihood. It will be of prime importance to acquire a sound database of the families who will be affected by the proposed project.

- To prepare a demographic profile of the project affected villages
- To assess the socio- economic status of the people and nature of displacement to be caused by the proposed project and rail and road alignment route
- To assess quality of life of the people falling under study area rail and road alignment route
- To assess the prospects and consequences of the project on social and economic lives of the people who would be alienated from their agricultural land
- Assessing the socio-economic growth profile and growth potentials in the surrounding areas of the project
- To understand the mood, perception and extent of preparedness of the people towards the establishment of the project
- To prepare the preliminary suggestions and rehabilitation plan of the project affected people.
- For such projects, the benefits of undertaking a systematic Social Impact Assessment (SIA) can include:
    - Reduced impact on communities or individuals – identification of mitigation measures is an integral element of SIA;
    - Enhanced benefits to those affected – SIA preparation also helps identify measures such as job training packages;
    - Avoiding delays and obstruction – a well prepared SIA demonstrates that social impacts are taken seriously and helps to gain development approval;
    - Lowered costs – addressing social impacts and mitigation measures at an early stage helps to avoid costly errors and remedial actions imposed at a later stage by regulatory agencies;

- Better community and stakeholder relationships – experience has shown that SIA can help to allay fear and concern and build a basis of trust and cooperation necessary for the proponent to successfully introduce and operate the project; and
- Improved proposals – an SIA provides information that adds value to existing projects and helps to design future ones.

4.10.3 Methodology Adopted for the Study

The methodology adopted for the study is based on the following

- Review of secondary data, such as District Primary Census and Statistical Hand Books of Thane and Palghar- 2011 and the data from National Informatics Center, New Delhi, for the parameters of demography, occupational structure of people within the study area around the proposed port project area and rail and road alignment route
- Review and collection of data from District Census Hand books and District Development plans
- Conducting Focus Group discussions in the villages for eliciting the general information of the study area, to support or supplement the information collected through secondary and primary surveys
- Interactions with senior citizens and various stakeholders in proposed project site and surrounding area to get primary information on stakeholder's concerns

4.10.4 Review of Demographic and Socio-Economic Profile - 2011

The sociological aspects of this study include human settlements, demography, social strata such as Scheduled Castes and Scheduled Tribes and literacy levels besides infrastructure facilities available in the study area. The economic aspects include occupational structure of workers. The information on socio-economic aspects of the study area has been collected from secondary sources, which mainly include District Primary Census Handbooks 2011 of Thane and Palghar districts, the latest census records available at the village level.

The proposed Vadhavan port is to develop all weather port village lands of Vadhavan, Tadiyali Varora and Gungvada of Dahanu Tehsil of Palghar District, Maharashtra. The study area within 10 Km around the periphery of the proposed port project is falling in tehsils of Dahanu and Palghar. About 33 villages of Dahanu Tehsil 7 villages of Palghar Tehsil of Palghar district are covered within the study area. Most of these settlements of the study area are shown in the Study Area

Map presented in following tables. The salient features of the demographic and socio-economic aspects of the study area are described in the following sections.

4.10.5 Demographic Aspects- Port area

Distribution of Population

As per 2011 census the study area consisted of 140070 persons inhabited in 40 villages of the study area. The distribution of population in the study area is shown in following table**.** The males and females constitute to about 50.29% and 49.71% of the study area

Table 83 Distribution of Population in Study Area – 2011

S. N.	Particulars	0-3 km	3-7 km	7-10 km	0 – 10 km
1	No. of Households	2298	18302	11087	31687
2	Male Population	5017	40817	24620	70454
3	Female Population	5079	39978	24559	69616
4	Total Population	10096	80795	49179	140070
5	% Of Males to Total Population	49.69	50.51	50.06	50.29
6	% Of Females to Total Population	50.31	49.49	49.94	49.71
7	Average Household Size	4.40	4.41	4.44	4.42
8	Sex Ratio	987.7	1020	1002	1012

Source: District Primary Census Hand Books, Thane district, 2011

Average Household Size

The study area had an average family size of 4.42 persons per household in 2011. This is a normal family size in India, however less in comparison with the other areas of Maharashtra. This normal family size could be attributed to a considerable degree of influence of local living conditions with migration of people with higher literacy levels who generally opt for smaller family size with family welfare measures to this study area and also due to the prevalence of single member families, a common phenomenon in geographical conditions of district.

Sex Ratio

The configuration of male and female indicates that the males constitute to about 50.29 % and females to 49.71% of the total population as per 2011 census records. The sex ratio i.e., the number of females per 1000 males indirectly reveals certain sociological aspects in relation with female births, infant mortality among female children and single person family structure, a resultant of migration of industrial workers. The study area on an average has 1012 females per 1000 males as per 2011 census. This ratio is considered to be lower in comparison with other states but more in comparison with the other parts of Maharashtra.

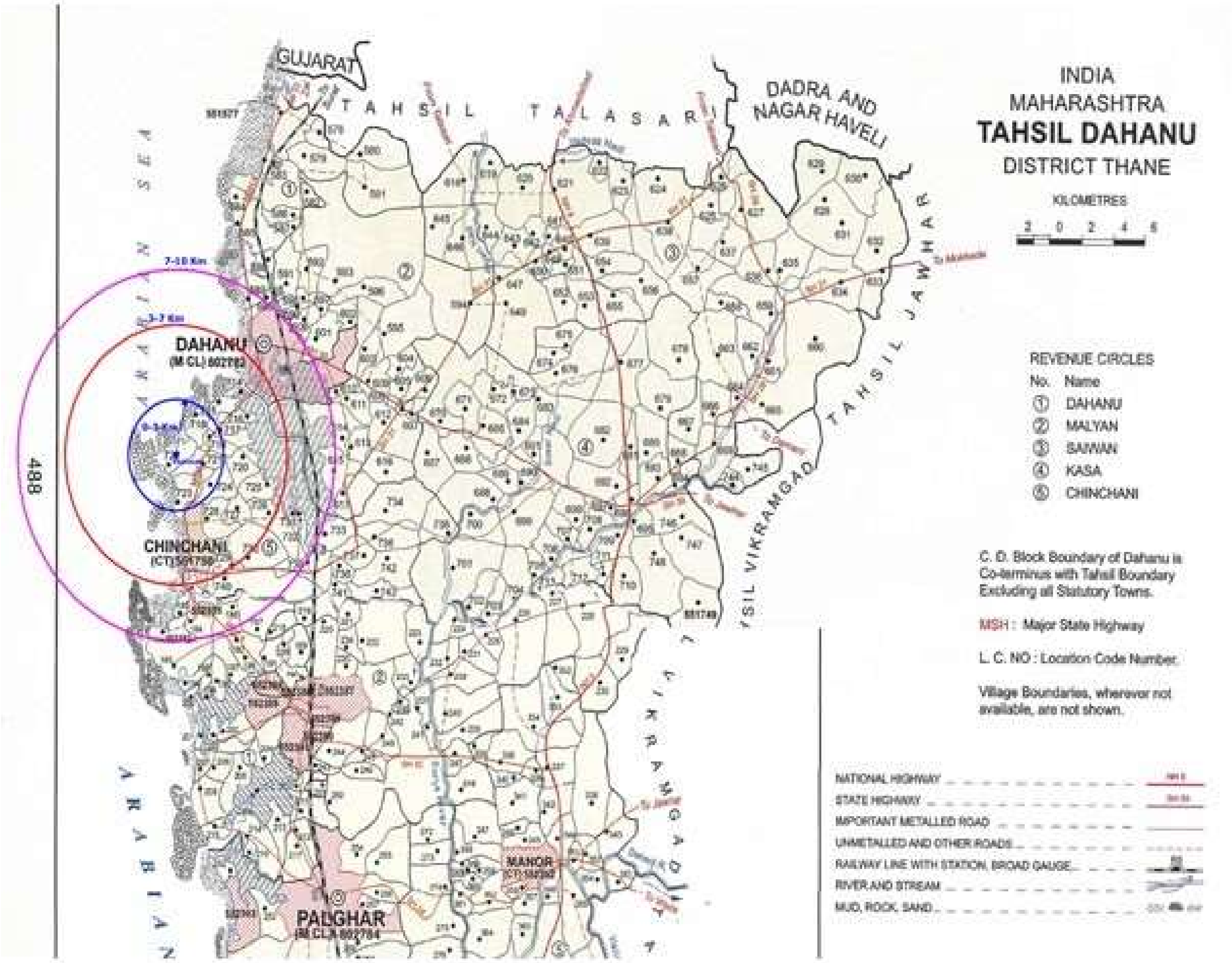


Figure 84 Socio-Economic Map of the Study Area

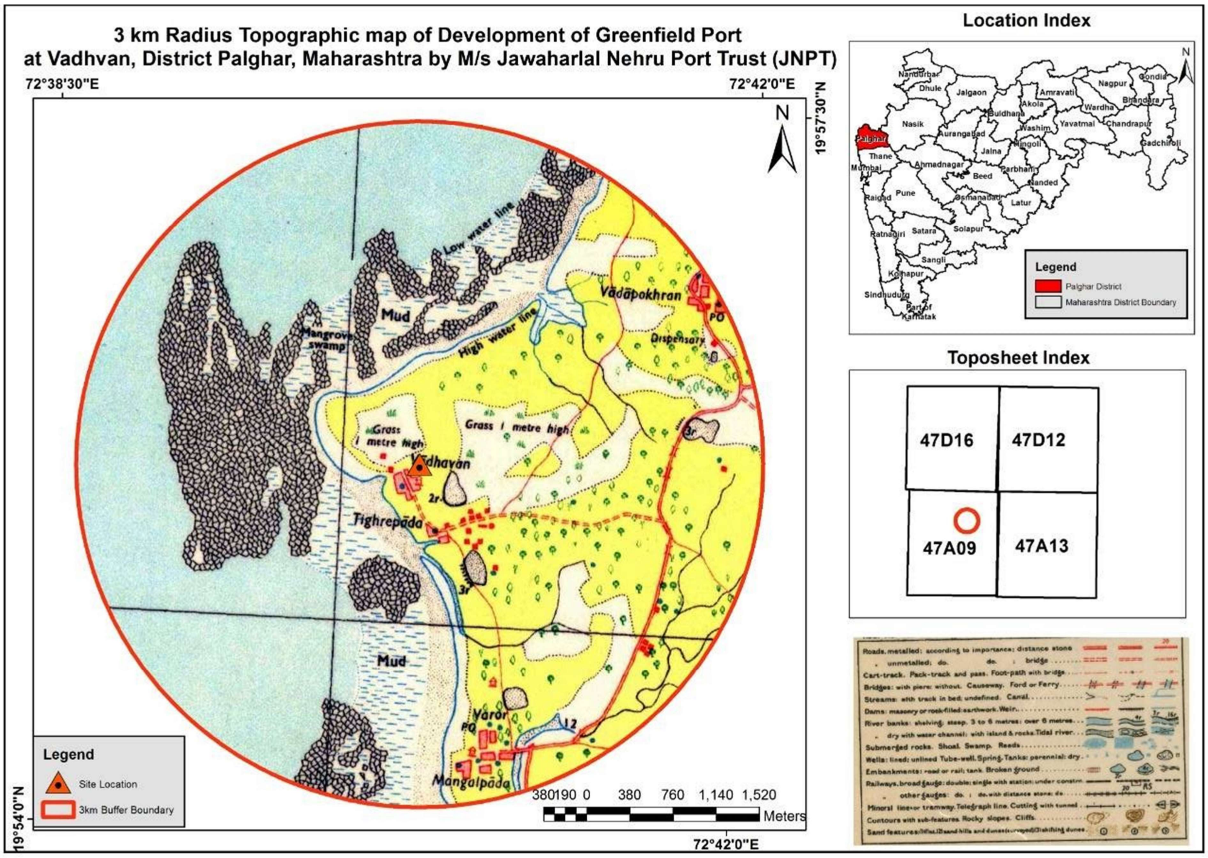


Figure 85 0 to 3 km map of the study area

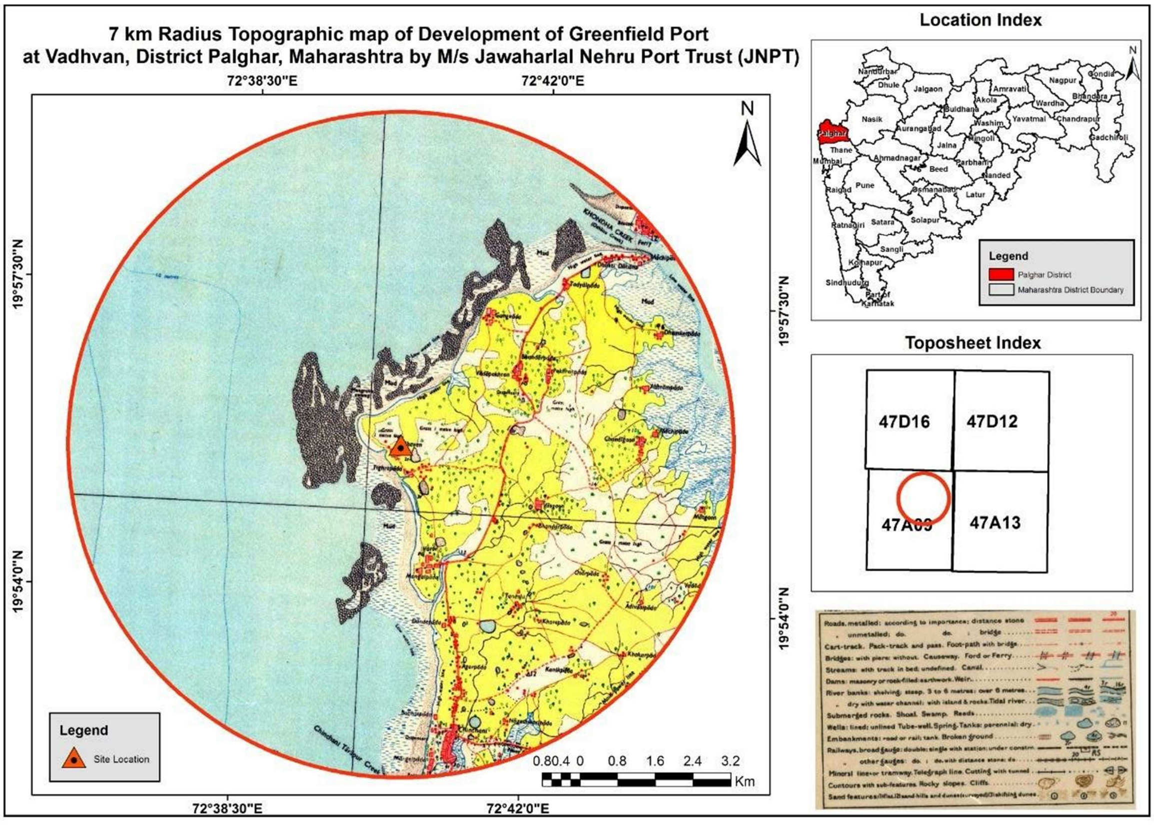


Figure 86 0-7 km Map of the Study Area

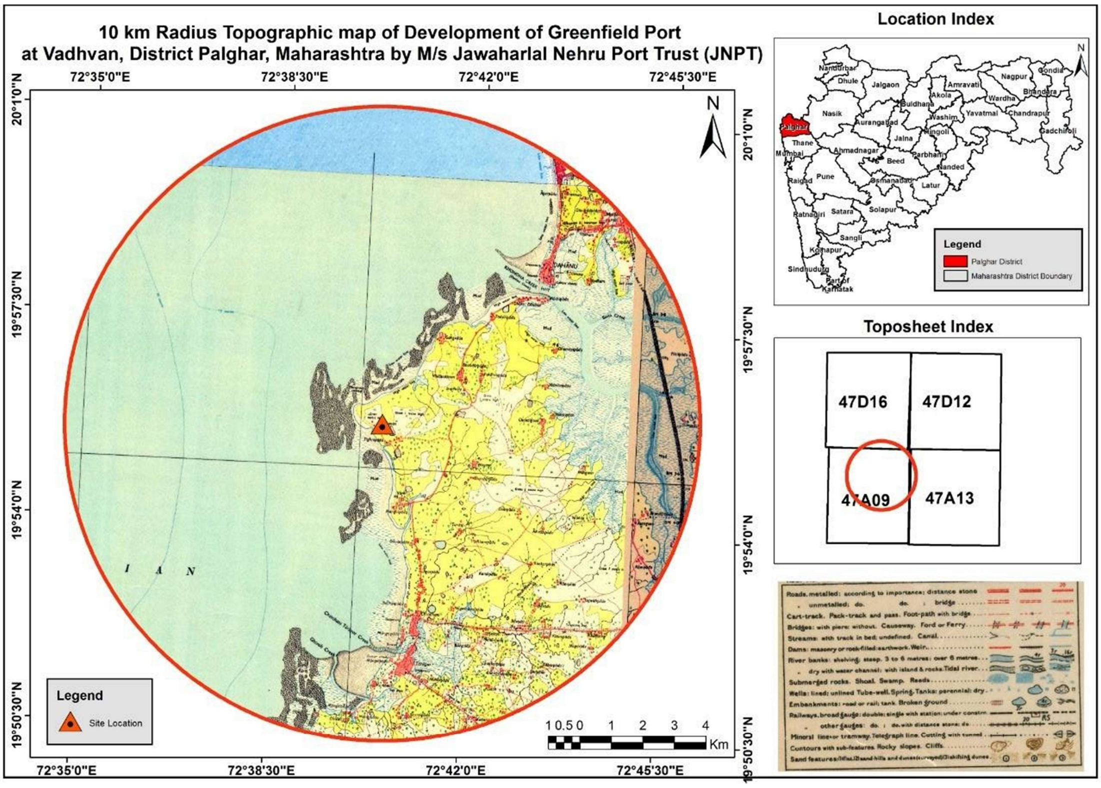


Figure 87 0-10 km Map of the Study Area

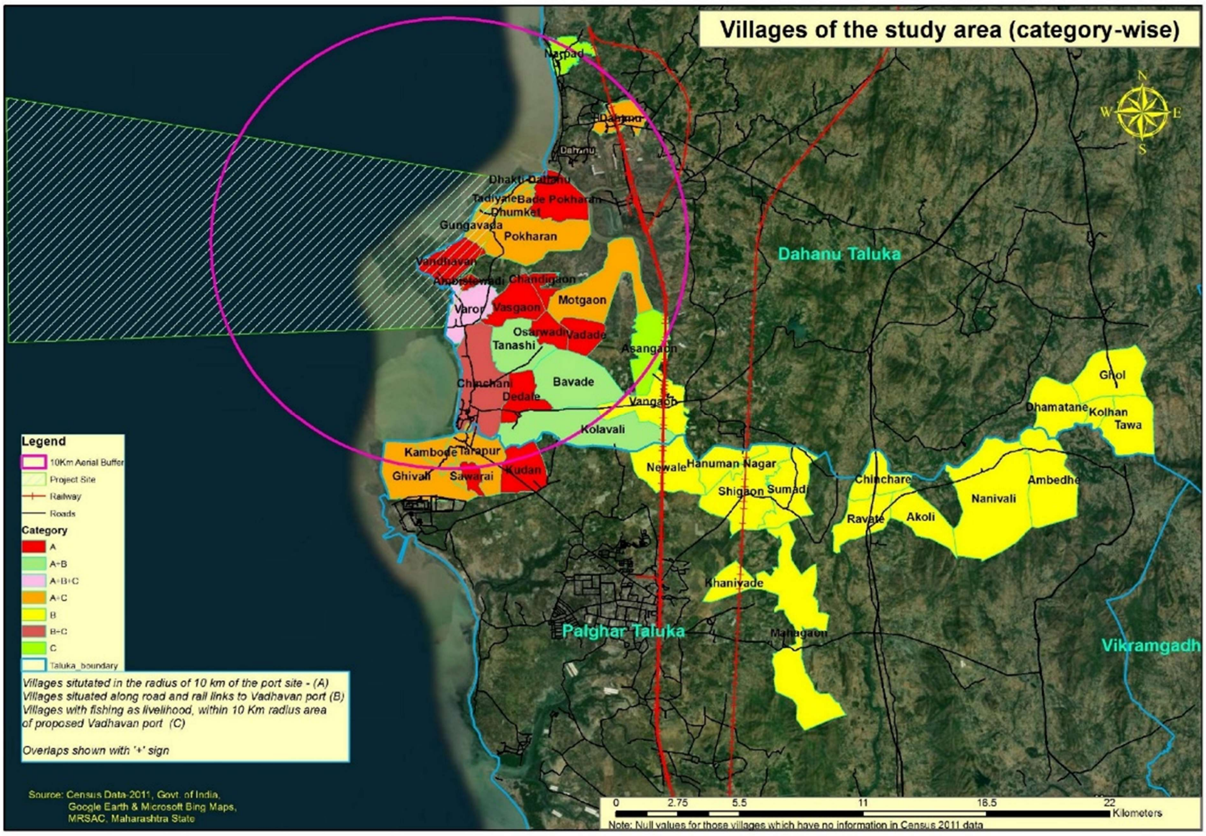


Figure 88 Villages in the 10 km Study Area (Category-wise)

Social Structure

In the study area, as per 2001 census, 3.79% of the population belonged to Scheduled Castes (SC) and 22.28% to the Scheduled Tribes (ST). This indicates that about one fourth of the population in the study area belong to weaker sections and works to about 26.07% of the total population in 2011. The distribution of population in the study area by social structure is shown in following table

Table 84: Distribution of Population by Social Structure – 2011

S. N.	Particulars	0-3 km	3-7 km	7-10 km	0 – 10 km
1	Scheduled Castes	285	2795	2229	5309
2	% To total population	2.82	3.46	4.53	3.79
3	Scheduled Tribes	712	15525	14963	31200
4	% To total population	7.05	19.21	30.42	22.28
5	Total SC and ST	997	18320	17192	36509
6	% To total population	9.87	22.67	34.95	26.07
7	Other castes	9099	62475	31987	103561
8	% To total population	90.13	77.33	65.05	73.93
9	**Total Population**	**10096**	**80795**	**49179**	**140070**

Source: District Primary Census Hand Books, Thane district, 2011

Literacy Levels

The analysis of the literacy levels in the study area reveals a higher literacy rate in the study area. The study area experienced a literacy rate of 74.22% in 2011. If this is computed only for the people of above the age group of 5 years, i.e., the school going age people, this may slightly increase the literacy rate. The distribution of literates and literacy rate in the study area is given in following table

Table 85 Distribution of Literates and Literacy Rates – 2011

S. N.	Particulars	0-3 km	3-7 km	7-10 km	0 – 10 km
1	Total Literates	8074	61189	34704	103967
2	Average literacy (%)	79.97	75.73	70.56	74.22
3	Male Literates	4234	32968	18862	56064
4	Male Literacy (%)	52.43	53.87	54.35	53.92
5	Total Male	5017	40817	24620	70454
6	% Male Literates to total Literates	52.43	53.87	54.35	53.92
7	Female Literates	3840	28221	15842	47903
8	Total Female	5079	39978	24559	70454
9	Female Literacy (%)	75.60	70.59	64.50	67.99
10	% Female Literates to Total Literates	47,56	46.13	45.65	46.08
11	**Total Population**	**10096**	**80795**	**49179**	**140070**

Source: District Primary Census Hand Books, Thane district, 2011

The male literacy i.e., the percentage of literate males to the total males of the study area works out to 53.92%. The female literacy rate, which is an important indicator for social change, is observed to be only 46.08% in the study area as per 2011 census. This indicates that there is a need for major sociological development in the region with the increase in literacy levels of both males and females.

Occupational Structure

The occupational structure of people in the study area is studied with reference to main workers, marginal workers and non-workers. The main workers include 10 categories of workers defined by the Census Department, which consists of cultivators, agricultural laborers, those engaged in live-stock, forestry, fishing, mining and quarrying; manufacturing, processing and repairs in household industry; and other than household industry, construction, trade and commerce, transport and communication and other services.

The marginal workers are those workers engaged in some work for a period of less than six months during the reference year prior to the census survey. The non-workers include those engaged in unpaid household duties, students, retired persons, dependents, beggars, vagrants etc.; institutional inmates or all other non-workers who do not fall under the above categories.

Table 86 Occupational Structure – 2011

S. N.	Occupation	0-3 km	3-7 km	7-10 km	0-10 km
1	Total Main Workers	3916	27984	17448	49348
2	Percentage to Total Population (%)	38.78	34.73	35.47	35.23
3	Main workers-Male	2777	20437	12319	35533
4	Main workers-Male % total Population	27.50	25.29	25.05	25.37
5	Main Workers- Female	1139	7547	5129	13815
6	Main workers-Female % total Population	11.28	9.34	10.42	9.86
7	Marginal Workers	425	4850	3085	8360
8	Percentage to Total Population (%)	4.20	6.00	6.27	5.96
9	Marginal Workers –Male	247	2768	1588	4603
10	Percentage to Total Population (%)	2.44	3.42	3.22	3.28
11	Marginal Workers-Female	178	2082	1497	3757
12	Percentage to Total Population (%)	1.76	2.58	3.04	2.68
13	Total Non-Workers	5755	47961	28646	82362
14	Percentage to Total Population (%)	57.00	59.36	58.24	58.8

15	Non-Workers-Male	1993	17612	10713	30318
17	Percentage to Total Population (%)	19.74	21.79	21.78	21.64
18	Mon Workers-Female	3762	30349	17933	52044
19	Percentage to Total Population (%)	37.26	37.56	36.46	37.15
Total	**10096**	**80795**	**49179**	**140070**	

Source: District Primary Census Hand Books, Thane district, 2011

As per 2011 census records altogether the main workers work out to be 35.23% of the total population. The marginal workers and non-workers constitute to 5. 96 % and 58.8.% of the total population respectively. The distribution of workers by occupation indicates that the non-workers are the predominant population.

Dependency Ratio

Based on the occupational structure of the study area the dependency rate of non- workers on the workers category has been estimated at 142.72%, which is considered to be low or moderate while indicating that most of the people are engaged in some sort of income generating activity.

Infrastructure Facilities

The infrastructure and amenities available in the study area denotes the economic well being of the region. Reasonably good levels of infrastructure facilities are available in the study area, which consists of education, health care, communications, transportation, etc.

A review of infrastructure facilities available in the area has been done based on the information given in the District Census Hand Books and the data of National Informatics Center, for the year 2011.

Educational Facilities

The educational facilities are almost evenly distributed in the area. In all, there are 100 Pre-primary schools, 91 Primary schools, 63 middle schools, 22 Secondary schools and 2 Degree colleges and no technical institutes and colleges exists in study area. All the high schools are situated in larger villages. The available educational facilities in the area as per 2011 census are given in following table

Table 87 Educational Facilities in the Study Area

S. N.	Institution	Total
1	Pre- Primary schools	100
2	Primary schools	91
3	Middle schools	63
4	Secondary schools	22
5	Degree colleges	2
6	ITI, Polytechnic, Medical and Engineering institutes	0

Source: District Primary Census Hand Books, Thane district, 2011

Health Facilities

Different types of health facilities including hospitals, dispensaries and clinics are available in the study area. The health facilities include 1 hospital, 8 primary health centers, 12 dispensaries and others as shown in following table

Table 88 Health Facilities in the Study Area

S. N.	Type of Institution	No. of Institutions in Study Area
1	Medical facilities	
2	Community Health centers	1
3	Primary Health centers	0
4	Primary Health sub centers	11
5	Maternity and child welfare centers	2
6	TB clinic	1
7	Allopathic hospital	1
8	Dispensaries	1
9	Family welfare centers	1
10	Non-government medical facilities	2

Source: District Primary Census Hand Books, Thane district, 2011

Transport Facilities

The study area is served by rail and road transport facilities. All villages have paved road connections. As a whole, the study area has moderate level of communication network.

Post and Telegraphs

The study area has moderate level of Post and Telegraphic services. Altogether there were 18 Sub Post Offices and 4 Post and Telegraphic Offices in the study area in 2001. All human settlements had telephone facility in them.

Electrification

Almost all villages in the study were electrified in 2011. Electricity was supplied for domestic, agricultural, industrial and public lighting purposes. Subsequently the electric connections have been given to many other villages.

Drinking Water Facility

Water supply in the study area is mainly from wells, hand pumps followed by protected water supply system. As per records, all villages are being supplied protected water supply system.

4.10.6 Land-Use Based on Census Data – 2011 for Port area

Land Use Studies

Studies on land use aspects of eco-system play an important role in identifying sensitive issues and to take appropriate action to maintain Ecological homeostasis in the region. The main objective of this section is to provide a baseline status of the study area covering 10-km radius surrounding the proposed project, so that temporal changes on the surroundings due to the project activities can be assessed in future.

Objectives

The objectives of land use studies are:

- To determine the present land use pattern; and
- To facilitate determination of the temporal changes in the land use pattern after the execution of the proposed project.

Methodology

The land use of the study area has been studied by analysing the available secondary data from the District Census handbooks, agricultural census and other available records of the region.

As per the census records, the study area admeasures to about 24113.38 ha falling. The land-Use details based on census data are presented in **following table.** This includes forests, cultivated area, cultivable waste and the area not available for cultivation

Table 89 Land Use Pattern of Study Area

S. N.	Particulars of Land use	0-3 km	3-7 km	7-10 km	0-10 km
1	Forest Land	0	250.16	574.7	824.86
2	Land under Cultivation				
	a) Irrigated Land	58.52	177.37	580.79	816.78
	b) Un irrigated Land	1388.78	2986.46	8072.2	12447.44
3	Cultivable Waste Land	221.27	1109.40	1289.04	2619.71
4	Area not available for cultivation	856.26	1192.64	2204.42	4253.26
	Total Area	**2524.84**	**5716.03**	**12721.15**	**20962.05**

* All values are given in the table are in (Ha)

Forest Land

About 824.86 Ha (3.93%) of forest land is spreading over the 10-km radius study area and no forest land is present in 0-3 km radius of port project area.

Land Under Cultivation

Altogether 13264.22 ha cultivable land (irrigated and un- irrigated) was observed in the study area. The irrigated land admeasures to about 816.78 ha in the study area which works out to be 3.89 % of total study area. The un- irrigated land admeasures about 12447.44 ha and works out to about 58.38% of the total study area.

Cultivable Waste Land

Cultivable waste category of land includes the land which was cultivated sometime back and left vacant during the past 5 years in succession. These lands may either be fallows or covered with shrubs, which are not put to any use. The study area comprises of 2619.71 ha cultivable wastelands, which works out to about 12.49% of the total area. This percentage of land in this category indicates that almost all the cultivable lands are used for cultivation as well as various other purposes, while leaving a very less extent of land un-cultivated.

Land not Available for Cultivation

All the lands not included in the above categories of land uses are considered in the category of land not available for cultivation. This category of land use mainly consists of the hilly and barren lands, human settlements, roads, water-bodies, etc. About 4253.26 ha area working out to about 20.29% of the total study area falls in this category.

4.10.7 Demographic Aspects- Rail and Road Alignment

Distribution of Population

As per 2011 census the study area consisted of 49721 persons inhabited in 21 villages along with alignment route from Port to connecting National Highway. The distribution of population in the study area is shown in following table. The males and females constitute to about 50.44 % and 49.46% of the study area.

Table 90 : Distribution of Population

S. N.	Particulars	Alignment Route
1	No. of Households	10641
2	Male Population	25078
3	Female Population	24643
4	Total Population	49721
5	% Of Males to Total Population	50.44
6	% Of Females to Total Population	49.56
7	Average Household Size	4.67
8	Sex Ratio	1017

Source: District Primary Census Hand Books, Thane district, 2011

Average Household Size

The study area had an average family size of 4.67 persons per household in 2011. This is a normal family size in India, however less in comparison with the other areas of Maharashtra. This normal family size could be attributed to a considerable degree of influence of local living conditions with migration of people with higher literacy levels who generally opt for smaller family size with family welfare measures to this study area and also due to the prevalence of single member families, a common phenomenon in geographical conditions of district.

Sex Ratio

The configuration of male and female indicates that the males constitute to about 50.44 % and females to 49.56% of the total population as per 2011 census records. The sex ratio i.e., the number of females per 1000 males indirectly reveals certain sociological aspects in relation with female births, infant mortality among female children and single person family structure, a resultant of migration of industrial workers. The study area on an average has 1017 females per 1000 males as per 2011 census. This ratio is considered to be lower in comparison with other states but more in comparison with the other parts of Maharashtra.

Social Structure

In the study area, as per 2001 census, 1.36% of the population belonged to Scheduled Castes (SC) and 55.02% to the Scheduled Tribes (ST). This indicates that about more than half of the population in the study area belong to weaker sections and works to about 56.38 % of the total population in 2011. The distribution of population in the study area by social structure is shown in following table

Table 91 Social Structure

S. N.	Particulars	Alignment Route
1	Scheduled Castes	674
2	% To total population	1.36
3	Scheduled Tribes	27360
4	% To total population	55.02
5	Total SC and ST	28034
6	% To total population	56.38

7	Other castes	21687
8	% To total population	43.62
9	**Total Population**	**49721**

Source: District Primary Census Hand Books, Thane district, 2011

Literacy Levels

The analysis of the literacy levels in the study area reveals a higher literacy rate in the study area. The study area experienced a literacy rate of 63.54 % in 2011. If this is computed only for the people of above the age group of 5 years, i.e., the school going age people, this may slightly increase the literacy rate. The distribution of literates and literacy rate in the study area is given in following table

Table 92 Distribution of Literates and Literacy Rates – Census 2011

S. N.	Particulars	Numbers
1	Total Literates	31594
2	Average literacy (%)	63.54
3	Male Literates	17519
4	Male Literacy (%)	69.85
5	Total Male	17519
6	% Male Literates to total Literates	68.85
7	Female Literates	14075
8	Total Female	24643
9	Female Literacy (%)	49.56
10	% Female Literates to Total Literates	57.11
11	**Total Population**	**49721**

Source: District Primary Census Hand Books, Thane district, 2011

The male literacy i.e., the percentage of literate males to the total males of the study area works out to 69.85%. The female literacy rate, which is an important indicator for social change, is observed to be only comparatively low in study area as per 2011 census. This indicates that there is a need for major sociological development in the region with the increase in literacy levels of both males and females.

Occupational Structure

The occupational structure of people in the study area is studied with reference to main workers, marginal workers and non-workers. The main workers include 10 categories of workers defined by the Census Department, which consists of cultivators, agricultural laborers, those engaged in live-stock, forestry, fishing, mining and quarrying; manufacturing, processing and repairs in household industry; and other than household industry, construction, trade and commerce, transport and communication and other services.

The marginal workers are those workers engaged in some work for a period of less than six months during the reference year prior to the census survey. The non-workers include those engaged in unpaid household duties, students, retired persons, dependents, beggars, vagrants etc.; institutional inmates or all other non-workers who do not fall under the above categories. As per 2011 census records altogether the main workers work out to be 35.77% of the total population. The marginal workers and non-workers constitute to 9.9% and 55.12% of the total population respectively. The distribution of workers by occupation indicates that the non-workers are the predominant population. The occupational structure of the study area is shown in following table

Table 93 Occupational Structure – Census 2011

S. N.	Occupation	Numbers
1	Total Main Workers	17789
2	Percentage to Total Population (%)	35.77
3	Main workers-Male	12087
4	Main workers-Male % total Population	24.30
5	Main Workers- Female	5702
6	Main workers-Female % total Population	11.46
7	Marginal Workers	4522
8	Percentage to Total Population (%)	9.09
9	Marginal Workers –Male	2147
10	Percentage to Total Population (%)	4.31
11	Marginal Workers-Female	2375
12	Percentage to Total Population (%)	4.77

S. N.	Occupation	Numbers
13	Total Non-Workers	27410
14	Percentage to Total Population (%)	55.12
15	Non-Workers-Male	10844
17	Percentage to Total Population (%)	21.80
18	Non-Workers-Female	16566
19	Percentage to Total Population (%)	33.31
	Total Population	**49721**

Source: District Primary Census Hand Books, Thane district, 2011

Dependency Ratio

Based on the occupational structure of the study area the dependency rate of non- workers on the workers category has been estimated at 118.56%, which is considered to be low or moderate while indicating that most of the people are engaged in some sort of income generating activity.

Infrastructure Facilities

The infrastructure and amenities available in the study area denotes the economic wellbeing of the region. Reasonably good levels of infrastructure facilities are available in the study area, which consists of education, health care, communications, transportation, etc.

A review of infrastructure facilities available in the area has been done based on the information given in the District Census Hand Books and the data of National Informatics Center, for the year 2001. The infrastructure facilities available in the study area are described in the subsequent sections.

Educational Facilities

The educational facilities are almost evenly distributed in the area. In all, there are 22 primary schools, 3 Primary school and no other educational institutions exist in study area The available educational facilities in the area as per 2001 census are given in following table

Table 94 Educational Facilities in the Study Area

S. N.	Institution	Numbers
	Educational facilities	
1	Pre-Primary schools	18
2	Primary schools	3
3	Secondary schools	0
4	Colleges	0
5	ITI, Polytechnic, Engineering and Medical college Education Centers	0

Source: District Primary Census Hand Books, Thane district, 2011

Health Facilities

Different types of health facilities including hospitals, dispensaries and clinics are available in the study area. The health facilities include 1 community health Centre, 3 primary sub centers, 2 Maternity and Child welfare centers and 2 Veterinary Hospitals and others as shown in following table.

Table 95 Health Facilities in the Study Area

S. N.	Type of Institution	Numbers
1	Medical facilities	
2	Community Health centers	1
3	Primary Health centers	1
4	Primary Health sub centers	3
5	Maternity and child welfare centers	2
6	TB clinic	0
7	Allopathic hospital	0
8	Dispensaries	2
9	Family welfare centers	1
10	Non-government medical facilities	7
11	Veterinary Hospital	2

Source: District Primary Census Hand Books, Thane district, 2011

Transport Facilities

The study area is served by rail and road transport facilities. All villages have paved road connections. As a whole, the study area has moderate level of communication network.

Post and Telegraphs

The study area has moderate level of Post and Telegraphic services. Altogether there were 2 Sub Post Offices only in the study area in 2001. About 17 human settlements had telephone facility in them.

Electrification

As per records, almost all villages in the study were electrified. Electricity was supplied for domestic, agricultural, industrial and public lighting purposes. Subsequently the electric connections have been given to many other villages.

Drinking Water Facility

Water supply in the study area is mainly from wells, hand pumps followed by protected water supply system. In 2001 about 6 villages have protected water supply system. About balance villages villages were served by wells and about tanks as the source of drinking water supply. All villages were facilitated with hand pumps and bore wells for water supply.

4.10.8 Land-Use Based on Census Data – 2011 for Road & Rail Connectivity

As per the census records, the study area admeasures to about 16041.55 ha falling. The land-Use details based on census data are presented in following table**.** This includes forests, cultivated area, cultivable waste and the area not available for cultivation

Table 96 Land Use Pattern of Study Area

S. N.	Particulars of Land Use	Rail Road
1	Forest Land	4598.37
2	Land under cultivation	
	a) Irrigated Land	181.22
	b) Un irrigated Land	9484.34
3	Cultivable Waste Land	466.34
4	Area not available for cultivation	1311.28

S. N.	Particulars of Land Use	Rail Road
	Total Area	**16041.55**

Forest Land

4598.37 Ha of area of forest is spreading over the in rail and road alignment route villages in study area.

Land Under Cultivation

Altogether 9665.56 ha cultivable land (irrigated and un- irrigated) was observed in the study area. The irrigated land admeasures to about 181.22 ha in the study area which works out to be 1.12 % of total study area. The un- irrigated land admeasures about 9484.34 ha and works out to about 59.12 % of the total study area.

Cultivable Waste Land

Cultivable waste category of land includes the land which was cultivated sometime back and left vacant during the past 5 years in succession. These lands may either be fallows or covered with shrubs, which are not put to any use. The study area comprises of 466.34 ha cultivable wastelands, which works out to about 2.91 % of the total area. This percentage of land in this category indicates that almost all the cultivable lands are used for cultivation as well as various other purposes, while leaving a very less extent of land un-cultivated.

Land not Available for Cultivation

All the lands not included in the above categories of land uses are considered in the category of land not available for cultivation. This category of land use mainly consists of the hilly and barren lands, human settlements, roads, water-bodies, etc. About 1311.28 ha area working out to about 8.17% of the total study area falls in this category.

Socio- Economic Survey of Project Affected Families – Primary Survey Port Area

The prime objective of the study is to make a Social Impact Assessment (SIA) of the people who will be the affected due to proposed Vadhavan Port Project. It will enable the development agency JNPA, Maharashtra Maritime Board (MMB) as well as the government concerned to evolve suitable action plan for a systematic rehabilitation of Project Affected Families (PAFs).

Presently, for achieving it, one should know the people and their assets. This section deals with diverse socio- economic and demographic characteristics of the affected people.

The responsibility of the project for rehabilitation of the Project affected Families (PAFs) will be restricted to villages as their agricultural land and fishing activity, means of livelihood is going to be acquired for setting up of proposed project.

The proposed project does not involve any Gaothan area from any of these villages. Therefore, there is no displacement due to the proposed project and issues related to resettlement do not figure in this report.

Methodology

The study team keeping the objectives of social impact assessment (SIA) in view has used a variety of data collection methods. The study of such nature requires a primary household survey. However, for the limited purpose of SIA study the team collected data from two sources. First household survey of the project affected people of the study area, second from local offices as well as non-official sources. The methods applied for the data collection comprise of structured questionnaire, in depth interviews and focus group discussion.

The team went in each village at different days to conduct focused group discussions (FGD) of the villagers. Each of these FGDs comprises different group of panchayat members, school teachers, leaders of informal / formal organization & village epresentatives. Each of the FGDs has very extensive lasting for at least 2 to 3 hours of duration. Besides, a keen personal observation of the team was a part of SIA. Moreover, secondary sources of data comprised various government department (local & district level) and project authorities.

Religions & Castes

In terms of religions, the entire project area has some major religions and these are Hinduism, Christian, Parsis, Muslim and Buddha. Different caste and community living in the villages chiefly consist of Schedule Caste, Schedule Tribes, Kunabi, Mangeli, Bhandari, Vadval, Panchal, Suryavanshi Kshatriya, Vani, Machi and Maratha etc. It is observed from socio-economic survey that majority of Schedule caste and Maratha are in villages. It may be true that different caste & group may have their own close affinity with the parent caste, and creed but each village community in the area is well united as a strong entity. People interact with each other freely and have tremendous respect with each other.

Literacy Levels

The rate of literacy in India especially in the rural area is quite low. Literacy level of any area, sector or region is in fact an important indicator of social development of the people. The literacy levels are quite good in the villages of the study area.

Education Facility

It is quite noteworthy that the entire villages in the proposed project area have Anganwadi and primary school in their own village. For further education people of these villages either go to nearby village or Dahanu (13 km) where all educational facilities are available.

The proportion of students studying in various levels of education is in fact in accordance with size of population of the villages. The number of students studying in various classes of schools in the study area is proportionate to the population of village. In the existing facilities, basic requirements like drinking water facilities, school furniture, toilets, and playing tools are not available. There is no proper transportation facility for boys' students to go to other village or town for further education. This facility is available for girls' students only.

Land Acquisition

The proposed Vadhavan Port is going to be established in village Vadhavan. The total area acquired for the proposed project is 571 Ha. For road and rail connectivity. This area comprises of private Land, Government Land and Forest Land. Agricultural Private Land also includes irrigated land.

Land Holding Size

As far as rural areas are concerned land plays a key role in the human survival. Often it is 'the' means of livelihood for a majority of the rural population. In the project area villages, the land is often in the name of head of household or the father of children of family concerned. However, the present prevalent practice in the village is that the land is further sub-divided amongst the major sons in the family. One of the prime reasons of sub-division of land among the male members of a family is that each child legally inherits land from his father. Moreover, it is also used as a device to shrink in the total land ownership record into smaller size and thus acquire the title of marginal and small farmers for eligibility to benefits of government schemes for the marginal and small farmers.

The affected villages are Varor, Chinchani, Tanashi, Bavade, Vangaon, Kolavali, Newale, Hanuman Nagar, Shigaon, Sumadi, Gargaon, Ravate, Akoli, Akhegavaon, Nanivali, Ambhedhe, Dhamatane, Kolhan, Ghol and Tawa due to road & Rail development for the transportation & Communication of Vadhavan Port. The Villages affected due to Port development are Vadhavan, Varor, Chinchani, Dhakati Dahanu & Dhumket. This is precisely due to the division of land amongst the legal heirs of the family. Land ownership, in terms of its size, is categorized as less than 2 hectares, 2 to 4 hectares, 4 to 6 hectares and more than 6 hectares of land. According to the data its ownership of the highest land acquisition is done from the village Bavade i.e., 65 Ha. and least from village Akoli i.e., 5.52 Ha.

Land Use and Cropping Pattern

In agriculture, crop yield (also known as "agricultural output") is not only a measure of the yield of cereal per unit area of land under cultivation, yield is also the seed generation of the plant itself.

One of the three seeds must be set aside for the next planting season, the remaining two either consumed by the grower, or one for human consumption and the other for livestock feed. The higher the surplus, the more livestock can be established and maintained, thereby increasing the physical and economic well-being of the farmer and his family. This, in turn, resulted in better stamina, better over-all health, and better, more efficient work. In addition, the more the surplus the more draft animals -- horse and oxen -- could be supported and harnessed to work, and manure, the soil thereby easing the farmer's burden. Increased crop yields meant few hands were needed on farm, freeing them for industry and commerce. This, in turn, led to the formation and growth of cities.

During survey, all most all affected household in all villages appear to own some agricultural land. Entire area has big impact of sea water but potable drinking water is good. People in all these villages depend on rain so they do agricultural activities in Kharif Season. Few villages in the study area use water from estuary for irrigation while very few use ground water from their wells. Nevertheless, the crops developed and cultivated in the area are Paddy, Vari, Bean-Legume and Vegetables.

Status of Livestock

Animals play an important role in the lives of the villagers. Practically all the households in these villages have their own agricultural lands. Therefore, the primary occupation of all these households is agriculture and allied activities. There is a very close relationship between the farmers and the animals. Animals often constitute as an asset as well as a means of livelihood. Farmers use bullocks for ploughing their agricultural field and pulling bullock carts. There are plenty of grazing lands in the area though; green fodder is available only for a small period after the monsoons. The district has unlimited potential for Dairy activity. Allied activities have also good scope, as the gigantic market of Mumbai and Thane is at the door step of the district.

Drinking Water Facilities

Potable Water

According to the observations of the survey team, there are very few sources of potable water in the study area. Most common source comprises of open well, panchayat tank, private hand pump and common hand pump.

Water Structures on Farm Side

There are various types of structures on the farm side as bore well. These structures mainly consist of farm wells, check dams and Canal Irrigation. It is apparent that the most prominent water structures in the study villages are the farm wells. Most of these wells are the lifelines of the farmers because this is one of the main irrigation facilities especially during the rabi crops in the study area.

Community Facility

The availability of community facilities such as health, education, potable water, community hall, public distribution system, electricity and recreational facilities, etc. is an important indicator of the wellbeing and quality of life of the villagers.

Electricity

Electricity supply is essential in enhancing social and economic quality of life of the rural population. All the villages in the study area have electricity supply. As per the survey, in fact, almost all the households in villages of study area have electricity supply in their houses. Only 5 % households do not have electricity in their houses mainly because they cannot afford to pay for it. There are very few households in most of the villages which have electricity for running electric pumps at their agricultural farms.

Primary Health Center

In the study area there is PHC at Chanchani, Tarapur and Tawa and rural health center at Town Dahanu & Kasa which is well maintained with personnel, equipment and drugs. During the discussion with the medical practitioner at all PHCs, it was revealed that the general prevailing diseases are diarrhea, cough and common fever. He also added that water borne diseases like cholera, typhoid, and gastroenteritis are recorded in PHC and even the Covid 19 Pandemic also affect the population of the study area. Besides, people in the area are not at all aware about personal hygiene which may be due to low level of literacy among the people.

Sanitation

There is no congestion problem in the study area. Moreover, the availability of water for domestic use is just adequate and hence there is no question of excess use of water. Domestic waste especially consisting of cow dung is used as manure in agricultural fields. Thus, there is hardly garbage accumulation in the village creating any health hazards. People in the village do not feel to have toilet facilities in their houses. When they have an option of vast stretch of fields, they would not like to construct toilet in their houses and bear a burden of cleaning and maintaining them. That is why; some of the houses in the affected families have toilet facility. However, the village panchayats have constructed toilet facilities in some villages which are also not in use.

Community Hall

A community hall in the villages may not have much meaning as it has in the urban area. Recreation, meeting, hosting marriage functions etc. are some of the functions carried out in the community hall. However, as far as rural areas are concerned, these functions can very conveniently be conducted outdoor in the open fields, under tree shadow or schools.

Public Distribution System (PDS)

PDS is a system by which the government tries to reach basic food items to the people below poverty line at subsidized price. All the villages in the project area have PDS in the village itself. Food items available at these PDS comprise of rice, wheat and sugar which are conveniently acquired by the beneficiaries.

Burial Ground

Availability of burial ground/cremation is one of the essential requirements in the village. Some villages have cremation ground at their own villages but not developed with required facilities.

Communication Infrastructure

Infrastructure facilities chiefly comprise of road network, State bus service, post office and telephone. These facilities are essential for the rural masses for their mobility, development and better quality of socio-economic life.

Transportation

All the villages are well connected with Tar Road, Kuccha as well as pucca road. Internal village road is not fully developed. Very few roads are constructed under Prime Minister Gram Sadak Yojana. The Mumbai- Surat Railway line passes through study area and the nearest railway station is at Dahanu.

Postal Facilities

The parent postal Centre for all the villages of the project area is available in their own village. The Urban facilities in postal services are available in Dahanu.

Telephone Services

During survey, it is observed that most of the villagers in the study area use Mobile Phone Set and people are very much aware of utilizing this facility. They said that the BSNL land line phone is not in use now days in their villages. Some villages have Internet facility in Gram panchayat whereas every mobile has internet connections.

4.10.9 Primary Data Collection - Rail and Road Alignment

Socio Economic Profile of Affected population

A baseline primary socio-economic profile of the project affected persons has been presented in the following sections with special reference to proposed port to National Highway connectivity and rail network system to be developed as part of port infrastructural facilities A socio-economic survey and verification of the affected persons is critical in identifying adverse project impacts on people and assets and designing mitigation plans. It acts as baseline information and provides a cut-off point for eligibility for compensation or assistance for people lost assets and affected with other adverse impacts.

Survey Methodology

The primary survey is conducted for all the land owners identified through the revenue records subject to their availability and accessibility and willingness to participate in the survey. The survey has tried to capture all the socio-demographic characteristics of the land owners such as education level, occupational patter, social pattern, income levels, indebtedness and perceptions on project and other assistances. The survey questionnaire also included sections on perceptions of the affected people on resettlement and rehabilitation options and onion on resettlement preferences, employment, training and skill up gradation. The survey was conducted during July–August 2019 and revalidated in the months of October-2021. As part of the survey a Household is considered as a unit where the affected land owners along with their family and other dependents having a separate kitchen. In some households it is observed that more than one affected land owners living together with his or her family and dependents. A total of 125 households are covered from all the rail and road alignment project villages and details are presented below;

Table 97 Details of Households and Influenced Landholders

S. N.	Name of Village	Number of House holds	Number of Influenced Land lords	Size of sample
1	Varor	678	282	282
2	Vangaon	1645	77	77
3	Tawa	289	0	0
4	Tanashi	255	93	9
5	Akegavhan	161	34	3
6	Akoli	134	15	2
7	Ambedhe	169	31	3
8	Bhadave	164	151	15

S. N.	Name of Village	Number of House holds	Number of Influenced Land lords	Size of sample
9	Chinchare	171	0	0
10	Hanuman Nagar	327	0	0
11	Nanivali	591	40	4
12	Newale	103	229	23
13	Ravate	177	21	2
14	Shigoan	998	117	12
15	Khanivade	222	28	3
16	Sumadi	223	19	2
17	Dhamatane	285	28	3
18	Ghol	312	0	0
19	Kolavali	486	17	2
20	Kolhan	122	7	1
21	Chinchani (CT)	3129	48	5
	Total	**10641**	**1237**	**125**

Headship of Family

As per survey, the headship of family depicts that in 88.8% families have male head. The (11.20%) families have female headship due to death of their husband. This pattern depicts that the population follows patriarchal family system. Details of headship of family are presented in following table;

Table 98 Details of Headship of Family

S. N.	Name of village	Total	Male	Female
1	Varor	28	28	0
2	Vangaon	8	7	1
3	Tawa	0	0	0
4	Tanashi	9	8	1
5	Akegavhan	3	2	1
6	Akoli	2	1	1
7	Ambedhe	3	3	0
8	Bhadave	15	13	2
9	Chinchare	5	5	0
10	Hanuman Nagar	0	0	0
11	Nanivali	4	4	0
12	Newale	23	19	4
13	Ravate	2	2	0
14	Shigoan	12	10	2
15	Khanivade	3	3	0
16	Sumadi	2	2	0
17	Dhamatane	3	3	0
18	Ghol	0	0	0
19	Kolavali	2	1	1
20	Kolhan	1	0	1
21	Chinchani (CT)	5	5	0

S. N.	Name of village	Total	Male	Female
	Total	**125**	**111**	**14**
	%	**100**	**(88.8)**	**11.2**

Age Profile

The age distribution of male and female of the total affected population surveyed is presented in following table. As per survey reveals that the percentage of respondent from relatively young age group is 8% while 17.60% of the respondents are in above middle ae group and old age each. The highest percentage of respondents are from the middle- aged group accounting to 27.20% and that from adults age is 29.60%. The depicts nearly two third of the respondents are in adult and middle age group

Table 99 Details of Age Group

S. N.	Age group	Number of respondents	%
1	21-30	10	8.0
2	31-40	37	29.60
3	41-50	34	27.20
4	50-61	22	17.60
5	Above 60	22	17.60

Religion

Religion has the profound influence on way of living and shapes of customs and culture of the community. Among the interviewed respondents all are Hindus. It is clear that majority of the respondents are Hindus and details are presented in following table

Table 100 Details of Religion

S. N.		Religion	Number of	%
1		Hin	1	1

Languages

Majority of population in the study area speaks Marathi language followed by Hindi & English. Dahanu is predominantly dominant by tribal population speaks Thakari, Warli, Koli languages (16%). In general majority of people speak in Marathi, but most of these people are proficient in multiple languages and detail are presented in following table

Table 101 Details of Respondents-Languages

S. N.	Religion	Number of Respondents	%
1	Marathi	105	84.00
2	Hindi	05	4.0
3	Other tribal languages	20	16
4	English	01	0.80

Literacy Profile of Affected People

Literacy levels of the affected population are presented in **following table.** as per survey reveal that the study area relatively large percentage of population is literate which is lower than the Dahanu taluka. People who have obtained primary and secondary level of education combine together is of 57.60% and very few have attended/obtained higher secondary education. The overall trend of educational status reveals that majority of population does not have privilege of gaining substantial education qualification. The reason could be directed to lack of understanding among the people for need of education and to a certain extent, absence of schools/institutes and facilities in abundance near the area with Dahanu urban area

Details of Educational Status-Respondents

Table 102 Details of Educational Status-Respondents

S. N.	Education	Number of respondents	%
1	Illiterate	42	33.60
2	Literates	83	67.40
3	Primary education	31	24.80
4	Secondary education	41	32.80
5	Secondary education	10	8.10

S. N.	Education	Number of respondents	%
6	Others	01	0.80

Family Information

Family is an important institution in society. Family members are born with ties of blood, love and law to their household members. This can bind generations together into a supportive and nurturing unit which provides security, care to its members. For almost everyone, the family where gender expectations and aspirations are instilled, where the value systems by which they will act later on life is formed. Details of nature of interfamily relations and affections and units in studied populations are presented in following table

Table 103 Details of Family Relationships

S. N.	Relationship	Number of respondents	%
1	Strong	97	77.60
2	Weak	28	22.40

Membership in Organization

To capture the social organization in the affected villages the membership of the affected person in local organizations was asked. As per the study analysis it is reported that only 7% of the affected people have some membership in associations such as Panchayat, Cooperative society, Self-help group, youth club, religious organization or political organizations. Details are presented in following table. As per survey reveals that 65.60% respondents are not associated with any kind of organization, only 19.20% respondents and their family members are associated with village panchayat. Balance respondents are associated with political parties and co- operative societies and non-government committees

Table 104 Details of Association

S. N.	Organization	Number of respondents	%
1	Village panchayat	24	19.20
2	Political party	8	6.40
3	Co-operative society	5	4.0

S. N.	Organization	Number of respondents	%
4	Committees (GOs)/NGOs)	6	4.80
5	Without association	82	65.60
	Total	125	100

Education

Education is a weapon to improve one's life. It is probably the most important tool to change one's life. Education for a child begins at home. It is a lifelong process that ends with death. Education certainly determines the quality of an individual's life. Education improves one's knowledge, skills and develops the personality and attitude. Most noteworthy, Education affects the chances of employment for people. A highly educated individual is probably very likely to get a good job. In this essay on importance of education, we will tell you about the value of education in life and society. As per primary survey results reveals that 46.40 of the children are going to Higher secondary schools, 36% of children are enrolled in private school (Aided by Government) while 12.00% and 5.6% are attending government and aided ashramshalas supported by ITDA (Integrated Tribal Development) exclusively meant for tribal and details are presented in following table.

Table 105 Presence of Education Systems in Study Area

S. N.	Organization	Number of Respondents	%
1	Higher secondary school	58	46.40
2	Government- Ashramshala	15	12.00
3	Government-Aided Ashramshala	07	5.60
4	Private school (aided by Government)	45	36.00
	Total	**125**	**100**

Economic Information

Economic condition is an important determinant for the standard of living and status of an individual, in the community. A good economic condition definitely has bearing on the family. Future planning, ambitions and aspirations of the family members depend upon the visibility of the family. In the study area study area has a large number of tribes still have the characteristics of under development such as poverty, low standard of living, economic and social inequalities, non-utilization of natural and human resources. The economic condition information which includes economic conditions of respondents, economic background, occupations, size and nature of possession of land holding, nature of land, migration, animals, crops, vehicles and selling of products. The occupational profile of respondents is presented in following table **.** Most of the family members are engaged in different types of occupations. The major occupations of the respondents are farming, fishing and dye making. Around 68% of respondents are engaged in agriculture and animal husbandry.10.40% respondents are involved in farming and daily wages. While a less no of respondents i.e., 10.40% are shopkeepers. 5.60% of respondents are involved each in private services & artisans. The majority of the population is involved in agriculture related farming and allied occupations

Table 106 Details of Occupational Profile of Respondents

S. N.	Name of Village	Farming & Animal Husbandry	Farming and Daily Wages	Shopkeepers Business	Dye Making Artisans	Private Services	Total
1	Varor	19	1	3	3	2	28
2	Vangaon	4	2	1	0	1	8
3	Tawa	0	0	0	0	0	0
4	Tanashi	5	1	1	1	1	9
5	Akegavhan	3	0	0	0	0	3
6	Akoli	2	0	0	0	0	2
7	Ambedhe	2	1	0	0	0	3
8	Bhadave	9	2	2	0	2	15
9	Chinchare	0	0	0	0	0	0
10	Hanuman Nagar	0	0	0	0	0	0
11	Nanivali	4	0	0	0	0	0

S. N.	Name of Village	Farming & Animal Husbandry	Farming and Daily Wages	Shopkeepers Business	Dye Making Artisans	Private Services	Total
12	Newale	20	0	3	0	0	23
13	Ravate	1	1	0	0	0	2
14	Shigoan	6	2	2	1	1	12
15	Khanivade	2	1	0	0	0	3
16	Sumadi	2	0	0	0	0	2
17	Dhamatane	3	0	0	0	0	3
18	Ghol	0	0	0	0	0	0
19	Kolavali	1	1	0	0	0	2
20	Kolhan	1	0	0	0	0	1
21	Chinchani (CT)	1	1	1	2	0	5
	Total	**85**	**13**	**13**	**7**	**7**	**125**
	%	**68.00**	**10.40**	**10.40**	**5.60**	**5.60**	**100**

Agricultural Landholding

Details of landholding of respondents in study area are presented in **following tables.** As per survey report reveals that majority population has holding less than 1 Ha where as 17.60% own land parcels between 1-4 Ha. Around 10.40% of the population is landless and only 8 of respondent own land having size more than 4 Ha. It is clearly shows that half of the population have size of agricultural land less than one Ha

Table 107 Details of Land Holding-Respondents

S. N.	Agricultural Land holding possession	Number of Respondents	%
1	Ancestral land holding	100	80.0

S. N.	Agricultural Land holding possession	Number of Respondents	%
2	Tenancy right	2	01.60
3	Land given on rent	14	11.20
4	Land purchased	5	04.00
5	forest encroachment	4	03.20
	Total	**125**	**100**

Table 108 Details of Size of Land Holding-Respondents

S. N.	Agricultural Land holding possession	Number of Respondents	%
1	Landless	13	10.40
2	Less than 1 ha	80	64.00
3	1 Ha-4 Ha	22	17.60
4	Above 4 Ha	10	8.00
	Total	**125**	**100**

4.10.10 Land Use of Road and Rail Alignment

As per primary survey results reveals that nearly 54.40 of the respondent land is non- irrigated land whereas 36% of the population has irrigated land and 9.60% population has partial irrigated land and detail of land use pattern of respondent's land are presented in folllwing tables

Table 109 Detail of Land Use Pattern- Respondents

S. N.	Name of village	Un-Irrigated	Partial irrigated	Irrigated	Total
1	Varor	12	12	4	28
2	Vangaon	5	3	0	8
3	Tawa	0	0	0	0
4	Tanashi	4	4	1	9
5	Akegavhan	2	1	0	3

S. N.	Name of village	Un-Irrigated	Partial irrigated	Irrigated	Total
6	Akoli	1	1	0	1
7	Ambedhe	1	2	0	3
8	Bhadave	6	6	3	15
9	Chinchare	0	0	0	0
10	Hanuman Nagar	0	0	0	0
11	Nanivali	3	1	0	4
12	Newale	14	6	3	23
13	Ravate	1	1	0	2
14	Shigoan	7	5	0	12
15	Khanivade	2	1	0	3
16	Sumadi	2	0	0	2
17	Dhamatane	3	0	0	3
18	Ghol	0	0	0	0
19	Kolavali	1	1	0	2
20	Kolhan	1	0	0	1
21	Chinchani (CT)	3	1	1	5
	Total	**68**	**45**	**12**	**125**
	%	**(54.40)**	**(36.00)**	**(9.60)**	**(100)**

Livestock Ownership

Details of livestock owner ship of respondent are presented in following table**.** Many of them possess more than one variety of animal and chicken and goat are preferred animals by respondents compare to other animals.

Table 110 Details of Livestock-Respondents

S. N.	Live stock	Number of Respondents	%
1	Goats	21	16.80
2	Cows	23	18.40
3	Chicken	40	32.00
4	Buffaloes	17	13.60
5	Bullock	14	11.20
6	None	10	8.0
	Total	**125**	**100**

Agricultural Crops

Paddy is major crop in Dahanu and Palghar tehsils and while Nagali, Warai are the other cereals grown in the area. Apart from that commonly grown crop are Udid, Reg gram & Bengal gram. The mango, sapota and Banana, etc., Capsicum, turmeric, coconut and cashew are commonly grown in this region. Details of commonly grown cereal and fruits in respondents' lands are presented in following table

Table 111 Details of Major Crop and Horticulture

S. N.	Live stock	Number of Respondents	%
1	Rice	99	79.20
2	Vegetables	14	11.20
3	Fruits	12	9.60
	Total	**125**	**100**

Income Levels of Affected Households

The analysis on the income levels of the affected households shows that out of the total 125 households a majority (51.20%) are coming under low-income category with annual income of up to Rs. 10,000. This due to the incidence of large number of small and marginal farmers with agriculture as main occupation. They are followed people (poor class) who earn (39.20%) between Rs. 10,000-40000 per annum. The income levels for the people who are into govt/private service and trade and business are high are above middle income of Rs. 40000-100000 (12%) per annum

Table 112 Economic Status

S. N.	Economic status	Number of Respondents	%
1	Below poverty line	64	51.20
2	Poor class	49	39.20
3	Middle class	12	9.60
	Total	**125**	**100**

Selling of Agricultural Commodity

As per primary survey results reveals that the majority of population (49.60%) consumes food grains and other products produced by themselves for family needs. About 36% of the respondents are selling their production for traders, only 8% respondents selling for money lenders. Details are presented in following table.

Table 113 Details of Agricultural Produce Trading

S. N.	Production Selling to	Number of Respondents	%
1	Money lenders	10	8.0
2	Traders	45	36.0
3	Individual customer	4	3.20
4	Tribal development corporation	4	3.20
5	Self-consumption	62	49.60
	Total	**125**	**100**

Domestic Asset Ownership

Details of domestic asset ownership of respondent's area presented in following table

Table 114 Details of Domestic Asset Ownership-Respondents

S. N.	Production Selling to	Number of Respondents	%
1	Bullock carts	9	7.20
2	Bicycle	27	21.60
3	Motorcycle	35	28.00
4	Tractor	7	5.60
	Jeep and car	5	4.0

Housing and Other Facilities

Asset ownership is one of the indicators to assess the economic status of a family/household. Ownership of land, house and other assets and access to various amenities are taken as indicators for asset ownership. It is observed that almost all the households had their own houses.

Housing is one of the basic essentials and an important factor which influences the occupants in many ways. A good housing keeps the people healthy, physically and mentally. Although demographic and livelihood differences can be seen between households in project area villages. The housing structure of the tribals with the project area reflects dependency on natural, local resources and lack of ability to purchase external, more durable and manmade construction materials. Predominantly tribal houses jave walls made from mud and buffalo or cow dung or both. These roofs are covered with tree branches and waste from farm lands. The House ownership and others of the affected households is presented in following table

Table 115 Details of Housing Information

S. N.	Production Selling to	Number of Respondents	%
1	**Construction of House**		
	Own	106	84.80
	Indira Awas Yojana	19	15.20
2	**Type of Housing**	125	100
	Kacha house	41	32.80
	Pakka house	84	67.20

S. N.	Production Selling to	Number of Respondents	%
3	**Location of House**	125	100
	Gavthan	79	63.20
	Own land	45	36
	Forest land	1	0.80
	Total	**125**	**100**
4	**Drinking Water Facilities**		
	Private well	7	5.60
	Public well	17	13.60
	Other bore wells	31	24.80
	Springlet	2	1.60
	Lake/dam	3	2.40
	Rivers	5	4.0
	Panchayat pipeline (treated)	44	35.20
	Hand pump	13	10.40
	Canal	3	2.40
	Total	**1125**	**100**
	Cooking facilities		
	Kerosene	7	5.60
	Biogas	4	3.20
	BULK LIQUID	90	72.00
	Firewood etc.	24	19.20
	Total	**125**	**100**
	Electricity		
	Without electricity	29	23.20
	With electricity	96	76.80

S. N.	Production Selling to	Number of Respondents	%
	Total	**125**	**100**

Health Information

Health is an important asset of a community and community is the base foundation of a strong nation. Health is important determinant of economic and socio development because disease creates vicious circle by depleting human energy leading to low productivity and earning capacity, deterioting quality and quantity of consumption and standard of living

World Health Organization (WHO) defines health state of complete physical, mental and social well-being. Health is major problem among tribal. The nature of living, the environment and conditions of living are more susceptible to them for causing onset of diseases. Sickness is major social problem and a universal one. Sickness is not only a ource of immediate suffering in terms of pain, discomfort and dislocation of routine, it is also source of anxiety as it can fatal, and can lead to all the agony of bereavement by premature death, it can also chronically disable and result in poverty and hardship. Details of health facilities and prevailing diseases in study area presented in following table.

Table 116 Details of Health Facilities and Diseases- Study Area

S. N.	Health facilities	Number of Respondents	%
1	**Health institutes**		
	Sub center	6	
	Public health centers	2	
	Private dispensary	9	
	Sub –district hospital	0	
2	**Usage of**		
	Sub-centers	36	28.70
	Primary Health Centre	44	35.20
	Rural hospital	28	22.40
	Private dispensary	9	7.20

S. N.	Health facilities	Number of Respondents	%
	Total	**125**	**100**
3	Patients		
	Help of medical practioners		
	Doctor	104	83.20
	Mantrik	3	2.40
	Nurse	8	6.40
	Asha worker/MPHW	10	8.0
	Total	125	100
4	Prevailing diseases		
	Diseases		
	Tuberculosis (T.B)	4	4.0
	Cancer	6	4.80
	Malaria	1	0.80
	Jaundice	5	4.0
	Scabies/skin	16	12.80
	Sickle cell	1	0.80
	Physically handicapped	4	3.20
	Malnutrition	32	25.60
	No disease	55	44.0
	Total	125	100
5	**Diseases among women**		
	Anemia	29	23.20
	No disease	96	76.80
	Total	125	100
6	**Diseases among Children**		

S. N.	Health facilities	Number of Respondents	%
	Acute diarrhea	17	13.60
	Acute respiratory tract disease	20	16.00
	Malnutrition	7	5.60
	Vitamin A deficiency	43	34.40
	No disease	38	30.40
	Total	**125**	**100**

Public Response on Project

Project related information such as awareness, views and perception of people is presented in follow section. In addition to that, impact of proposed port project on personal, family, social, cultural and economic life of people are presented. Details of public awareness information are presented in following;

Table 117 Public Awareness on Project Activities

S. N.	Project Information	Number of Respondents	%
1	Yes	59	47.20
2	No	66	52.80
	Total	**125**	**100**

Awareness of Proposed Project

Primary survey was conducted to know the people aware of project information and details are presented in Table- 2.33. It can be seen from data that 52.80 are unaware of proposed project activities and only 47.20% respondents only said that they are aware about development of the project. It is necessary to inform them about the project in detail and benefits due to this development.

Regarding perception of people on project activities, more than two third of respondents felt that there will be disturbance in current way of living of fishermen, farmers and artisans and only less than one third feared about increase of crime in the area. More than half of them is worried about less employment opportunities, loss of land, danger to marine environment and submergence of Rama's temple at Vadhavan. Slightly more than half of people are anxious about minimal returns of poverty and loss of natural resources. While little less than half were perceived that they will be forcefully displaced to Jawahar and Mokhada tehsils. Details are presented in following table

Table 118 Perception of People About the Project

S. N.	Perception of People	Number of Respondents	%
1	Displacement of many villages (loss of houses, agricultural land and community resources)	90	72.00
2	Resettlement to Jawahar and Mokhada Tehsils	56	44.80
3	Forceful displacement	57	45.60
4	Minimal returns against property	69	55.20
5	Loss of job opportunities for project affected families	78	62.40
6	Loss of natural resources in the region	67	53.60
7	Loss of land and marine environment	76	60.80
8	Increase in crime and loss of social peace	36	28.80
9	Disturbance in current way of living of fisherman, farmers and artisans	100	80.00
10	Loss of religious places in Vadhavan	72	57.60

4.10.11Fishing Villages and Fisheries in study Area

Introduction

The site in the village Vadhavan and its coast near Dahanu has been selected for Port from the logistic and operation angle such as deep draught, very near to the coastline, vast hinterland of north and northwest of India, easy rail and road access to the hinterland and suitability of the site to develop a Port between Gujarat Ports and Mumbaiand Jawaharlal Nehru Port.

The proposed Vadhavan port area is located in the intertidal zone and nearshore areas of Vadhavan village. The zone is rocky and at places, rocky prominences are visible during the low tide period. Rocky patch areas along the northern Maharashtra coastline extend from Dahanu to Vasai and Madh island near Mumbai. The rock crevices provide shelter and habitat for the crawling organisms like lobsters and protect the coast. Studies conducted by other agencies revealed that the mud in that area is a source of Calcium Carbonate clay (lime mud). A large number of fishermen families depend exclusively on fishing for their livelihood in the region. The developmental activities in this area may affect the fishing activity and thus livelihood. The present study comprises of

- Extent of fishing areas and the fishing villages around the proposed port.
- Number of fishing vessels operating in inshore, near-shore and offshore fishingarea.
- Number of fishermen families likely to be partly and fully affected.
- Economics of various fishing activities around the port and likely loss of fishing area and livelihood of the dependent population.
- Existing facilities like fishing jetty/harbour, cold storage etc. in the region, number of fisheries societies in the region, and accordingly suggestion of measures tostrengthen the fishing activities.

Data on Fishing Villages Around Proposed Port Area

The proposed Vadhavan Port is planned almost at the northern side of coastal Maharashtra, very near to the Dahanu creek, Palghar. Fishing and allied works arethe major livelihood activities for the majority of the population in the selected 16 fishing villages within 10 km radius of the proposed Vadhavan port area. The fisher population, in general, and the fishing crafts and gears in particular, operating from villages near to the proposed site are likely to be affected by the port construction and activities. As per the guidelines of environmental impact studies, an area of 10 km radius and the villages falling in this area from the boundaries of the proposed port area have been identified. Asexplained earlier, a few villages beyond the radius of 10 km are also included in the survey as the fishing boats from these villages utilizing the landing, operating facilities in the identified coastal villages within 10 km range. The identified fishing villages within the port area and in also study area are presented in following table

Table 119 List of Fishing Villages in Study Area

S. N.	Name of Village
1	Ghivali
2.	Kambode
3.	Tarapur
4.	Chinchani
5.	Tadiyale
6.	Varor
7.	Dhakti-Dahanu
8.	Dahanu
9	Gungwada
10	Matgaon
11	Asangaon
12	Agar
13	Narpad
14	Dandepada
15	Dhumket
16	Abram

Households and Population

ICAR-CMFRI tried to undertake socio-economic surveys in 16 selected fishing villages around the 10 km radius of the proposed port limit based on a structured questionnaire prepared by the Socio-Economic Evaluation and Technology Transfer Division (SEETTD) of ICAR-CMFRI. The fisher population of these fishing villages is 20,809 residing in 5,333 households and details are presented in following table

Table 120 Demographic Details of Fishing Villages

S. N.	Village	Fishermen Households	Total Population	Male	Female
1	Agar	116	514	261	253

S. N.	Village	Fishermen Households	Total Population	Male	Female
2	Narpad	45	180	96	84
3	Dahanu	465	1927	989	938
4	Dhakti-Dahanu	1110	4370	2207	2163
5	Gungwada	537	1788	904	884
6	Tadiyale	229	869	456	413
7	Varor	299	1269	631	638
8	Dandepada	219	925	487	438
9	Chinchani	416	1816	924	892
10	Tarapur	154	605	293	312
11	Kambode	135	487	271	216
12	Ghivali	611	1814	901	913
13	Dhumket	345	1569	767	802
14	Abhram	157	684	314	370
15	Matgaon	300	1257	613	644
16	Asangaon	195	735	361	374
	Total	**5333**	**20809**	**10475**	**10334**

It is seen from the table that out of 5,333 fisher households, 91.2% are pucca houses while 470 households (8.8%) are kutcha houses. Of the total, 3,582 (67.2%) fisher households are above the poverty line (APL) and 1,751 households (32.8%) are below the poverty line (BPL). Most of the fisher population seems to be congregated in Dhakti- Dahanu village (21.0%) followed by Dahanu (9.3%), Chinchani (8.7%), Ghivali (8.7%), Gungwada (8.6%), Dhumket (7.5%). The remaining 7,525 fisher population (36.2%) resides in the remaining 10 villages. The sex ratio was 1:0.99 in the 16 villages.

Age Group

Details of age groups of studies are presented in following and the analysis revealed that among fisher population, adults age group dominated 15,940 individuals (76.6%) followed by 3,531 children (17.0%) and infants 1,338 (6.4%).

Table 121 Details of Age Groups in Study Area

S. N.	Village	Adults	Infant (Below 5 year)	Children (Year 5 to 18)
1	Agar	397	36	81
2	Narpad	143	7	30
3	Dahanu	1510	125	292
4	Dhakti-Dahanu	3306	179	885
5	Gungwada	1425	115	248
6	Tadiyale	643	59	167
7	Varor	960	84	225
8	Dandepada	749	57	119
9	Chinchani	1438	148	230
10	Tarapur	479	30	96
11	Kambode	402	21	64
12	Ghivali	1536	82	196
13	Dhumket	1105	155	309
14	Abhram	459	48	177
15	Matgaon	845	115	297

Literacy

Data analysis show that 17,486 individuals (89.8%) of the fisher population were literates and the remaining 1,985 individuals (10.2%) were illiterates. It was observed that out of 19,471 adult population most of them (41%) have studied up to higher secondary level, followed by primary level 7,565 (38.9%), those above higher secondary level 1,408 (7.2%) and graduation & above 528 (2.7%). Dhakti- Dahanu fishing village has maximum number of 3,352 individual's educated accounting for 19.2% followed by Dahanu 1,783 (10.2%), Ghivali 1,760 (10.1%), Chinchani 1,728 (9.9%) and Gungwada 1,653 (9.5%). Details are presented in following table;

Table 122 Details of Literacy- Study

			Higher Secondary	Above Higher Secondar	Graduation& above
1	Agar	63	218	77	63
2	Narpad	60	88	14	10
3	Dahanu	699	948	113	23
4	Dhakti-Dahanu	1354	1505	426	67
5	Gungwada	890	601	149	13
6	Tadivale	155	465	41	7
7	Varor	329	700	125	34
8	Dandepada	183	527	115	58

Fishing Activity and Associated Activities

Details of fishing and associated activities involved in fishing village population are presented in **following table.** The fishers who spend at least 90% of the fishing time (excluding closed season) in a year for the source of income in were considered as "Full-time fishers" whereas fishers those who spend less than 90% of the fishing time in a calendar year were considered as "Part-time fishers". The study revealed that 3,537 (17%) of the total fisher population is involved in actual fishing activities. Among them 1,734 fishers (49.0%) are engaged full time and the remaining 1,803 fishers (51.0%) have part-time involvement in fishery- related activities. A total of 7,580 fishers are engaged in fishing associated activities viz. marketing of fish, making/repairing of nets, curing / processing, peeling/cutting, laborer and other activities such as the collection of bivalves, seaweeds, collection of ornamental fishes, etc. Substantial number of fishermen (771 individuals) work as laborer's (66.1%) including hired fishing crew members followed by 166 fishermen involved in net mending/repairing (14.2%) and 79 individuals marketing of fish (6.8%). Most of the laborer's working as crew members on board the fishing boats come from Dhumket, Abhram, Matgaon and Asangaon villages which do not have direc access to the sea coast

Table 123 Village-Wise Fisher Population Involved in Fishing and Fishing Associated Activities

S.N.	Village	Members Involved in Actual		Number of members involved in Fishing associatedactivities					
		Full Time	Part Time	Marketing of Fish	Making / Repairing net	Curing / Processing	Peelingg / Cutting	Labourer	Others
1	Agar	99	0	0	1	57	0	52	3
2	Narpad	24	1	1	0	45	0	12	0
3	Dahanu	171	67	107	14	455	1	274	0
	Dhakti-								
5	Gungwada	79	406	63	10	344	0	37	11
6	Tadivale	74	126	65	14	134	2	8	0
7	Varor	60	162	248	51	0	0	0	125
8	Dandepada	19	146	141	14	0	0	1	64

S.N.	Village	Members Involved in Actual		Number of members involved in Fishing associatedactivities					
		Full Time	Part Time	Marketing of Fish	Making / Repairing net	Curing / Processing	Peelingg / Cutting	Labourer	Others
9	Chinchani	3	0	409	15	87	128	47	226
10	Tarapur	6	132	127	22	0	0	1	124
11	Kambode	0	1	16	1	0	0	0	173
12	Ghivali	0	0	0	0	0	10	197	513
13	Dhumket	176	178	167	81	222	2	191	0
14	Abhram	39	64	36	28	121	1	104	2
15	Matgaon	66	211	204	27	3	8	52	6
16	Asangaon	31	137	158	21	6	0	18	1
	Total	**1734**	**1803**	**2592**	**305**	**2212**	**152**	**1069**	**1250**

Unlike male fisher population, 4,691 fisherwomen (73.2%) are involved in post- harvest management of fish. These activities are the marketing of fish and curing/processing of the fish catch (Fig. 9). Main post-harvest activity undertaken in these villages is fish drying of Bombay duck (*Bombil*), golden anchovy (*Mandeli*), non- penaeid prawns (*Jawala*, *Kardi*, *Ambadi*/*Bhobi*), lesser sardines (*Kati*), ribbon fishes (*Wakati*), solefish (*Lep*) and sciaenids (*Dhoma*) etc. Remaining 1,723 fisherwomen (26.9%) are engaged in making / repairing of net, peeling/cutting, labour activities and other activities. Unlike male fisher population, 4,691 fisherwomen (73.2%) are involved in post- harvest management of fish. These activities are the marketing of fish and curing/processing of the fish catch (Fig. 9). Main post-harvest activity undertaken in these villages is fish drying of Bombay duck (*Bombil*), golden anchovy (*Mandeli*), non- penaeid prawns (*Jawala*, *Kardi*, *Ambadi*/*Bhobi*), lesser sardines (*Kati*), ribbon fishes (*Wakati*), solefish (*Lep*) and sciaenids (*Dhoma*) etc. Remaining 1,723

fisherwomen (26.9%) are engaged in making / repairing of net, peeling/cutting, labour activities and other activities. A large number of coastal communities, mostly women are involved in fish drying for consumption purpose and trade along the open, common spaces in the village and beach areas. This provides income and economic security to women.

An inventory of registers maintained by the State Fisheries Offices at Palghar and Dahanu and digital platform (ReALCraft) maintained by the department shows that only 11 villages Ghivali, Kambode, Tarapur, Dahanu, Narpad, Agar, Dhakti-Dahanu, Gungwada, Tadiyale, Chinchani and Varor have fishing boats. Altogether there are 470 fishing boats registered in the online site (ReALCraft) of the Fisheries Department, Govt. of Maharashtra, but it was found that at present only 337 boats are having fishing licenses as presented in following table.

Table 124 Village Wise Details of Operational Fishing Crafts in the Study Area

S. N.	Name of the Village	ReALCraft registered vessels		Licensed Fishing Boat	
		Mechanized	Non mechanized	Mechanized	Non mechanized
1	Ghivali	20	01	08	00
2	Kambode	01	00	01	00
3	Tarapore	05	00	05	00
4	Dahanu	171	07	115	00
5	Narpad	08	00	01	00
6	Agar	12	00	08	00
7	Dhakti-Dahanu	190	01	154	00
8	Gungwada	06	00	06	00
9	Tadiyale	07	00	04	00
10	Chinchani	17	03	06	00

S. N.	Name of the Village	ReALCraft registered vessels		Licensed Fishing Boat	
		Mechanized	Non mechanized	Mechanized	Non mechanized
11	Varor	29	00	29	00
	Total	**470**	**12**	**337**	**00**

(Source: Department of fisheries, Maharashtra state, Year 2018)

Existing Fishery Infrastructure Facilities in Study Area

The fisheries infrastructure in the region are limited. Ice factory/cold storage facility is available only in Dahanu village among the villages. Other villages purchase ice from the Dahanu ice factory which needs up- gradation. Six registered fishermen co-operative societies from the study area are located in Ghivali, Varor, Chinchani, Gungwada, Dhakti-Dahanu and Dahanu fishing village. The diesel storage facility is available only in Gungwada and Dhakti-Dahanu. The villages lack proper fish landing facilities like jetty or harbour. Most of the fish landings are taking place in the beach

Table 125 Fisheries Related Infrastructure in the Selected Villages

S. N.	Name ofvillage	Fisher Societies	Ice Factory/Cold Storage	Diesel Storage Facility
1.	Ghivali	1	-	-
2.	Kambode	-	-	-
3.	Tarapur	-	-	-
4.	Chinchani	1	-	-
5.	Dandepada	-	-	-
6.	Varor	1	-	-
7.	Gungwada	1	-	1

8.	Tadiyale	-	-	-
9.	Dhakti-Dahanu	1	-	1
10.	Dhumket	-	-	-
11.	Abhram	-	-	-
12.	Matgaon	-	-	-

4.11 Biological Environment

4.11.1 Terrestrial Biodiversity

The present document is a flora, fauna and associated ecology status assessment report for the proposed port at Vadhavan, Dahanu Tehsil of district Palghar. The study was commissioned to M/s. Enkay Enviro Services Pvt. Ltd in order to review the present status of natural ecology and biodiversity elements in the Core area and surrounding region i.e., Buffer area. The objectives of this study were to provide an assessment of present status of flora, fauna and ecological habitat in the site, comment upon ecological richness, assess the occurrence of ecologically important or rare variety of floral and faunal species, evaluate possible direct or indirect impact of the project on ecology - biodiversity and suggest mitigation measures accordingly.

A separate study was also carried out for Marine Biodiversity Management Plan for the Proposed Greenfield Port at Vadhavan, Palghar District, Maharashtra by CSIR - National Institute of Oceanography (NIO), June 2023.

The present document considers definition of ecological impact as "any and all changes in the structure and function of ecosystems." In a general perspective, loss or alteration of species, communities and population structure may cause changes in ecological dynamics, interactions and functions and thereby may lead to ecological impact. Therefore, flora and fauna is documented and used in this particular study/survey as a primary tool to understand the status of ecology in core and buffer areas and analyze the ecological impact of the corresponding project

The site

The proposed project site is located offshore Vadhavan village of Dahanu Tehsil in Palghar district.

Figure 89 - Vadhavan port site

1. Location:
   a) Site Village : Vadhavan
   b) District : Palghar
   c) State : Maharashtra
   d) Latitude : 19°55'58.30"N
   e) Longitude : 72°39'18.18"E
2. Nearest Railway Station : Vaangaon, Dahanu
3. Nearest Airport : Mumbai
5. Nearest City : Mumbai
6. Nearest River : Dahanu creek
7. Nearest highway : NH 8 (Mumbai Ahmedabad)

Scope of the study

1. Site Description
2. To assess the flora and fauna present in the core site of the proposed project and in surrounding area i.e. Buffer region (10 Km radius range)
3. To document cultivated, planted and naturally occurring species in the core site
4. To document Rare, Endangered, Threatened (RET) species in the Core site and in the Buffer region
5. Assessment of species protected by specific legislation (Rare, endangered, critically endangered, endemic and vulnerable)

6. To identify designated locations, habitats and features of ecological significance
7. Assess the impact on the surrounding environment due to the plant activity & provide mitigation measures for the same

Activities undertaken during the study

- Flora survey
  - Tree, shrub, herb, climber and grass species identification and enumeration
  - Diversity of species
  - Analysis of Rare-Endangered-Threatened flora
- Fauna survey
  - Documentation of Avian, Reptilian, Insect, Amphibian, Mammal and other faunal diversity
  - Observations by direct and indirect evidences (Direct evidence- Sighting and hearing, Indirect evidence- Pug marks, nests and other signs)
  - Documentation of aquatic fauna like fish (fish market survey, interaction with local fisherman), phytoplankton, zooplankton, benthic organism, crustacean etc.
- Habitat/microhabitat diversity in the Core site and Buffer areas
- Photo documentation

Survey Limitation

This survey records the flora and fauna evident on the days of the site visit and field survey. It does not record any flora or fauna that may appear at other times of the year, and as such, were not evident at the time of visit. The report represents ecological status of the area evident during the particular period of the study

Approach of the study

To assess the ecological issues and document flora and fauna associated with the project following tasks were undertaken:

(i) Preliminary visit on the site

(ii) Desk Study

(iii) Site Survey by subsequent visits

(iv) Strategic sampling of 1 km and 10 km radius areas from the project location.

Materials and Methods

Desk Study

The purpose of the desk study was to identify habitats and species of conservation value that may not have been present or apparent during the survey visit (e.g. season specific plants). The desk study was also helpful in understanding the historical biodiversity and ecological status of the site. The desk study was carried out by referring the hard copy literature related to ecology and biodiversity of the region or of other related areas encompassing the proposed site. Literature survey was also undertaken by collecting and stating research papers and reports specific to the region.

Habitat Survey

To collect data on flora (Herbs, Shrubs and Trees) and fauna (Birds, Insects, Spiders, Reptiles, Mammals) various strategies were practiced. These strategies differed as per the habit and habitat of concerned group of species. Various methodologies have been used to document aquatic diversity (phytoplankton, zooplankton, benthic organism, crustacean, algae etc).

Flora

The structure and composition of vegetation cover was studied by using Phytosociological methods. Analysis and estimation of diversity, density, dominance and frequency of different members of plant populations encountered were made. Observations were made in the forest area as well as in non-forest areas by laying plots and adopting quadrate method. The quadrate method included laying down square sample plots or units for quantitative analysis of vegetation. The sample plot method given by Clements (1898); Philips (1959); Muller and Ellenberg (1974) and Rau and Wooten (1988) EIA Hand Book (ch.7, pp.44) was followed. The Quadrate sizes of 1 m x 1m, 5m x 5m and 10m x 10m were taken for herbs, shrub and trees respectively.

Fauna and Avifauna

The assessment of wild fauna was based on random search-research survey. For animals, other than directly sighted, secondary evidences were recorded through calls, dung boles, scats, spoors, rub signs, signs of debarking, drag mark etc. For birds, actual counts at each sampling site were made, by walking through a chosen one-kilometre stretch of the site and the number of birds were directly counted and listed. For reptile and amphibian survey direct searching method, searching along the stream or water body, night survey was conducted. A species list was prepared along with taxonomic position of each species.

Sampling stations

Various sampling stations were chosen in the buffer and core. These locations were the sites of quantitative sampling. Within each sampling station, 4-6 quadrates flora or points sampling units are placed for fauna to estimate biodiversity parameters. For the current project, 10 sampling locations were selected in the buffer area and the overall core area represented by 40 quadrates respectively. The sampling locations are distributed as follows:

The sampling location can be grouped into buffer zones and impact categories as follows

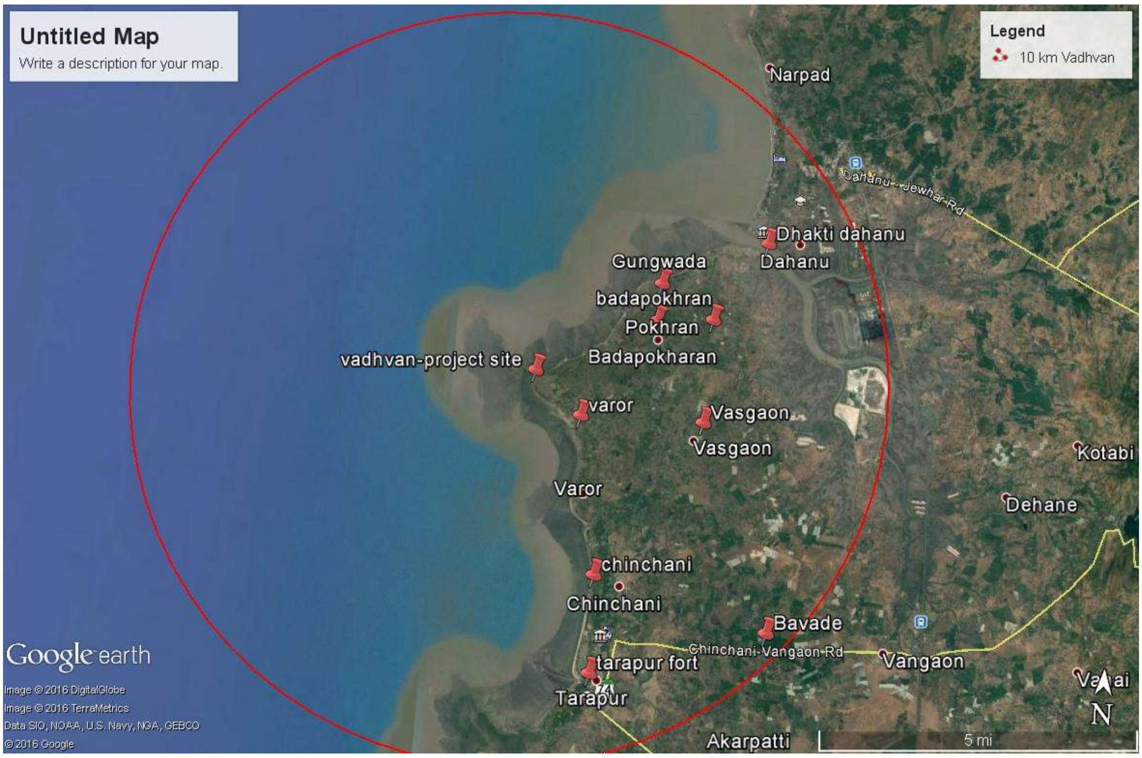


Figure 90 - Map of sampling location and buffer zones around the core area

Table 126 - Sampling locations

Location	Distance	Habitat status
Core site	Core site	Intertidal zone/beach area
Varor	2 km	Beach area, creek area
Chanchani	6 km	Semi urbnised, beach, creek area

Location	Distance	Habitat status
Bawade	9 km	Paddy field, grassland
Tarapur fort	8 km	Fort area, Unurbanised
Vasgaon	5 km	Agricultural, field, grassland
Badapokhran	4 km	Unurbanised, agricultural
Pokhran	5 km	agricultural
Gungwadas	5 km	Unurbanised, agricultural
Dhakti Dahanu	8 km	Near creek area

Observations

Observations were made for all possible habitats and flora and fauna species in and around the site (except micro organisms). All possible landscape features and areas in the site were visited to collect the required amount of data. The observations recorded are site, time and season specific observations. However, the actual observation data was supported by the data obtained from secondary sources (reports, research papers, literature survey) to gather a wide and in-depth perspective

Habitat Survey

Habitats are decisive factors and determine the diversity and distribution of flora and fauna in any given ecosystem. Therefore, it is vital to understand dynamics and diversity of habitats and micro ecosystems in and around the area that are proposed for the project. Google earth and actual field observations were used to characterize and distinguish landscape diversity in the study site and the buffer region.

The habitat represents most of the agricultural field/paddy field, barren land along with riverian and lake ecosystems. The project location comprises intertidal zone of the sea. Reliance energy power plant and Tarapur atomic power station are situated in 10 km radius of the project. Loss of natural habitat has been observed due to urbanization & conversion of land into agricultural as well as industrial use. Presence of natural ecosystem within 10 km radius from the project site is high, habitat like chinchani beach, Dahanu creek, Varor coastal area are an ideal habitat for many migratory as well as residential birds.

Area within 1km radius range

The region in the 1 km radius range contains intertidal area and Vadhavan village. Vadhavan village comprises of shrublands, small agricultural Farms, households and other construction and rest is of open areas and barren land. Coastal area of in 1 km radius comprises a vast patch of Suru tree and sparse patches of mangroves.

Areas within 5 km range

The area within 5 km radius range includes some villages like Vadhavan, Varor, Chinchani, Badapokhran, Ambistewadi etc. this area comprises agricultural farm, grassland, and khazan land. The overall region within 5km radius can be categorized as semi evergreen to dry with patchy vegetation areas. Google image of 5km range is shown in the following figure.

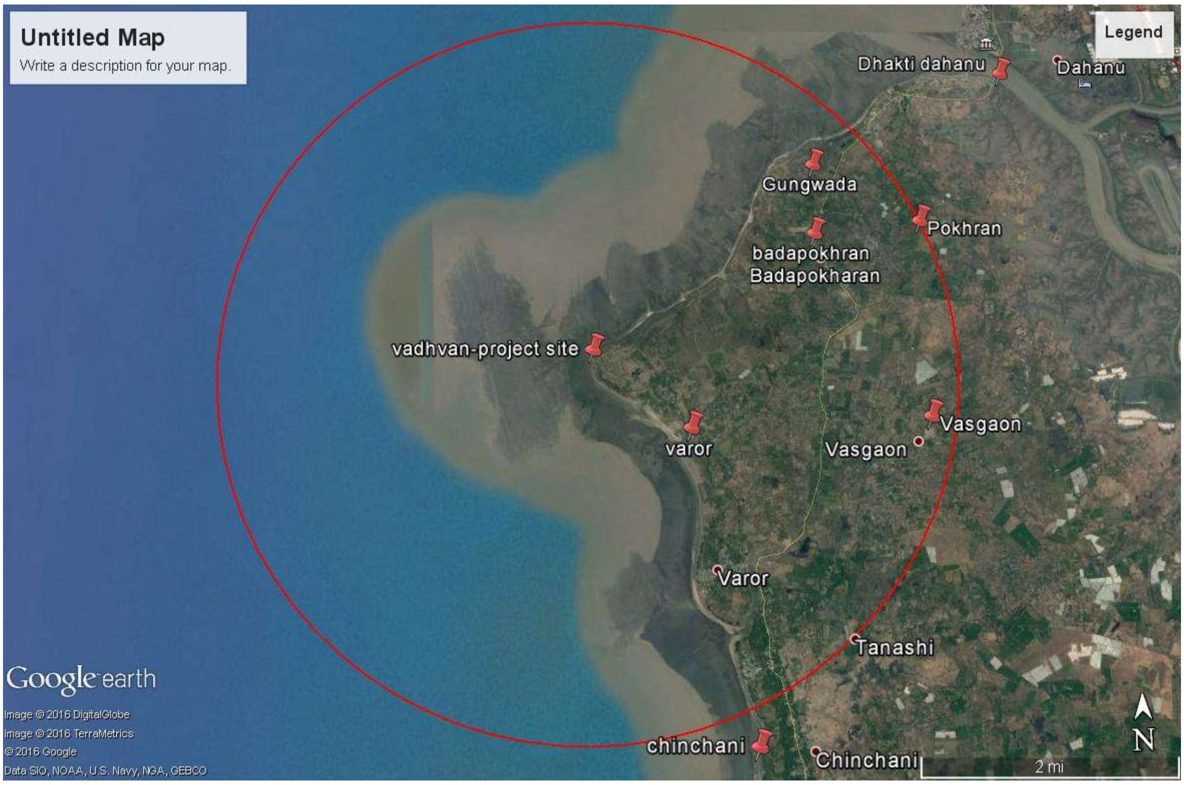


Figure 91 - Areas within 5 km radius

Areas within 10 km range

Areas within 10 km zone are moderate to non forest cover. There are patches of forests interrupted by many human habitations and fields. The overall area has relatively good potential and ecological value. Regions within the 10 km range such as the Dahanu creek, Kondha creek, Davale lake, Babule lake, wetland near Chinchani, creek area of Varor, vegetation near Tarapur fort can provide good habitat for biodiversity and upturn the ecological significance of the buffer. Google image of 10 km range is shown in the following figure.

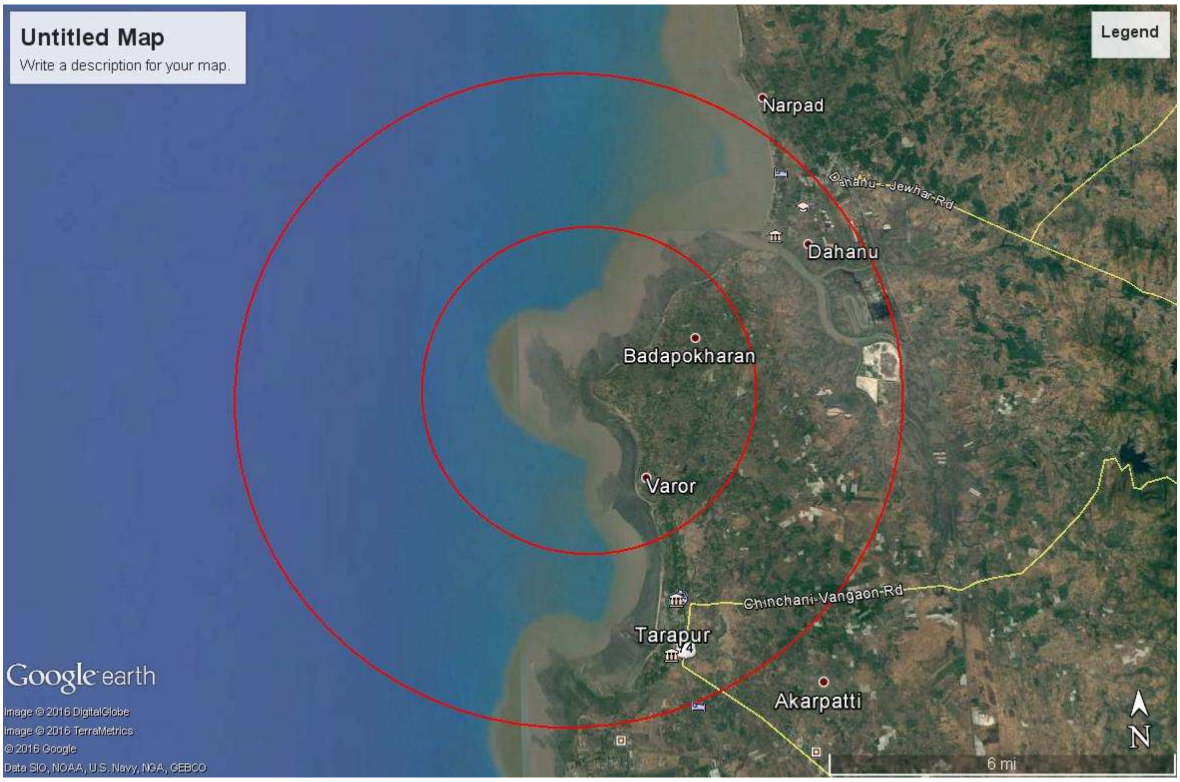


Figure 92 - Areas within 10 km radius

Floral Diversity

Floral study was undertaken to document diversity and density of herb, shrub, climber and tree species prevalent in the areas falling within the Core site and Buffer region. Background information on floristic/vegetation diversity from literature survey was used to create a detailed account of local vegetation that may not have been encountered during the study. Sampling was done by using Quadrates. Quadrates were laid randomly at various locations within the Core and Buffer region of the project. Random survey was also undertaken to create a detailed list of species. Important plants were photographed and specimens that could not be identified on field were preserved/ photographed for off-field analysis. The specimens were identified by using keys from Floras. Pascal key was used for specimens without reproductive organs. Based on direct field observations and strategic selection of sampling locations primary data was collected to represent the status of flora prevalent in the core site and the buffer region of the project.

Flora in the project site (Core area- 1 km area *from coast*)

The landward side area around the actual project site is dominated by tree species of mostly native and indigenous tree species representing considerable vegetation diversity and ecological significance. Total 53 species were observed during the study. Checklist of the fauna in core region is attached in the following table. The species can be categorized into following habit group combinations.

Table 127 – Group wise categories of flora in core area (1 km area from coast)

Habitat	No. of species
Tree	26
Shrub	8
Herb	8
Climbers/Creepers	6
Grass	5
Total	**53**

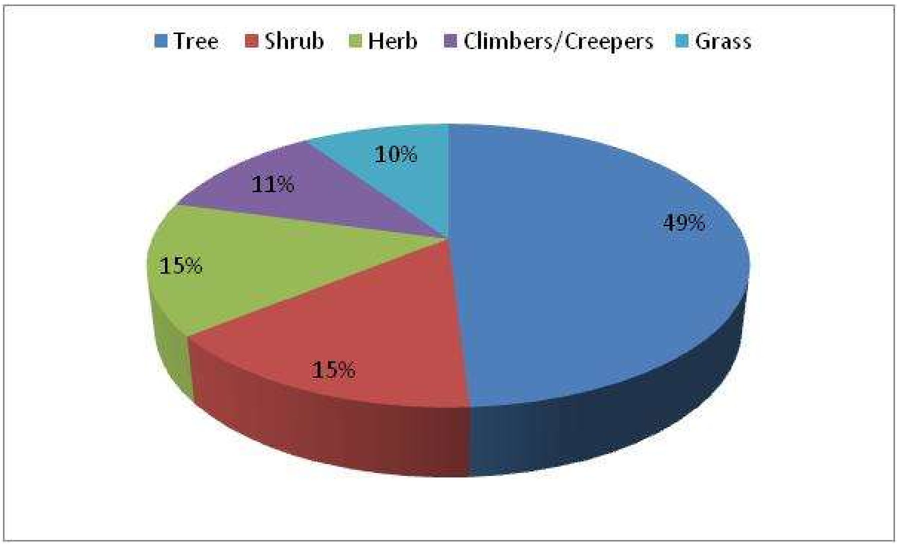


Figure 93 - Composition of plant diversity seen in 1 km radius of the project site

Flora in the Buffer range (within 10 km radius)

The buffer range of the proposed project as per the literature review falls between open to non forest areas. However, during the study considerable amount of diversity was observed.

In the Buffer range, the vegetation diversity can be divided into mostly urban and forest based. Common cultivable plants like Coconut can be observed. In the semi forested landscapes, the floristic diversity is composed of wild flora such as, *Bombax cieba* (Savar), *Terminalia elliptica* (Ain), *Wrightia tinctoria* (Kuda), *Buchanania cochinchinensis Almeid* (Charoli), *Morinda tinctoria* (Baratondi), *Butea monospera*, *Erythrina indica* (Pangara) and related species. Checklist of the fauna in buffer is attached in Table 148

Qualitative study:

During the study in the buffer area, the data about diversity and community arrangement of plant species was collected by plotting 40 quadrates across 10 locations divided on the basis of 1 km, 5 km and 10 km radius range from the project location. Overall, 149 species of plants were observed in following compositions of habits:

Table 128 – Group wise categories of flora in buffer area

Habitat	No. of species
Tree	64
Shrub	22
Herb	36
Climbers/Creepers	14
Grass	14
Total	**150**

It is clearly seen that vegetation diversity is dominated by tree species followed by herbs, shrubs, climbers/creepers and grasses.

Table 129 Checklist of flora observed in the study area

Sr. No	Botanical name	Local Name	family
	Tree		
1	*Pongamia pinnata*	Karanj	Fabaceae
2	* *Acacia auriculiformis A. Cunh.*	Aakashi	Fabaceae
3	*Acacia catechuoides (Roxb.)Benth.*	Khair	Fabaceae

Sr. No	Botanical name	Local Name	family
4	*Acacia leucoploea (Roxb.) Willd.*	Hivar	Fabaceae
5	*Acacia nilotica (Linn.) Del.*	Babul	Fabaceae
6	*Albizzia procera*	Kinhai	Fabaceae
7	**Ammania baccifera*	Bhor Jambhul	Lythraceae
8	**Anacardium occidentale*	Kaju	Anacardiaceae
9	**Annona squamosa L.*	Sitaphal	Annonaceae
10	*Anogeisus latifolia (Roxb. ex DC.) Guillemin. & Perottet.*	Dhavada	Combrataceae
11	*Azadirachta indica (L.) A. Juss.*	Kaduneem	Meliaceae
12	**Bauhinia racemosa Lamk.*	Apta	Fabaceae
13	**Borassus flabellifer Linn.*	Tad	Arecaceae
14	*Bridelia spinosa Willd.*	Asana	Phyllanthaceae
15	*Buchanania cochinchinensis Almeida*	Charoli	Anacardiaceae
16	*Buchnania latifolia*	Char, Chroli	Anaeardiaceae
17	**Butea monosperma (Lamk.) Kuntze&n bsp;*	Palas	Fabaceae
18	**Cassia fistula*	Bava (Bhava)	fabaceae
19	**Casuarina equisetifolia*	Suru	Casuarinaceae,
20	**Citrus sinensis (L.) Osbeck*		Rutaceae
21	**Cordia dichotoma Forst.f.*	Bhokar	Boraginaceae
22	*Dalbergia lanceolaria*	Dandoshi	fabaceae
23	*Dellenia pentagyna*	Karambel	Dilleniaceae
24	*Delonix regia (Hook.) Rafin.*	Gulmohar	Fabaceae
25	*Dichrostachys cinerea (L.) Wight & Arn.*	Durangi Babool	Fabaceae
26	*Diospyros melanoxylon Roxb.*	Tendu	Ebenaceae
27	*Dolichandrone falcata (Wall. ex DC.) Seem.*	Medhshingi	Bignoniaceae
28	**Emblica officinalis*	Awla	Phyllanthaceae
29	**Erythrina indica*	pangera	Fabaceae
30	*Feronia limonia L.*		Rutaceae
31	**Ficus benghalensis L.*	Vad	Moraceae
32	**Ficus hispida Linn.f.*	Kala Umber	Moraceae
33	**Ficus racemosa Linn.*	Umber	Moraceae

Sr. No	Botanical name	Local Name	family
34	*Ficus religiosa L.*	Pimpal	Moraceae
35	*Flacourtia indica (Burm.f.) Merrill*	Tambat	Flacourtiaceae
36	*Gmelina arborea Roxb.*	Shivan	Verbenaceae
37	**Holarrhen aantidysentrica*	kuda	Apocynaceae
38	**Holoptelea integrifolia (Roxb.) Planch*	Vavla	Urticaceae
39	*Leucaena leucocephala (Lamk.) De Wit*	Subabul	Mimosaceae
40	*Madhuca indica*	Moha	Sapotaceae
41	**Mangifera indica Linn.*	Amba	Anacardiaceae
42	**Meyna laxiflora*	Alu	Rubiaceae
43	*Morinda pubesence Sm.*	Bartondi	Rubiaceae
44	*Moringa pterigospermaGaertn.*	Shevga	Moringaceae
45	*Phoenix sylvestris(Linn.)Roxb.*	Shindi	Arecaceae
46	**Pithecellobium dulce (Roxb.) Benth.*	Vilayati Chinch	Mimosaceae
47	**Psidium guajava Linn.*	Peru	Myrtaceae
48	**Bombax ceiba.*	katesavar	Bombacaceae
49	*Soymida febrifuga (Roxb.) A. Juss.*	Rakta-rohan	Meliaceae
50	*Stereospermum personatum (Hassk.) Chatt.*		Bignoniaceae
51	**Syzygium cuminii (Linn.) Skeels*	Jamun	Myrtaceae
52	**Tamarindus indica Linn.*	Chinch	Fabaceae
53	**Tectona grandis Linn.f.*	Sag	Verbenaceae
54	*Terminalia arjuna (Roxb.) Wt&Arn.*	Arjun	Combretaceae
55	*Terminalia bellirica (Gaertn.) Roxb.*	Beheda	Combretaceae
56	*Terminalia chebula*	hirda	Combretaceae
57	*Terminalia crenulata Roth.*	Ain	Combretaceae
58	*Wrightia tinctoria*	Kala kuda	Apocynaceae
59	*Zizyphus mauritiana Lamk.*	Ber	Rhamnaceae
60	*Carreya arborea*	Kumbhi	Lecythedaceae
61	*Chloroxylon swietenia*	Bhirra	Meliaceae
62	*Holoptelia integrifolia*	Chirol	Ulmaceae
63	*Lagerstroemia parviflora*	Seja	Lythraceae

Sr. No	Botanical name	Local Name	family
64	*Gmelina arbore linn.*	Suru	lamiaceae
	Shrubs		
1	*Acacia pennata (Linn.) Willd.*	Shembi	Mimosaceae
2	*bambusa arundinacea (retz.) willd*		Poaceae
3	**Calotropis procera (Aiton) Dryand.*	Rui	Asclepediaceae
4	** Calycopteris floribunda*	Ukshi	Combretaceae
5	*Capparis spp*		Capparaceae
6	*Capparis zeylanica L.*	Tarati	Capparaceae
7	**Datura innoxa Mill.*	Dhotra	Solanaceae
8	*Datura metal L.*	Kaladhotra	Solanaceae
9	**Eupatorium sp*	Raanmodi	Asteraceae
10	** Helicteris isora L.*	Murad-sheng	Sterculiaceae
11	*Hemidesmus indicus (Linn.) Schultes in Rome. & Schult.*	Anantmul	Periplocaceae
12	*Hygrophila schulli (Buch.-Ham.) Almeida & Almeida*	Talimkhana	Acanthaceae
13	*Jatropha curcas*	Mogli or Ran-arand	Euphorbiceae
14	**Lantana camara L.*	Ghaneri	Verbenaceae
15	**Opuntia dillenii*	Nivdung	Cactacea
16	*Ricinus communis Linn.*	- -	Euphorbiaceae
17	*Securinega leucopyros (Willd.) Muell.-Arg.*	Pandharphali	Euphorbiaceae
18	*Securinega obovata (Willd.)Almeida (comb. nov.)*	Pandharphali	Euphorbiaceae
19	*Ventilago denticulata Willd.*		Rhamnaceae
20	**Vitex negundo*	Nirgudi	Verbenaceae
21	**Zizyphus oenoplia (Linn.) Mill.*	Burgi	Rhamnaceae
22	*Grewia asiatica L.*	Phalsa	Tiliaceae
	Herbs		
1	**Achyranthes aspera Linn.*	Aghada	Amaranthaceae
2	**Alternanthera sessilis (Linn.) R.Br.*	Kanchari	Amaranthaceae
3	**Cassia tora*	takala	Caesalpiniaceae
4	**Celosia argentea Linn.*	Kurdu	Amaranthaceae
5	*Chrozophora rottleri (Geiseler) A.Juss. ex Spreng.*		Euphorbiaceae

Sr. No	Botanical name	Local Name	family
6	*Clerodendrum inerme*	*Kadu Mendi*	Verbenaceae
7	*Cyathocline purpurea (Don) Kuntze*	Garotra	Asteraceae
8	*Cynodon dactylon (L.) Pers.*		Poaceae
9	*cyperus difformis L.*		Cyperaceae
10	*Cyperus rotundous L.*		Cyperaceae
11	*Cyperus spp*		Cyperaceae
12	*Echinochloa colonum (L.) Link*		Poaceae
13	*Echinops echinatus Roxb.*		Asteraceae
14	*Eleocharis geniculata (L.) Roem. & Schult.*		Cyperaceae
15	*Eragrostis tenella (L.) P. Beauv.*		Poaceae
16	*Euphorbia erythroclada Boiss.*		Euphorbiaceae
17	*Fimbristylis miliacea (L.) Vahl*		Cyperaceae
18	*Fimbristylis ovata (Burm. f.) Kern.*		Cyperaceae
19	*Heliotropium indicum Linn.*	- -	Boraginaceae
20	*Hyptis suaveolens (L.) Poir*	- -	Lamiaceae
21	*Kyllinga brevifolia Rottb.*		Cyperaceae
22	**Leea macrophylla*	Dinda	Leeaceae
23	*Ludwigia perennis L.*		Onagraceae
24	*Malachra capitate*	Vilayati bhendi	Malvaceae
25	**Parthenium hysterophorus Linn.*	White top weed	Asteraceae
26	*Persicaria glabra (Willd.) Gomez.*	Rakta-roda.	Polygonaceae
27	*Phyla nodiflora (Linn.) Greene*	- -	Verbenaceae
28	*Rungia pectinata (Linn.) Nees in DC.*	- -	Acanthaceae
29	*Scirpus spp*		Cyperaceae
30	**Sesamum indicum*	Til	pedaliaceae
31	*Sida acuta Burm.f.*	Bala	Malvaceae
32	*Sida cordifolia L.*	Kharenti	Malvaceae
33	*Synedrella nodiflora (Linn.) Gartn.*	- -	Asteraceae
34	*Tridax procumbens Linn.*	Dagdipala,Ekdandi	Asteraceae
35	*Urena lobata Linn.*	Van-bhendi	Malvaceae

Sr. No	Botanical name	Local Name	family
36	*Xanthium strumarium Linn.*	Sankeshwar	Asteraceae
	Climbers/Creepers		
1	**Abrus precatorius L.*	Gunj	Fabaceae
2	**Cajanus scarbaoides (Linn.)Thouars.*	Ghoshyachi vel	Fabaceae
3	**Cardiospermum helicacabum Linn.*	Ghanphodi	Sapindaceae
4	*Combretum albidum D. Don*	Zellusi	Combretaceae
5	*Cryptolepis dubia (Burm.f.) comb.nov.*	Kawa vel	Periplocaceae
6	*Gloriosa superba*		colchicaceae
7	*Impomoea digitate*	Bhuikohala	Convolvalaceas
8	*Ipomea alba*	Gulchandi	Convolvulaceae
9	*Ipomoea pes-caprae*		Convolvulaceae
10	**Mucuna pruriens*	Kuhili	Fabaceae
11	*Pergularia daemia (Forssk.) Chiov.*		Asclepiadaceae
12	*Rivea hypocaratiformis (Devs.) Choisy*	Phanji	Convolvulaceae
13	**Teramnus labialis (Linn.) Spreng.*	Ran-urid	Fabaceae
14	**Tinospora glabra (Burm.f.) Merill*	Gulvel	Menispermaceae
	Grasses		
1	*Oxytenanthera SP*	cher	Poaceae
2	**Andropogon sp*	Boru	Poaceae
3	**Aristida sp*	Bhuri	Poaceae
4	**Bambusa arundianacea*	katas	Poaceae
5	*Bothriochloa sp*	Ghanya	Poaceae
6	*Chrysopogon fulvus*	Dongari gavat	Poaceae
7	*Dendrocalamus strictus*	Manvel	Poaceae
8	*Dichanthium annulatum Stapf.*	- -	Poaceae
9	*Elusine indica L. Geartn.*	- -	Poaceae
10	*Eragrostis sp*	Chirika	Poaceae
11	*Heteropogon sp*	Kusali	Poaceae
12	**Mnesithea laevis*	Lavhala	Poaceae
13	**Themeda quadrivalvis*	Bhongrut	Poaceae

Sr. No	Botanical name	Local Name	family
14	*Thysanolaena latifolia (Roxb. ex Hornem.) Honda*		Poaceae

**Also found in Core area*

Domesticated plants during the survey

A survey was undertaken in and around the core site and other areas close to the actual project location. List of plant species associated with plantations, avenues and agricultural landscapes (Domestic plants) were made. List of Domesticated plants observed during the study can be seen in following;

Table 130 Checklist of domestic Plant species observed around the core site

Botanical Name	Local Name	Habitat	Status E: Exotic N: Native
Acacia auriculiformis	Australian babul	Tree	E
Anacardium occidentale	Kaju	Tree	E
Callistemon Citrinus	Bottle brush	Tree	E
Gmelina arbore linn.	Suru	Tree	N
Delonix regia	Gulmohar	Tree	E
Grevillea robusta	Silver Oak	Tree	E
Leucaena leucocephala	Subabul	Tree	E
Manilkara zapota	Chiku	Tree	E
Plumeria alba	Chapha (Pa)	Tree	E
Plumeria rubra	lal chafa	Tree	E
Polyalthia longifolia	Asupalav	Tree	E
Psidium guajava	Peru	Tree	E
Musa paradisiaca X	Banana	Shrub	E
Lantana camara	Ghaneri	Herb	E
Artocarpus heterophyllus	Phanas	Tree	N
Cicca acida	Amla	Tree	N
Citrus acida	Lemon	Tree	N
Madhuca indica	Moha	Tree	N
Mangifera indica	Amba	Tree	N

Botanical Name	Local Name	Habitat	Status E: Exotic N: Native
Bambusa bambos	Bamboo	Grass	N
Tectona grandis	Sagwan	Tree	N
Moringa pterigosperma Gaertn.	Shevga	Tree	N
Michelia champaka	Champa	Tree	N
Annona squamosal	Sitaphal	Tree	N

Ecologically important species

Plant species form the basis of ecological interaction in nature. In the web of life and natural ecology, the diversity of plants species is decisive factors. More the native plant species better is the association with faunal diversity. Documenting local species that are ecologically important may be helpful in restoration and greenbelt development planning. With the help of actual field observations and literature review, a list of plant species that are ecologically significant was prepared. These plant species are considered ecologically important as they attract and support faunal diversity. These plants can be helpful in restoration of natural ecology if planted in strategic composition. List of ecologically important plants found in the region is attached in the Following Table

Table 131 Ecologically important species of the region

Plant species	Common Name	Family	Habit	Status	Main Attractant for animals
Acacia catechu	Khair	Leguminosae	Tree	Native	Flowers
Bauhinia racemose	Asta	Leguminosae	Tree	Native	Flowers
Butea monosperma	Palas	Leguminosae	Tree	Native	Flowers
Carreya arborea	Kumbhi	Lecythedaceae	Tree	Native	Flowers
Cassia fistula	Amaltas	Leguminosae	Tree	Native	Fruits
Chloroxylon swietenia	Bhirra	Meliaceae	Tree	Native	Fruits
Diospyros melanoxylon	Tendu	Ebenaceae	Tree	Native	Fruits
Ficus benghalensis	Vad	Moraceae	Tree	Native	Fruits
Ficus recimosa	Umbar	Moraceae	Tree	Native	Fruits

Plant species	Common Name	Family	Habit	Status	Main Attractant for animals
Ficus religiosa	Pipal	Moraceae	Tree	Native	Fruits
Gmelina arborea	Shivan	Verbenaceae	Tree	Native	Flower
Holoptelia integrifolia	Chirol	Ulmaceae	Tree	Native	Fruit
Lagerstroemia parviflora	Seja	Lythraceae	Tree	Native	Flower
Mangifera indica	Amba	Anacardiaceae	Tree	Native	Flower and Fruits
Pongamia pinnata	Karanj	Leguminosae	Tree	Native	Flowers
Tamarindus indica	Imli	Leguminosae	Tree	Introduced	Fruits
Tectona grandis	Sag	Verbenaceae	Tree	Native	Flowers
Terminalia arjuna	Arjun	Combretaceae	Tree	Native	Fruits and flowers
Terminalia belerica	Bahera	Combretaceae	Tree	Native	Flowers
Terminalia chebula	Hirda	Combretaceae	Tree	Native	Flowers
Buchanania cochinchinensis Almeida	Charoli	Anacardiaceae	Tree	Native	fruits

Mangroves

Some sparse patches of mangroves are seen along the sea shore and the creek side. List of the mangroves is attached in following Table

Table 132 Mangroves species found in core and buffer area

Scientific name	Family
**Avicinnia alba*	Acanthaceae
**Acanthus ilicifolius*	Acanthaceae
**Sonneratia sp*	Lythraceae
Braguira spp	Rhizophoraceae
Acanthus ilicifolius	Acanthaceae
Rhizophora sp.	Rhizophoraceae

**Also found in Core area*

Summary of the Floristic Survey

Total number of plant species observed in the core site including trees, herbs and shrubs, climbers and grass: **53**

Total number of species observed in the buffer region: **150**

Number of quadrates used in studying buffer region: **40**

Number of locations studied: **10**

Rare, Endangered, vulnerable or protected species encountered in the project site area: **None**

Rare, Endangered, vulnerable or protected species encountered in buffer area: **None**

Faunal diversity

The Faunal diversity in the core site was limited to few common species of Birds, Butterflies, insects, rats and lizards. The areas surrounding the core site has a good Avifaunal diversity. Possibility of bigger mammals is very low. In the Buffer region due to khazan land and grassland, there was a good diversity of Birds, Butterflies and other insects.

To study faunal diversity and richness in the area, random sightings were preferred and various methods of observations were practiced. For reptiles, stone lifting was done; rock crevices and wall space of structures in the site were checked. Amphibians were searched near the stagnant water pools and small streams. Night trail was conducted during the survey especially to record reptiles, amphibians and mammals. Insects were observed on underside of leaves, nests, rock crevices, bushes and other places. Birds were studied by undertaking several field trails in and around the site. The observations made during the study phase in the site are as follows

Mammal Diversity

No mammals other than common Squirrel and domesticated cows or dogs were seen in and around the core site. On random survey and talking with local people, it was learnt that Presence of Jackals in some patches of the Buffer region and there were records of sightings in the nearby villages. Based on direct sightings, interaction with local people, indirect evidences, the presence of faunal species such as Wild Boar, Indian Hare, and Indian Mongoose were validated in the Buffer region. List attached in following table.

Table 133 Mammals observed in study area

Sr. no	Common name	Species	Habitat
1	*Indian palm squirell	*Funambulus palmarum*	Arborial
2	*Flying fox	*Pteropus giganteus*	Arborial
3	*Field mouse	*Mus musculus*	Terrestrial
4	Indian Grey Mongoose	*Herpestes edwardsii*	Terrestrial
5	Asian palm cievet	*Paradoxurus hermaphroditus*	Arborial
6	wild boar	*Sus scrofa*	Terrestrial
7	Blacknaped Hare	*Lepus nigricollis*	Terrestrial
8	common indian civet	*Viverricula indica*	Terrestrial
9	Barking Deer	*Muntiacus muntjak*	Terrestrial
10	Common Langur	*Presbytis entellus*	Terrestrial
11	Asian House shrew	*Suncus sp.*	Terrestrial

**Also found in Core area*

Avian diversity

In areas falling within the core site and adjoining areas, 30 species of birds were observed during the study. The observations were made based on direct sightings and bird calls. In the observed list of birds, none of the species were classified as Endangered or rare.

While surveying the buffer area, 76 species of birds were observed. It must be noted here that though most of the birds species recorded during the survey are of least concern classification. According to IUCN red list data of threaten species 4 species was recorded as Near Threaten sp. viz. Curlew Sandpiper (*Calidris ferruginea*), Eurasian Curlew (*Numenius arquata*), Black tailed godwit (*Limosa limosa*), Oriental ibis (*Threskiornis melanocephalus*). But these 4 species was observed at Chinchani beach which is 5 km away from the project site. Proposed project will not have any significant affect on the presence and migratory status of those Near Threaten species as well as for abundance of other birds which is present in the surrounding area. Necessary steps must be undertaken to reduce the impact on the reserve forest areas that support majority of the avian diversity. List of the birds observed is attached in the following table

Table 134 Checklist of birds observed in the study area

Sr. no	Common name	Scientific name	Family	IUCN Status
1	Ashy prinia	*Prinia socialis*	Passiriforms	LC
2	Asian koel	*Eudynamys scolopaceus*	Cuculidae	LC
3	Asian palm swift	*Cypsiurus balasiensis*	Apodidae	LC
4	Barn owl	*Tyto alba*	Tytonidae	LC
5	Baya weaver	*Ploceus philippinus*	Ploceidae	LC
6	Black- crowned night heron	*Nycticorax nycticorax*	Ardeidae	LC
7	*Black Drongo	*Dicrurus macrocercus*	Dicruridae	LC
8	Black kite	*Milvus migrans*	Accpitridae	LC
9	Black tailed godwit	*Limosa limosa*	Scolopacidae	NT
10	*Bramhini kite	*Haliastur indus*	Accpitridae	LC
11	Bronze winged Jakana	*Metopidius indicus*	jacanidae	LC
12	*Cattle egret	*Bubulcus ibis*	Ardeida	LC
13	*Common iora	*Aegithina tiphia*	Aegithinidae	LC
14	Common Kestrel	*Falco tinnunculus*	Falconidae	LC
15	Common Myna	*Acridotheres tristis*	Sturnidae	LC
16	*Common sandpiper	*Actitis hypoleucos*	Scolopacidae	LC
17	Common swallow	*Hirundo rustica*	Hirudinidae	LC
18	Common tailor bird	*Orthotomus sutorius*	Cisticolidae	LC
19	Crested Serpent Eagle	*Spilornis cheela*	Accipitridae	LC
20	Curlew Sandpiper	*Calidris ferruginea*	Scolopacidae	NT
21	Eurasian Curlew	*Numenius arquata*	Scolopacidae	NT
22	Glossy ibis	*Plegadis falcinellus*	Threskiornithidae	LC
23	Golden oriole	*Oriolus kundoo*	oriolidae	LC
24	*Great Egret	*Ardea alba*	Ardeida	LC
25	*Greater Coucal	*Centropus sinensis*	Cuculidae	LC
26	*Green bee-eater	*Merops orientalis*	Meropidae	LC
27	*Grey Heron	*Ardea cinerea*	Ardeida	LC
28	Grey-breasted prinia	*Prinia hodgsonii*	Cisticolidae	LC

Sr. no	Common name	Scientific name	Family	IUCN Status
29	*Gull billed Tern	*Gelochelidon nilotica*	*Gelochelidon nilotica*	LC
30	*House Crow	*Corvus splendens*	Corvidae	LC
31	*House sparrow	*Passer domesticus*	Passeridae	LC
32	*Indian Cormorant	*Phalacrocorax fuscicollis*	Phalacrocoracidae	LC
33	Indian peafowl	*Pavo cristatus*	phasianidae	LC
34	*Indian roller	*Coracias benghalensis*	Coraciidae	LC
35	*Intermediate egret	*Mesophoyx intermedia*	ardeidae	NE
36	Jungle babbler	*Turdoides striata*	Leiothrichidae	LC
37	*Large-billed Crow	*Corvus macrorhynchos*	Corvidae	LC
38	Lesser whistling Duck	*Dendrocygna javanica*	Anatidae	LC
39	Little Cormorant	*Phalacrocorax niger*	Phalacrocracidae	LC
40	*Little egret	*Egretta garzetta*	Ardeida	LC
41	*Little Ringed Plover	*Charadrius dubius*	Charadriidae	LC
42	*Little Stint	*Calidris minuta*	Scolopacidae	LC
43	Long-tailed shrike	*Lanius schach*	Lanidae	LC
44	Marsh harrier	*Circus aeruginosus*	Accipitridae	LC
45	*Marsh Sandpiper	*Tringa stagnatilis*	Scolopacidae	LC
46	Orange Headed thrush	*Geokichla citrina*	Turdidae	LC
47	Oriental ibis	*Threskiornis melanocephalus*	Threskiornithidae	NT
48	*Oriental magpie robin	*Copsychus saularis*	muscicapidae	LC
49	Osprey	*Pandion haliaetus*	pandionidae	LC
50	Pied bush chat	*Saxicola caprata*	muscicapidae	LC
51	plain prinia	*Prinia inornata*	Cisticolidae	LC
52	*Pond heron	*Ardeola grayii*	Ardeida	LC
53	*Purple heron	*Ardea purpurea*	Ardeida	LC
54	Purple moorhen	*Porphyio porphyrio*	Rallidae	LC
55	Purple rumped sunbird	*Leptocoma zeylonica*	Nectariniidae	LC
56	Purple sunbird	*Cinnyris asiaticus)*	Nectariniidae	LC
57	*Red-vented bulbul	*Pycnonotus cafer*	Pycnonotidae	LC
58	*Red-whiskered bulbul	*Pycnonotus jocosus*	Pycnonotidae	LC

Sr. no	Common name	Scientific name	Family	IUCN Status
59	*Rose ringed parakeet	*Psittacula krameri*	psittaculidae	LC
60	Scaly-breasted Munia	*Lonchura punctulata*	Estrildidae	LC
61	Shikra	*Accipiter badius*	accipitridae	LC
62	Siberian Stone chat	*Saxicola maurus*	muscicapidae	NE
63	*Small Blue Kingfisher	*Alcedo atthis*	Alcidinidae	LC
64	Spot billed duck	*Anas poecilorhyncha*	Anatidae	LC
65	*Spotted dove	*Streptopelia chinensis*	Columbidae	LC
66	Spotted owlet	*Athene brama*	strigidae	LC
67	Western reef egret	*Egretta gularis*	ardeidae	LC
68	*Whiskerd tern	*Chlidonias hybridus*	sternidae	LC
69	White brested water hen	*Amaurornis phoenicurus*	rallidae	LC
70	White rumped munia	*Lonchura striata*	Estrildidae	LC
71	white throted fantail flycatcher	*Rhipidura albicollis*	Rhipiduridae	LC
72	white-browed wagtail	*Motacilla maderaspatensis*	motacillidae	LC
73	White-cheeked barbet	*Psilopogon viridis*	megalaimidae	LC
74	White-throated kingfisher	*Halcyon smyrnensis*	Halcyondae	LC
75	Wire-tailed Swallow	*Hirundo smithii*	Hirundinidae	LC
76	Wood sandpiper	*Tringa glareola*	Scolopacidae	LC

**Also found in Core area*

Reptile and Amphibian Diversity

During the survey, 05 species of reptile and 02 species of amphibians were found in areas close to the project site.

On expanding, the survey to nearby ranges in the Buffer region, 15species of reptiles and 06 species of amphibians were encountered. For more reptilian data we interact with local people and we recorded total 15 sp. of reptiles of them 8 sp. of snake, 2 lizards, 2 sp. of geckos and a single species of terrapin and chameleon and skink. Thus in buffer area total 15 sp. were recorded during the survey. List attached in the following table .

Table 135 Checklist of Reptiles observed in the study area

Sr. no	Common Name	Scientific name
1	*Garden Lizard	*Calotis versicolor*
2	*Buff Strip Keelback	*Amphiesma stolatum*
3	*Bruks Gecko	*Hemidactylus brookii*
4	*House Gecko	*Hemidactylus frenatus*
5	Checkered Keelback	*Xenochrophis piscator*
6	Rat Snake	*Pantherophis obsoletus*
7	Spectacled Cobra	*Naja naja*
8	File Snake	*Acrochordus granulatus*
9	*Indian Forest Skink	*Sphenomorphus indicus*
10	Common Krait	*Bungarus caeruleus*
11	Indian Pond Terrapin	*Melanochelys trijuga*
12	Indian Chameleon	*Chameleon zeylanicus*
13	Common Indian Monitor	*Varanus bengalensisis*
14	Common Wolf Snake	*Lycodon aulicus*
15	Saw Scaled Viper	*Echis carinatus*

**Also found in Core area*

Table 136 Checklist of Amphibians observed in the study area

Sr.no	Common name	Scientific name
1	*Bull frog	*Hoplobatrachus tigerinus*
2	Skittering frog	*Euphlyctis cyanophlyctis*
3	*Common Indian toad	*Duttaphrynus melanostictus*
4	Tree frog	*Polypedates maculatus*
5	Fungoid frog	*Hydrophylax malabaricus*
6	Cricket frog	*Fejervarya sp*

**Also found in Core area*

Lepidoptera diversity

Lepidoptera is a group of insects consisting of butterflies and moths. Sampling for butterflies and moths was made based on random sightings, sitting across water puddles and searching of caterpillars and cocoon in and around the site.

In total 11 species of butterflies around the site were observed. Only 04 species of butterflies were found in areas nearby project site (Landward side) while in total 40 species were observed during surveying other areas in the region within 10 km range from the project site. List attached in the following table.

Table 137 Checklist of butterflies observed in the study area

Sr. No.	Common name	*Scientific name*	Family
1	Blue tiger butterfly	*Tirumala limniace*	Nymphalidae
2	Chesulnut striped sailor	*Neptis jumbah*	Nymphalidae
3	*Chocolate pansy butterfly	*Junonia iphita*	Nymphalidae
4	Commander butterfly	*Moduza procris*	Nymphalidae
5	Common baron butterfly	*Euthalia aconthea*	Nymphalidae
6	*Common Bush Brown	*Mycalesis perseus*	Nymphalidae
7	Common Castor	*Ariadne merione*	Nymphalidae
8	Common Emigrant	*Catopsilia crocale*	Pieridae
9	common Five- ring	*Ypthima baldus*	Nymphalidae
10	*Common Grass Yellow	*Eurema hecabe*	Pieridae
11	*Common Indian Crow	*Euploea core*	Nymphalidae
12	*Common Jezbell butterfly	*Delias eucharis*	Pieridae
13	Common Mime	*Papilio clytia*	Papilionidae
14	Common Mormone butterfly	*Papilio polytes*	Papilionidae
15	Common Nawab	*Polyura athamas*	Nymphalidae
16	Common palmfly butterfly	*Elymnias hypermnestra*	Nymphalidae
17	*Common pierrot butterfly	*Castalius rosimon*	Lycaenidae
18	Common rose butterfly	*Pachliopta aristolochiae*	Papilionidae
19	Common sailor	*Neptis hylas*	Nymphalidae
20	Common silverline butterfly	*Spindasis vulcanus*	Lycaenidae
21	Dark Banded Bush Brown	*Mycalesis mineus*	Nymphalidae

Sr. No.	Common name	*Scientific name*	Family
22	*Glassy Tiger	*Danais aglea*	Nymphalidae
23	Gram Blue	*Euchrysops cnejus*	Lycaenidae
24	Grass demon	*Udaspes folus*	Hesperiidae
25	Great Mormon	*Papilio memnon*	Papilionidae
26	Dennaid egg butterfly	Hypolimnas misippus	Nymphalidae
27	Greater Orange Tip	*Hebomoia glaucippe*	Pieridae
28	Grey count	*Tanaecia lepidea*	Nymphalidae
29	grey pansy butterfly	*Junonia atlites*	Nymphalidae
30	Hedge blue	*Acytolepis puspa*	Lycaenidae
31	Lemon pansy	*Junonia lemonias*	Nymphalidae
32	*Lime butterfly	*Papilio demoleus*	Papilionidae
33	Orange staff seargent	*Athyma nefte*	Nymphalidae
34	*Peacock Pansy	*Precis almana*	Nymphalidae
35	*Plain Tiger	*Danaus chrysippus*	Nymphalidae
36	Red Base Jezabel	*Delias pasithoe*	Pieridae
37	Red pierrot butterfly	*Talicada nyseus*	Lycaenidae
38	Southern rustic butterfly	*Cupha erymanthis*	Nymphalidae
39	striped tiger butterfly	*Danaus genutia*	Nymphalidae
40	Three spotted yellow grass	*Eurema blanda*	Pieridae

**Also found in Core area*

Other insect diversity

Insects were observed by random sightings coupled with extensive searching at ideal locations and microhabitats present in the site and surrounding areas. List attached in following table. 8 species of insects (other than Lepidoptera and Odonota) were observed in areas nearby the actual project site. During the survey in the surrounding regions, there were few more observation of species made and the total species observed was 24 species.

Table 138 List of insect observed in the study area

Sr. no	Common name	Scientific Name	Family	Type
1	Asiatic blood tail	*Lathrecista asiatica*	Libellulidae	Odonates/Dragonflies

Sr. no	Common name	Scientific Name	Family	Type
2	Asiatic honey bee	*Apis cerana*	Apidae	Bees
3	Bark praying mantis	*Gyromentis sp.*		Mantis
4	*Blue dasher	*Brachydiplax chalybea*	Libellulidae	Odonates/Dragonflies
5	Catydid		Tettigoniidae	Grasshopper
6	Coromandal Marsh Dart	*Ceriagrion coromandelianum*	Coenagrionidae	Odonates/Damselflies
7	*Crimson tailed marsh Hawk	*Orthetrum pruinosum*	Libellulidae	Odonates/Dragonflies
8	*Fulvous Forest Skimmer	*Neurothemis fulvia*	Libellulidae	Odonates/Dragonflies
9	Giant honey bee	*Apis dorsata*	Apidae	bees
10	Globe Skimmer	*Pantala flavescens*	Libellulidae	Odonates/Dragonflies
11	*Golden Dartlet	*Ischnura aurora*	Coenagrionidae	Odonates/Damselflies
12	*Grasshopper	*Macrotona australis*	Acrididae	Insects
13	Green Marsh Hawk	*Orthetrum sabina*	Libellulidae	Odonates/Dragonflies
14	Ground skimmer	*Diplacodes trivialis*	Libellulidae	Odonates/Dragonflies
15	Honeybee	*Apis mellifera*	Apidae	bees
16	Pied Paddy Skimmer	*Neurothemis tullia*	Libellulidae	Odonates/Dragonflies
17	*Praying mantis	*Mantis sps.*	Mantidae	Mantis
18	Pygmey wisp	*Agriocnemis pygmaea*	Coenagrionidae	Odonates/Damselflies
19	Rosy Skimmer	*Orthetrum luzonicum*	Libellulidae	Odonates/Dragonflies
20	ruddy marsh skimmer	Crocothemis servilia	Libellulidae	Odonates/Dragonflies
21	Scarlet Skimmer	*Crocothemis servilia*	Libellulidae	Odonates/Dragonflies
22	Jewel bug	Chrysocoris sp	Scetulleridae	bug
23	*Stag beetle	*Lucanus capreolus*	Lucanidae	Beetle
24	*Termites	*Termitoidae sps.*	order: isoptera	..

**Also found in Core area*

Spider diversity

Spiders are functionally important features in any ecosystem. They play a unique role of controlling pests or specifically population of insects in an ecosystem. The species observed in the site area were common species and are associated with urban environments. However areas with thick vegetation, more forest representative individuals/species were observed. During survey 4 sp. of spider were observed in core site while in buffer area total 17 species were recorded. List attached in the following table.

Table 139 Checklist of spider observed in the study area

Sr. no	Common name	Species
1	*Signature Spider	*Argiope sp*
2	Common Funnel Web Spider	*Hippasa sp*
3	*Striped Lynx Spider	*Oxyopes sp*
4	Tent Spider	*Cyrtophora sp*
5	Fishing Spider	*Dolomedes sp*
6	*Giant Wood Spider	*Nephila sp*
7	Wolf Spider	*Lycosa sp*
8	Neoscona	*Necoscona bangalansis*
9	Gastricantha	*gastricantha sp*
10	Jumping Spider	*plexippus paykulli*
11	Jumping Spider	*Cyclosa sp*
12	Tetragnatha	*leucauge decorata*
13	Tetragnatha	*tetragnatha viridorufa*
14	Saltysidae	*crossopriza*
15	Two Tailed	*Hersilia sp*
16	*Jumping Spider	*carrhotus viduus*
17	Jumping Spider	*hasarius sp*

**Also found in Core area*

Domesticated animals

At some open spaces near the project location, domesticated/ Urban diversity specific animals such as a Stray dogs (*Canis lupus*), and domestic cows (*Bos primigenius indicus*) are common around the proposed project site.

Summary of faunal observations

Number of Bird species observed in the core site: 30

Number of reptile species observed in the core site: 05

Number of amphibian species observed in the core site: 02

Number of Butterfly species observed in the core site: 11

Number of other insects observed in core area: 08

Number of Bird species observed in the 10 km radius: 76

Number of Reptile observed in the 10 km radius: 15

Number of Amphibian species observed in the 10 km radius: 06

Number of Butterfly species observed in the 10 km radius: 40

Number of other insects observed in the 10 km radius: 24

Number of spider species observed in the 10 km radius: 17

Number of Rare, Endangered, Threaten, Near threaten species in the area (As per IUCN red data list): 04

Note- These 4 NT species were recorded in 10 km radius area and it is 5 km away from the actual project site. All these birds are seasonal migratory and the proposed project work will not affect their presence and migratory pattern.

4.11.2 Marine Diversity by NIO

Marine bio-diversity study has been carried out by NIO in Januray 2022 and the report is attached as **Annexure 6.** Summary of the NIO report is as follows.

Prevailing environment

The subtidal studies were conducted. A total of 9 subtidal stations and 6 intertidal stations were sampled. Stations VN1, VN2, VN3 and VN4 were between 2 to 5m depth (nearshore region), stations VN5, VN6 and VN7 were in 10 m contour depth (coastal) and stations VN 8 and VN9 were located in 20m depth (offshore) in the study area

Sediment quality

Sub-tidal stations were mainly dominated by silt and clay. The silt and clay contents varied within a narrow range of 80 - 87% and 11 - 17%. Heavy metals in the study area were lithogenic in origin. These values may be considered as baseline concentration and can be used for post-project monitoring. PHc concentration of sediment from the subtidal study area were low (0.1-1.1 µg/g wet wt.). Organic carbon (C) content of sediments within the region off Vadhavan during December 2020 varied within a close limit between 1.3 and 1.9% (av. 1.5%).

Sediment phosphorous content off Vadhavan ranged between 604 and 784 µg/g (av.675 µg/g), without much difference among different zones, which indicated relatively lower levels of P

Assessment of flora and fauna

Microbiology

The total viable count (TVC) of bacteria in the water samples ranged between 10 x 10^2 to 200 x10^2 CFU/mL. The lowest counts were recorded at station VN1 and the highest counts were recorded at station VN7. The TVC count in the sediment samples ranged between 30 x 10^3 to 100 x 10^3 CFU/g. Total Coliform (TC), Faecal Coliform (FC), Escherichia coli like organisms (ECLO) and Streptococcus faecalis like Organism (SFLO) were recorded only in the water samples.

Phytoplankton

The concentrations of chlorophyll a ranged from 0.2 to 0.7 mg/m^3 indicating less variable phytoplankton biomass in the study area. Nearshore stations showed comparatively higher values of chlorophyll than coastal and offshore stations. The average concentration of phaeophytin ranged between 0.1 and 1.4 mg/m^3. In general, bottom water recorded higher values of phaeophytin concentration compared to surface waters. Phytoplankton population in surface waters were in the range of 10.2 to 127.4x 10^3 cells/ L and bottom between 11.0 and 151.2x 10^3 cells/L. A total of 36 genera of phytoplankton were recorded from the study region, belonging to 4 major taxonomic groups namely, diatoms, dinoflagellates, cryptophytes and euglenophytes. Diatoms formed the most dominant group, comprised of 24 genera. The most dominant genera were Thalassiosira (38.3%), followed by Cylindrotheca (10.5%), Navicula (7.9%) and Nitzschia (5.4%).

Zooplankton

During the survey, zooplankton biomass ranged from 0.4 to 8.4 ml/100m^3 and the population varied between 11.0 and 110.5 x 10^3 . Bothbiomass and population were found high at VN2. There was no significant trend observed in the distribution of zooplankton biomass and population from the study area. 22 mesozooplankton groups were identified from the study area with the dominance of copepods (75.0%) in all the stations. Fish larvae, fish eggs and decapod larvae were observed in all the stations.

Macrobenthos

The subtidal benthic macrofaunal standing stock in terms of biomass and population varied from 0.01 to 1.3 g/m^2 and 25 to 100 no/m^2. The faunal composition indicated the dominance of polychaetes (84.9%), followed by amphipods (12.7%) and mysids (2.4%) in the study area.

Cossuridae (62.6%) was found to be the dominant polychaete family, which was present at all subtidal stations. The intertidal benthic standing stock in terms of biomass and population varied from 0.002 to 162.4 g/m^2 and 25 to 2875 no/m^2. The highest macrobenthic biomass was observed at IT5 and the lowest was at IT1. Polychaeta (53.8%) were the major group followed by Anomura (16.1%) and Amphipoda (11.3%). In total, 11 polychaete families were observed from the intertidal region with the dominance of Spionidae (21.2%), followed by Capitellidae (16.1%) and Orbiniidae (4.2%).

In the Low water region of IT2, the substratum was comprised of solid rocks with intermittent tide pools, fragments of rocks and stones. The tide pools and part of the rock were smothered with cyanobacterial mats and turf algae. At location IT3, macroalgae, Ulva sp. showed a spatial variation and a percent cover between 17.3 ± 24.5%. Other benthic fauna including molluscs, gastropods, and sponges contributed about 0.3%. Low water area of IT4, polychaete worms, bivalves, pseudocorals, crabs and gastropods were present. Midwater region of IT4 macroalgae Ulva sp. were the dominant life form accounting for 32.7 ± 3.5%. Other benthic forms including the pseudo coral Palythoa sp., gastropods and bivalves collectively contributed 0.8 ± 2.9 % to the total benthic community.

Mangroves

The intertidal regions of the Vadhavan area have the distribution of mangrove species of Avicennia marina. Saplings of the Rhizophora sp. were also found in the intertidal regions of Jhoting Bhabha Mandir. A survey conducted by the Institute of Remote Sensing, Anna University during September 2023 describes about 98.25 acres of area in the vicinity of proposed port has been classified under CRZ1A. Mangroves at Tadiyala area were surveyed by quadrat method and the density ranged between 40 and 132 no/100m^2

Fishery

ICAR-CMFRI conducted the fishery survey for the proposed project. During their survey, they recorded the occurrence of a variety of finfishes and shellfishes. Fishes (126 species) including 86 species of teleost, 4 sharks, 20 crustaceans and 13 molluscs were reported from the study area.

Reptiles

No sightings of marine turtles were recorded during the present study period.

Birds

The coastal areas of the Palghar district have different marine habitats, like rocky/sandy/muddy intertidal and mangroves for a variety of resident and migratory birds. e-Bird India has recorded 86 species of birds from the Vadhavan region. The main avian fauna recorded during the current study were Lesser egret, Intermediate egret, Pond heron, Black headed ibis, Black winged still and Plovers.

Marine mammals

Published and confirmed records of cetaceans in the coastal waters of Maharashtra state describes the occurrence of 7 species, including Balaenoptera musculus (Blue whale), Balaenoptera physalus (Fin whale), Neophocaena phocaenoides (Finless porpoise), Sousa chinensis (Indo-Pacific humpbacked dolphin, Sousa plumbea (Indian ocean humpback dolphin), Globicephala macrorhynchus (Short finned pilot whale) and Delphinus capensis (Long-beaked common dolphin).

4.11.3 Marine Biodiversity at Shankodhar Point, Dahanu Taluk, Maharashtra conducted by CSIR – National Institute of Oceanography (June 2023)

The report is attached as Annexure –17. The summary of the report is as follows;

Shankodhar point (19°56’44.78”N; 72°38’14.6”E), is a small rocky patch that remain submerged throughout the year and gets exposed during the extreme low tides. This rocky intertidal area is located ~1 km east of the port limit and this place is of religious significance and attracts pilgrims during a particular day in a year when the tides are negative. Besides, Shankodhar point is also considered to be an ecologically sensitive area due to the presence of diverse group of marine organisms as claimed by the local people.

Sampling was carried for two days on 18/05/2023 and 19/05/2023 during the low tide between 06:30 AM and 08:30 AM. Different species of marine flora and fauna observed on the rocks were digitally recorded and their abundance was estimated within 0.5 sq. m area in quadruplicates. The organisms were photographed using an Olympus digital camera and the photographs were used to recognize the taxonomic identity of the organisms to maximum possible resolution. In addition, the habitat characteristics of the study area was assessed.

Fauna

Molluscs

A total of five different species of Gastropods was recorded and identified from the Shankodhar point of which two species Gyrineum natator, and Indothais sacellum was consistent with the previous report. Additionally, three species, Semiricinula tissoti, Chicoreus maurus, and Trochus maculatus were recorded during the present study. In total, 81 individuals of Molluscs were recorded of which Indothais sacellum was the most abundant species. The density of these organisms varied between 2 and 11 individuals 0.25 m^{-2} with a mean of 6.1 individuals 0.25 m^{-2}.

Cnidarians

Two species, *Paracyathus profundus* and *Pennaria disticha*, under the phylum Cnidaria was recorded during the present survey. As such, no scleractinian corals were recorded over the exposed rocky patches during the survey. The tide pools were turbid likely due to turbid waters and zero visibility and only very few organisms of other phyla were recorded.

Arthropods

Two species of barnacles, *Chthamalus sp.* and *Megabalanus sp.* and one species of crab *Petrolisthes boscii.* was recorded from the exposed rocks in Shankodhar point. The barnacle Chthamalus sp. dominate the exposed rocks and the individuals measured up to 8-15 mm in diameter. The shell of the barnacle *Chthamalus sp.* was grey and brown in color with an operculum that measure 3-6 mm in diameter. The population density ranged between 56 – 70 individuals 0.25m^{-2}.

Only one individual of the crab *Petrolisthes boscii* was recorded during the survey. Multiple species of crabs are likely to be present which couldn't be recorded due to turbid waters inside the tide pools.

Annelida

Two species of tube worms belonging to the genus *Sabellaria* and *Serpula* species were recorded during the survey. The *Serpula sp.* are commonly known as calcareous marine tube worm are sessile organisms belonging to the family Serpulidae. They were abundant and predominantly present in the holes and crevices of the rocks. The density of the *Serpula sp.* ranged between 18 - 34 individuals 0.25 m^{-2}. The *Sabellaria* belongs to the genus of marine polychaete worms in the family Sabellariidae. The tubes of these worms are attached to the rocks especially under the holes and crevices in between the *Serpula tubes*. Unlike *Serpula*, the tubes of *Sabellaria* were composed of sand and broken shells. The population density of the *Sabellaria* species ranged between 6-11 individuals 0.25 m^{-2}.

Marine Flora

Crustose coralline algae (CCA): The CCA occur in patches amidst the *Chthamalus sp.* on the rocks. They are more prevalent on the horizontal surface of the exposed rocks. In general, CCA are the important primary producers distributed over a wide range of habitats ranging from Intertidal rocks, coral reefs, and other subtidal marine habitats. They play a major role in building the reef by cementing together the fragmented corals, rocks and other hard substrates. The presence of CCA over the rocks will attract the settlement of other benthic organisms including the corals.

Figure 94 - Diversity of invertebrates recorded at Shankodhar point, Dahanu. (a)Chthamalus sp; (b) Megabalanus sp; (c) Pennaria disticha; (d) Petrolisthes boscii; (e) Paracyathus profundus.; (f) Crustose coralline algae; (g) Gyrineum natator; (h) Chicoreus maurus; (i) Indothais sacellum; (j) Semiricinula tissoti; (k) Trochus sp. (l) Gastropod egg capsules; (m) Sabellaria sp; (n) Serpula sp.

4.11.4 Biodiversity Study For The Proposed Burrow Pit Region In Arabian Sea by Zoological Survey of India (ZSI)

The report is attached as Annexure –11. The summary of the report is as follows;

The Ministry of Environment, Forests and Climate Change, Government of India has issued the Terms of Reference (ToR) for prior Environmental Clearance for the project in April 2022, and accordingly, all the studies as per the ToR have been completed. The Dahanu Taluka Environment Protection Authority (DTEPA) has granted JNPA permission to establish and develop the Vadhavan port in the Dahanu Taluka on 31st July 2023.

The MoEF&CC Appraisal Committee has suggested the Zoological Survey of India to study the biodiversity at Daman Offshore area (proposed burrow pit), from where the sand to be extracted for port construction. The Zoological Survey of India was also advised to monitor the offshore marine mammal movement and fish aggregation sites if any, along with the study on the biodiversity in the proposed burrow pit in the Arabian sea, off Daman coast.

Location of Marine Burrow Pit for Sand Mining

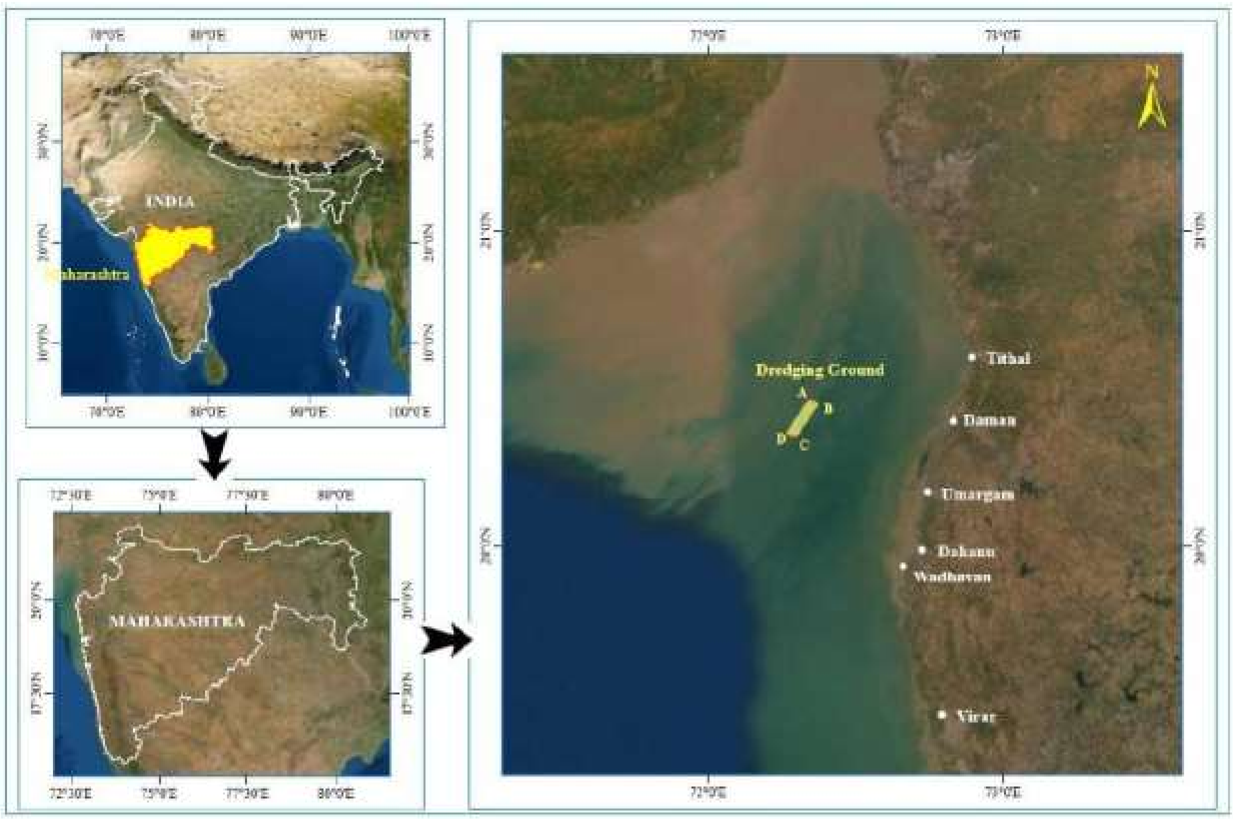


Figure 95 – Location of Marine Borrow pit

The marine borrow pit was identified in the offshore of the Daman coast about 50 km from the proposed port site at a depth varying from 20 m to 25 m. The proposed area falls under Exclusive Economic Zone (EEZ) of India and it stretches from the outer limit of the territorial sea (12 nautical miles from the baseline) out to 200 nautical miles from the coast.

Biodiversity of Proposed Burrow Pit - Faunal composition

Fish: A total of 16 fish species belonging to 16 genera, 13 families and 11 orders were caught by 10 hauls of single-day trawlers. In total, Finfishes (10 species), elasmobranch (six species), shrimps (four species), lobster (one species), crabs (11 species), cephalopods (two species) and other shellfishes (14 species of mollusca) comprised the trawl catch.

Family-wise species richness of fish assemblages revealed that the family Synodontidae were dominant followed by Sciaenidae, Engraulidae, Gobiidae and Carcharhinidae. Finfishes from the trawl catches of the Burrow pit were mainly composed of 13 families constituting of 62 to 94% of the total catch. Synodontidae formed 22-76% followed by Sciaenidae (2-22%), Engraulidae (4-17%), Carcharhinidae (1%) and the rest by other families. The non- commercial catch comprises 3 species of Jellyfishes and one species Squilla and two shrimp species and two crab species which constituted about 7-58% of the trawl catches. Among the catches, *Harpadon nehereus* contributed maximum catch with size ranges 5.5- 58 cm SL. About 68% of catch *Harpadon nehereus* shows mature individuals with ripe ovaries and few trawls caught 2-3% juveniles with size ranges 5.5 to 7.5 cm SL. This indicates the habitat is a nursery and breeding ground for Bombay-duck. Spadenose shark *Scoliodon laticaudus* is a common species of small sized shark in the trawler and dolnet fishery along the west cost of India, especially along Mumbai and Gujarat coast. A large number of juveniles and mature adult animals in the trawling catches were enumerated. The shark gut shows the presence of Bombay-duck juveniles indicates that the area may be used as feeding grounds for Spadenose shark, which is having high withstanding ability against intensive fishing pressure.

Crustacea:

Mantis shrimps: There are four species of Mantis Shrimp i.e. *Clorida bombayensis* (Chhapgar & Sane, 1967), *Erugosquilla hesperia* (Manning, 1968), *Harpiosquilla harpax* (de Haan, 1844) and *Miyakella nepa* (Latreille in Latreille, Le Peletier, Serville & Guérin, 1828) recorded from west coast of India. Mantis shrimp being non-edible, are neglected group although forms a major portion of the catches, mostly while trawl fishing.

However, there were no targeted fishing of mantis shrimp recorded during the surveys.

Prawns/Shrimps: There are atleast 35 species of Decapod Prawns/Shrimps documented from the eastern Arabian sea, belonging to 17 genus and five families. However, among them, five species of shrimps *Metapenaeus monoceros* (Fabricius, 1798), *Metapenaeus affinis* (H. Milne Edwards, 1837) *Metapenaeus brevicornis* (H. Milne Edwards, 1837), *Parapenaeus indicus Crosnier*, 1986 and Parapenaeopsis stylifera (H. Milne Edwards, 1837) are caught for commercial fishing purpose.

Crabs: Among the decapod crabs, there are 70 species reported from eastern Arabian sea, of which predominantly there are mangrove associated intertidal species. However, several species of crabs are also known to occur in the deeper waters and during the surveys, 11 species of crabs, belonging to eight genera with three families have been recorded of which *Charybdis (Charybdis) hellerii* (A. Milne-Edwards, 1867), *Charybdis (Charybdis) lucifer* (Fabricius, 1798), *Portunus sanguinolentus* (Herbst, 1783), *Portunus segnis* (Forskål, 1775), and *Thalamita crenata* (Latreille, 1829) are known to be commercially exploited.

Mollusca: A total of 34 species of mollusca of which 18 species of bivalves belonging to seven families and 17 genera as well as 16 species of gastropods with 11 families and 16 genera have been reported from the project locations. During the fishing operation, four bivalves, eight gastropods and two species of cephalopods (one species of Cuttlefish and one species of Loligo) have been documented.

Echinodermata: A total of 11 species of Echinoderms have been reported with nine families and 10 genera among which three are starfish, one feather star, two sea urchin and five brittle starfish known to occur in the area. However, during the trawling operation, no species encountered during the fishing operations. Nevertheless, considering the sandy-muddy bottom, their occurrence in the burrow pit site is possible.

Avian fauna: A total of 16 species of birds belonging to 16 genera under eight families and five orders were observed during the offshore surveys. Out of 16 species, two species – Gull-billed tern Gelochelidon nilotica (Gmelin, JF, 1789) and Indian Swiftlet *Aerodramus unicolor* (Jerdon, 1840) are categorized in the Schedule- I of the Indian Wildlife Protection Act (2022 amendment) and all the species are listed in the Least concern category of the IUCN Redlist. During the visit to the burrow pit area, three species of birds i.e., Common Tern, Bridled Tern and the Arctic Skua observed very frequently.

Other than the above, there are at least three species of sea turtles (Olive ridley, Hawksbill and Green turtles), eight species of sea snakes and 16 species of marine mammals are reported to inhabit in the eastern Arabian sea. During trawling operation, a pod of 5-8 Chinese White Dolphins *Sousa chinensis* seen in the study area but the sighting was only for few minutes on three occasions on separate dates. Hence, marine mammals may be visiting the project area occasionally as there are reports of 11 species of marine mammals in the eastern west coast of India. All the above species of turtles, sea snakes mammals are protected under the Wildlife (Protection) Act, Amended 2022 of Government of India and are also migratory species known for their upward and download migrations in the Arabian sea and to the Indian Ocean.

Observations

The proposed project location seemed to be a soft bottom habitat and water was too murky with sandy, muddy substratum. During the survey, major catch while trawling in the proposed burrow pit site was Bombay-duck (Harpadon nehereus) fish including that of juveniles and therefore, it is presumed to be fishing site for the species, where they may be feeding and breeding.

September to January is reported to be more productive, adults predominant over juveniles during fishing along the upper west coast of India. Traditional stationary bag net (dol net), Gill-nets, boat seine and trawls are used for fishing.

During the surveys, on an average 10 fishing boats were observed in the vicinity of the study site and these were actively fishing, may be targeting for such fish species in the area.

A total of 51 marine species that comprised finfishes, elasmobranch, shrimps, lobster, crabs, cephalopods, stomatopods and other shellfishes were documented by 10 hauls of day trawlers operated off Daman coast and within the proposed burrow pit. Biodiversity in terms of number of species was in the depth range of 20-30 m and poor representation of the faunal groups indicate that the area in not rich or productive.

The propose burrow pit area is unlikely to be a major fishing ground for commercially viable fishes and shellfishes and in terms of capture fisheries in the Arabian Sea, it is not an important fishing area.

4.11.5 Impact Assessment of Proposed Sand Mining on the Marine Fisheries and Fisher Community of Daman Union Territory by ICAR-Central Marine Fisheries Research Institute, Mumbai Regional Station, ICAR-CMFRI

The report on Impact Assessment of Proposed Sand Mining on the Marine Fisheries and Fisher Community of Daman Union Territory is prepared by by ICAR-Central Marine Fisheries Research Institute, Mumbai Regional Station, ICAR-CMFRI (October 2023). The report is attached as Annexure –13. The summary of the report is as follows;

MoEF&CC in their additional ToR has asked for Comprehensive and dedicated socio-economic studies to be conducted with specific focus on fisherman community both in Dahanu and Daman region considering large scale sand mining that may have an impact on active fishing grounds. Such fishing grounds to be documented by Central Marine Fisheries Research Institute (CMFRI).

The scope of the study from CMFRI is to evaluate the effect of the removal of sea sand on the fisheries composition and socio-economic conditions of dependent local community of Daman based on the available secondary data. Secondary data comprises the published and unpublished data/literature of research organizations/ institutions/ fisheries department related to socio-economic conditions and fishing activities of Daman.

Demography features of Daman

There are six marine fishing villages and five landing centres in Daman. There are 3163 marine fishermen families in the Union Territory (Daman & Diu) of which Daman have 438 families. The total marine fisherfolk population in the Daman is 1990 out of which adult male constitute 39.6 %, adult female 37.6% and children 22.8 %. Among 438 fishermen families, 84.7 % are traditionally into fishing. The average number of families in a village is 73, with 332 persons per village. The average family size is five in Daman district. Females form 47.3 % of the population and female to male ratio is 899 per 1000 males.

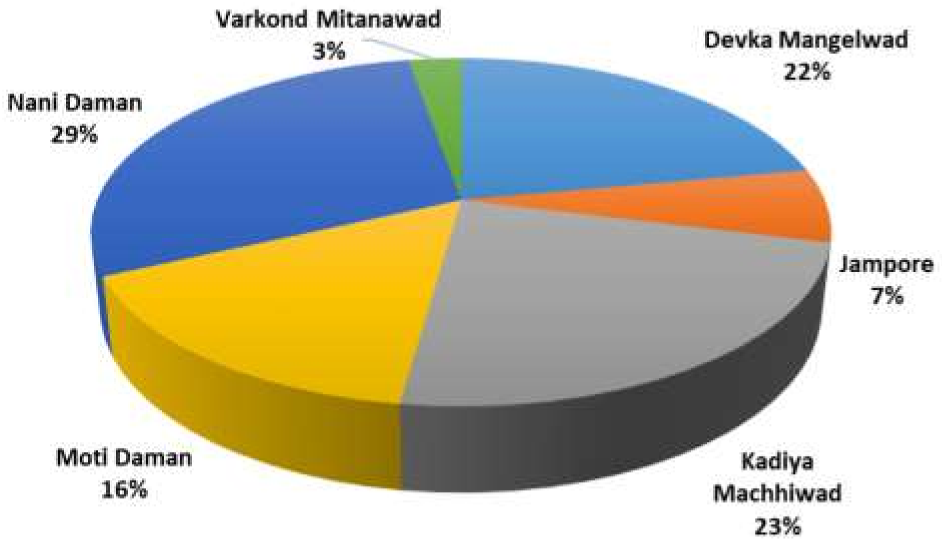


Figure 96 - Fisherfolk population of Daman fishing villages

(Source: CMFRI Report – Oct. 2023)

In Daman, 79% of the eligible fisherfolk are educated with different levels of education. About 35% of eligible fisherfolk have education upto primary level, 54 % have education upto higher secondary level, 10 % have senior secondary level education and 2% are graduates and above. The rest 21% of the population are unschooled.

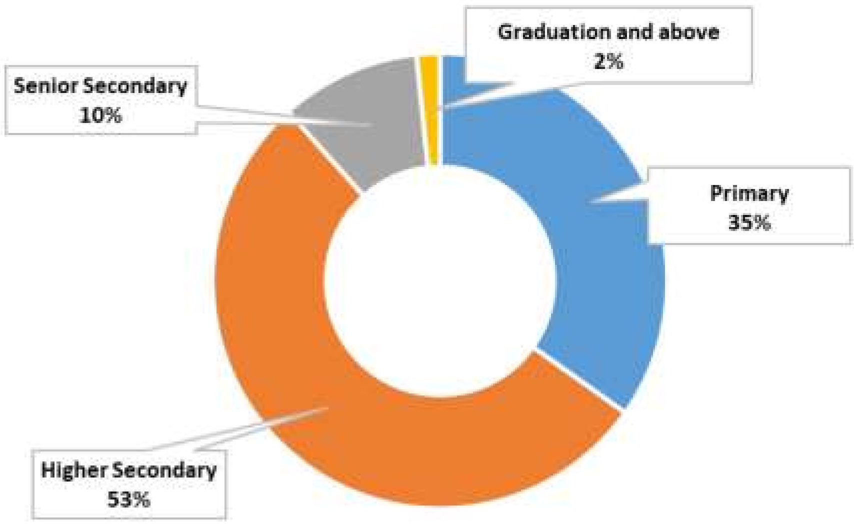


Figure 97 - Education status of Daman fisherfolk

(Source: CMFRI Report – Oct. 2023)

There are about 364 active marine fishermen in Daman of which 96% are full time, 4 % are part time. Among the occupied, 48 % of fisherfolk are engaged in active fishing and 46 % in fishing allied activities and 6% in other areas not related to fishery.

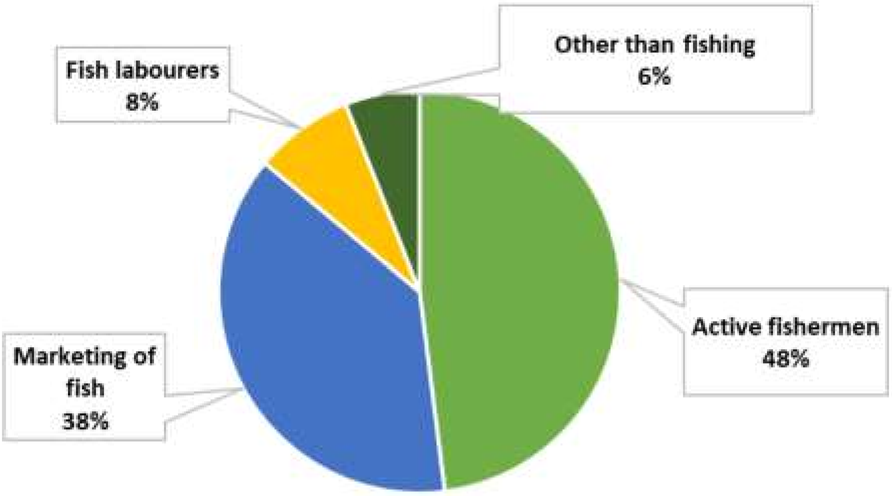


Figure 98 - Occupation profile of Daman fisherfolk

(Source: CMFRI Report – Oct. 2023)

Fisherfolk engaged in fishing allied activities are marketing, making/repairing nets, curing/ processing and labourers. Women outweigh men in fishing allied activities. Among the major fishing allied activities, women dominate in marketing of fish. Among the total families, most of the families (99.8%) belong to Hinduisim, including SC/ST community (4%). Around 30 % of the adult fisherfolk are having membership in co-operative societies.

Infrastructure

In Daman, 98% of fishermen houses are pucca houses and rest are formed by kutcha houses. All the houses of fishermen are electrified in Daman region. All the houses are having drinking water facilities like well, tap, bore well/ hand pump, etc. There are nine primary schools, eight secondary schools, three colleges and four technical institutions in the fishing villages of Daman. All the fishing villages have cellphone coverage and other facilities such as hospitals, post office, police station, cyclone shelters, boat jetties, market facilities, auction sheds, petrol bunks, community centres, cinema theatres, etc are available.

According to Fisheries Department, Daman, there are three known fisheries co-operative societies namely;

1. Matsya Udyog Vividh Karyakari Sah. Society Ltd. , Nani Daman
2. Matsya Gandha Fishing Co-op Society, Nani Daman
3. Daman Ganga Fisheries Society, Nani Daman

Fishing activities and socio-economic conditions

Past fisheries activities in daman coast indicated the presence of more than 130 species of fin fish and more than 30 species of crustaceans. Fishing activities in Daman are carried out by four gears namely trawl net, gill net, bag net and traditional gears.

According to marine fisheries census, 2016 (ICAR-CMFRI- DoF, 2020) there are 170 fishing crafts operated in the five landing centres of Daman, of which 75 are mechanized and 95 are inboard motorized. Trawlers (28) and gill netters (57) are the main craft in mechanized sector. There are no non-motorized craft operating in Daman region, all are operated from Diu only.

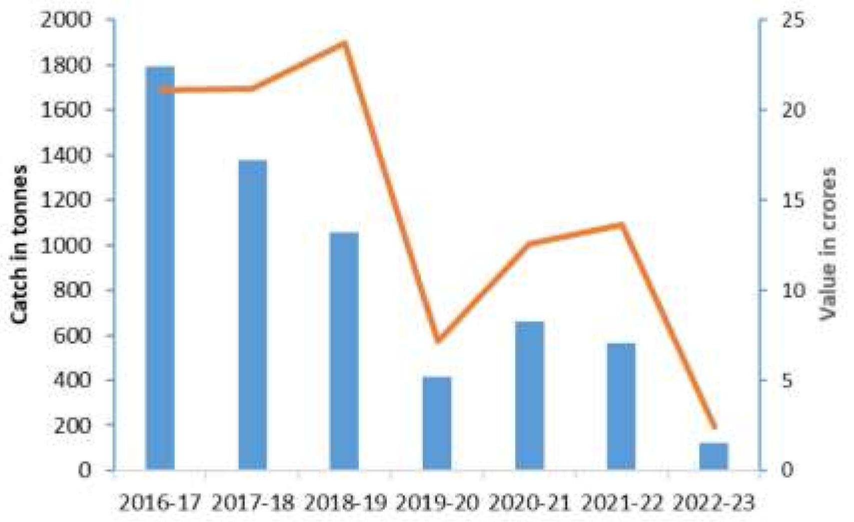


Figure 99 - Marine fish catch of Daman during 2016-2023 (Source: CMFRI Report – Oct. 2023)

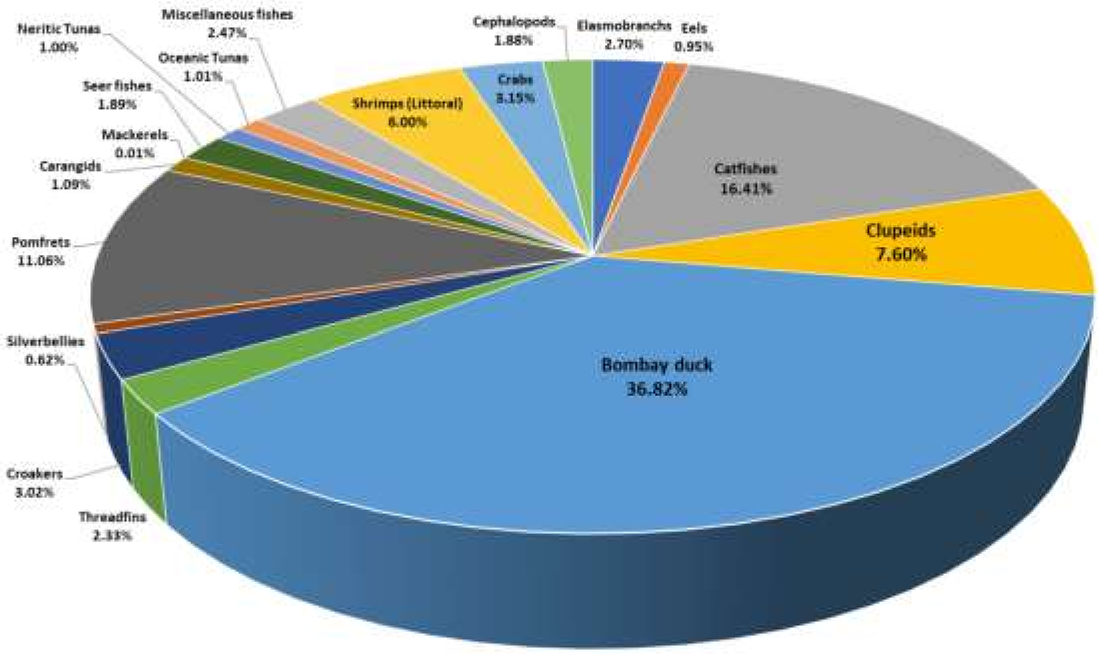


Figure 100 - Percentage composition of major resources of Daman coast (Source: CMFRI Report – Oct. 2023)

Magnitude of the impact due to sand borrowing will be dependent on the mechanism, frequency and the duration of borrowing operations. The removal of sand layer would have an impact on the productivity of the dredged area, which would recover fully over a period of time.

Conclusion and recommendations of CMFRI report

- The offshore sand borrow method is the most environmentally acceptable method of obtaining the required fill material. The site is selected with a view to achieving the smallest and least persistent environmental impact as possible. The method of dredging, the area of dredging and times of the dredging operations have all been selected with this in view.
- Lanka Hydraulic Institute Ltd. (2000) studying in offshore sand mining reported that the impact of removal of 1 m of bed is not expected to create a significant physical impact, the maximum possible impact will be from the temporary raising of the turbidity levels during dredging operations. The loss of productivity in the dredged area will be temporary. The inconvenience and restrictions imposed on small scale fishermen have to be minimized. The distance and depth at which dredging takes place will ensure that this activity will in no way have an impact on coastal stability.
- As the marine borrow pit location far away from the coastal region approximately 50 - 60km with high tidal range and associated strong currents, the concentration of the sediment plume gets weakened immediately during the dredging activity. This was validated by model simulation studies of IIT. The model simulation shows that the turbid plume does not reach the shore. Based on the above scenarios, it can be observed that, the plume trajectory of the dredged sediment does not move towards the coast, and they appear not to cause any impact on the shore and the marine environment.
- JNPA should allocate a reasonable amount of funds to monitor longterm effects of dredging operation on the ecosystem.
- Fishermen affected during the operation period of dredging need to be compensated against the non-accessibility of fishing ground by the fishers. In case of trawl and gillnet fishing operations, diesel cost has to be compensated if they are moving to new fishing ground.
- Guidelines for Management of Marine Sediment Extraction may be followed strictly to prevent any harmful effect on fisheries and their dependent community.
- Proposed mitigatory measures should be followed stringently in order to prevent the impact of dredging activity on productivity and fisheries of proposed sand mining area.

- A number of commonly accepted and proven practices are available for mitigation of specific effects associated with offshore extraction of sand mining. These practices reduce the potential for deleterious/ detrimental effects on the environment of the proposed sand mining area.
- Sea bed at site is completely flat and does not contain any reefs or habitats such as seagrass bed, coral reef etc. as evinced by the detailed bathymetric survey. Zoological Survey of India in its technical report also mentioned that there is no significant nesting/ breeding grounds for any endemic or threatened marine species observed in the proposed sand mining area.

CHAPTER 5 - ANTICIPATED ENVIRONMENTAL IMPACT AND MITIGATION MEASURES

5.1 General

The impacts related to construction are normally short term, which can be off-set to a large extent by observing a set of precautionary measures. The impacts during operation phase are permanent and can be mitigated following environment management plan provided in next section strictly.

All mitigation and avoidance measures are designed or formulated to negate the predicted possible and probable impacts described for all relevant environmental parameters and ecological and physical environmental components. During the whole process the nature, type of the predicted potential impacts likely on the physical, biological and social environmental components are assessed to the extent possible. For the assessment of impacts, the baseline information based on the primary surveys, secondary surveys, field visits and stakeholder consultations relating to various environmental components have been utilised.

This chapter deals with the assessment of project impacts on environment. Mitigative measures are suggested to minimize the likely negative impacts. An environmental management plan is also suggested along with an estimate of environmental costs as an input for evaluation of the economic feasibility of the project.

The project will have impacts of varying magnitude on different environmental components. These impacts could be categorized as-

- Primary impacts, i.e. impacts which occur as a direct result of the project activities
- Secondary and tertiary impacts, i.e. impacts that occur as a result of primary impacts.

Impacts could occur during the construction phase as well as during the operational phase. Impacts during these phases are discussed separately in this chapter.

5.2 Significant Environmental Impacts and Mitigative Measures

In view of the above study, we will sub divide the key environmental factors into 3 groups:-

- In respect of existing status
- In respect of construction phase and
    1. Construction of breakwater and terminals
    2. Dredging and Reclamation

1. Capital Dredging
2. Reclamation and Shore protection bund
3. Disposal of unsuitable material
4. Sourcing of sand from offshore location within 50 km from the port.

3. Quarrying including transportation of quarry materials
4. Road & rail connectivity
5. Port infrastructure
6. Ancillary facilities
7. Residential accommodation and Labour Camp
8. Batching Plant

- In respect of operation phase
    1. Container Termnials
    2. Multipurpose Terminals
    3. RORO Terminal
    4. Other Liquid Terminal
    5. Liquid bulk terminals
    6. Buildings for port use and port users

Project aspects and impacts assessed are:

- Land Environment
- Water Environment
- Marine Environment (Coastal/ Hydrology/ Bottom sediments/ Harbour water quality)
- Air Environment
- Noise Pollution
- Biological Environment (Coastal and Marine Ecology)
- Waste Management

The type and magnitude of the impacts is entirely site specific. In order to logically analyze situation on a probable scale, following standards have been devised for the project under consideration to quantify the impact:

0 = No Impact
1 = Negligible
2 = Mild
3 = Moderate

4 = Significant

5 = Severe

Utility of the above noted qualitative scale is that it can be used as a method to approximately indicate varying order of caution while dealing with different stretches of the project. Each of the negative impacts on the environment requires consideration of mitigative measures. Some of these measures require judicious application of engineering design and construction methodology while others require special techniques. An attempt has been made to indicate the required mitigative measures for each type of identified negative impact.

5.3 Land Environment

5.3.1 Potential Impact due to Port Location

5.3.1.1 Impacts due to land acquisition

There is no land acquisition related to the port terminals and is proposed to be developed on reclaimed land. The port terminals require offshore reclamation of 1227 Ha and nearshore area of 221 ha of reclaimed land (Total 1448 Ha). Whereas, the rail/road connectivity to the port requires land acquisition.

It is estimated that the total land area required by JNPA for Phase 1 development is around 1,162 Ha for port infrastructure. Apart from the port infrastructure, the project also envisages acquiring land for the road and rail connectivity which in total is another 571 Ha; which includes 405 Ha for the road alignment and 69 Ha for the railway alignment and other facilities associated with highway requirements such as service lanes, fuel station and motels etc

Impacts due to Changes in Land Use Pattern

The proposed port is planned to be developed completely on reclaimed land however the Raod/Rail Connectivity will be developed on the landside adjacent to the reclaimed land of the port. An area of about 1162.00 Ha in the sea will be reclaimed for Phase 1 development of port. Most of the land cover of the landside area of the port is covered with trees and negligible builtup area and will be retained wherever possible and the rest will be impacted.

Mitigation Measures - Land Use

The land use of the backup areas may not be changed, and the facilities and other building will be constructed as per the existing landscape without any major cutting and filling and hence will not be impacted. All planning will be in accordance with land scape planning concepts to minimise major land scape changes. Land reclamation and change in land use pattern will be limited to the proposed port limits and will be carried out in such a way that to ensure the proper drainage by providing surface drainage systems including storm water network, etc.

With regards to the road and rail connectivity the change in land use has been depicted in the environmental strip plan prepared using satellite imagery (google image was used). The entire strip of land along a 33.4 km road (120m wide) and 12 km for rail (60 m wide) will be transformed to port owned transportation land. This will not be generally available for the public use.

5.3.1.2 Impacts due to Change in Coastline/ Shoreline

The coastal geomorphology of the Vadhavan coastal area consists of the pocket beaches, rocky coasts, headlands, and bays. There are no habitats/ establishments in the close proximity to the shoreline in the areas adjacent to the proposed port. Therefore, to study the current status/trend of the shoreline change JNPA through CWPRS carried out Assessment of longterm Shoreline Changes in and around the Proposed Port at Vadhavan. In order to assess the impact of the port on the coastline, LITLINE module of LITPAC software was used. The length of the shoreline considered for the studies is 20 km The shoreline under study is between Dahanu and Tarapur. It was divided into 4000 grid points of grid size 5 m. The proposed Port layout was finalized based on extensive mathematical modeling for tidal hydrodynamics and wave tranquility studies was studied for shoreline evolution studies including offshore breakwater of length 10.1 km. The model was run for 1, 2, 4 and 6 years with the proposed breakwater as shown in following figures

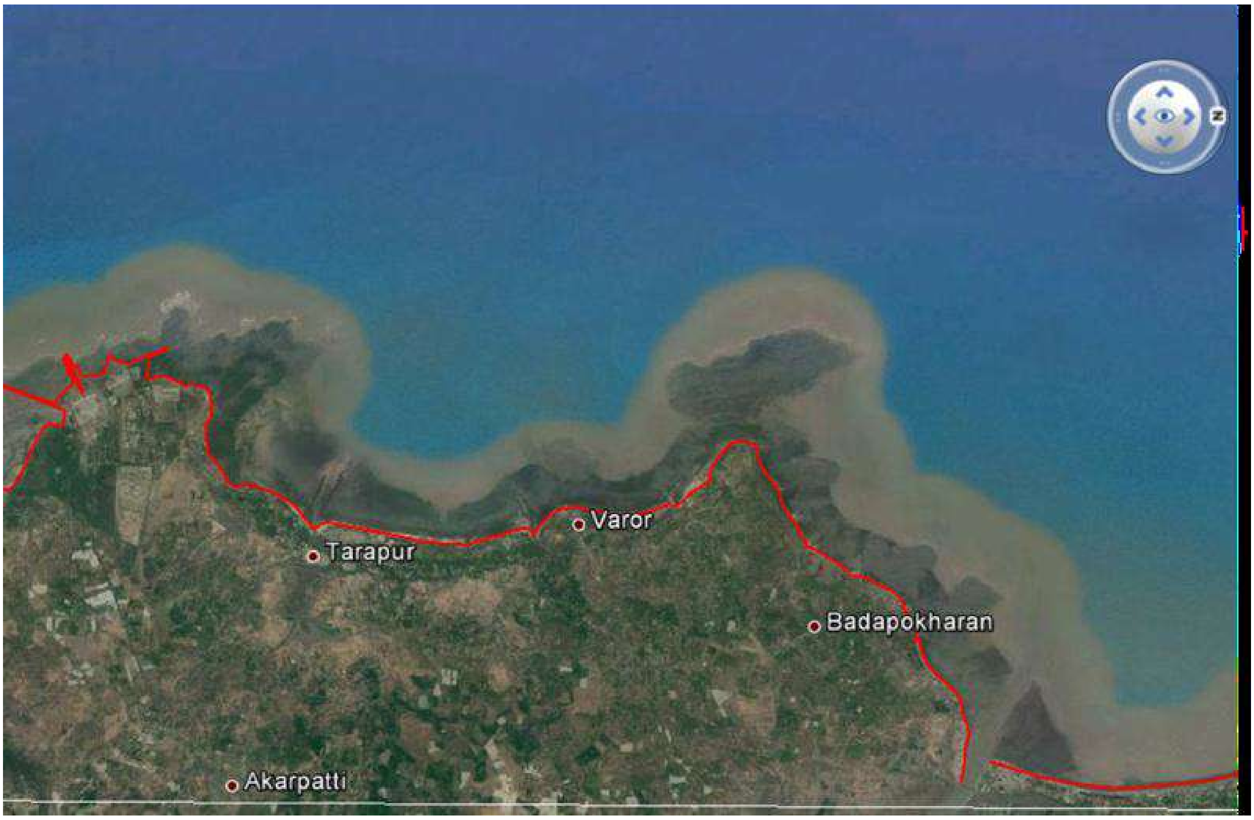


Figure 101 Shoreline Considered For Shoreline Evolution

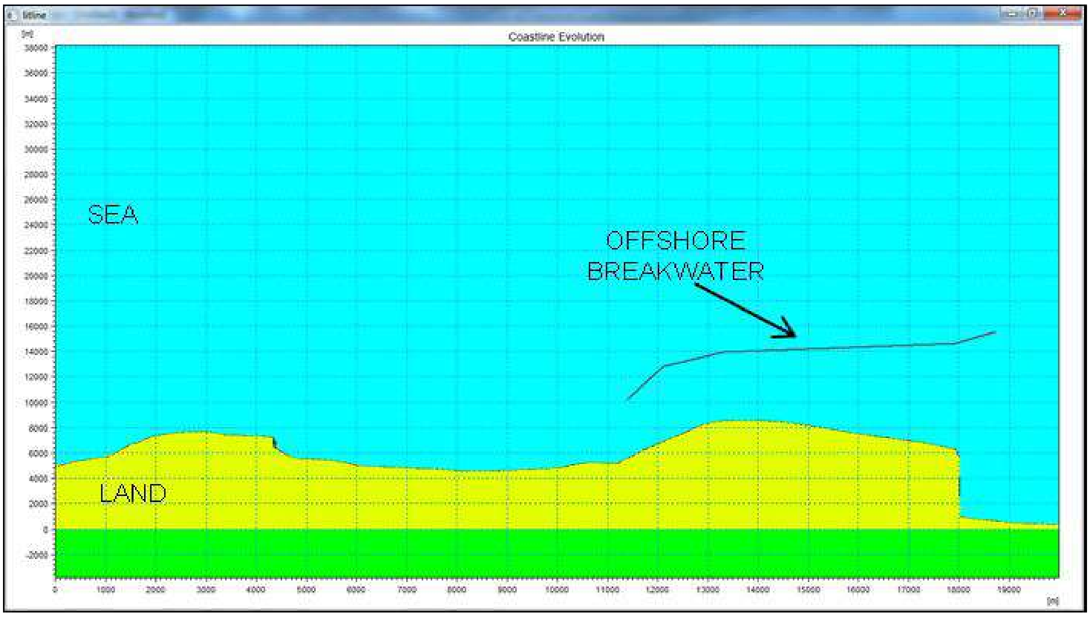


Figure 102 Model Output for Shoreline Evolution

Figure above shows shoreline changes likely to occur after 1, 2, 4 and 6 years. With the proposed breakwater shoreline advancement is negligible.

5.3.1.3 Land Reclamation

Land reclamation will be carried out within port limits. About 177 Million cum of the dredged material will be used for reclamation. Land reclamation with dredged material through capital dredging as well as material sourced from marine borrow pits is likely to impact the reclamation area/site with the turbid water. Predominantly the port land proposed to be reclaimed is intertidal zone which is saline in nature and also low-lying area having slope towards sea. In phase-I, entire dredged material will be used for port reclamation and unusable material will be disposed off in the designated marine disposal location.

To check the suitability of dredge material for reclamation, detailed study on characteristics of dredge material was studied by a marine bore hole study. Analysis was carried out to study the quality of dredge material in terms of toxic metals and in accordance with schedule II of the hazardous waste management rules 1989 as amended. Analysis was done for toxic/ heavy metal concentration in/near the dredging area is given below.

The sediment was found to be sandy in nature with percentage of sand ranging from 97 to 99%. Results of the analysis shown that the concentration of the toxic/heavy metals in the material to be dredged, is within the acceptable concentration limits. Hence based on this analysis, the dredged material can be suitably used for reclamation and any excess material can be safely disposed in appropriately selected offshore location.

Mitigation Measures

Judicial planning of port facility will be carried out. Reclamation bunds and setting ponds shall be constructed, the dredged material will be pumped into the reclamation area enclosed by reclamation bunds wherein the solids will be allowed to settle and the return water will be directed into sea through appropriate return channel/pipelines. The dredge fill will be covered by gravel before hard standing. After completion of the reclamation and hard standing, necessary development shall be carried out.

In order to prevent the seepage of return sea water into the groundwater, suitable impervious liners such as LDPE will be provided all along the return water channel. Also, minimum required retention time of return water in the reclamation area as well as in the return channel will be ensured.

But predominantly the port land proposed to be reclaimed is an intertidal zone which is saline in nature and also low-lying area having slope towards sea. Hence, the impact due to this activity will not be significant. In order to study variations in groundwater quality of nearby villages due to reclamation, regular water quality monitoring will be carried out.

5.3.2 Potential Impacts during Port Construction

During construction phase changes in Land use/land cover may arise, Topography changed. Due to construction activity and Soil compaction, consolidation may cause in loss of vegetation and tree cover, soil pollution and even flooding also. Most of these impacts are short lived and reversible in nature, hence proper care is must to minimize the disturbance so as to the restoration of natural and ecological services.

The Dahanu Taluka has rich floral diversity and seashore also has a thick patch of *Casuarina* vegetation. The *Casuarina* plantation in the areas acts as wind-breaker and as a shield during cyclonic conditions. Moreover, this plantation also protects erosion of the shoreline.

The proposed port is planned on reclaimed land between shoreline to 15 m depth. Thus, no land is required for port development and only activities that require land are road and railway connectivity development. Thus, vegetation clearing will be kept to the minimum. The anticipated impact of the project is soil contamination that may be caused from roadside litter, oil spillage from machinery, sanitation and waste disposal, spillage of hazardous chemicals etc. Any soil contamination will also impact marine water as the site is located in the intertidal region. These details of the impact are discussed in sections below.

5.3.2.1 Impact on Local Infrastructure

During construction phase, significant amount of construction material will be required, particularly quarry stone for the construction of breakwater, bunds, murrum for reclamation, aggregates for berths/ terminals, buildings, other civil works etc. This will be obtained generally by excavating from the quarry sites. It is imperative that these sites be treated, once the excavation of construction material is completed. The ideal measure for treatment is the refilling of these sites to its original level and their re-vegetation.

Currently, there is no road connectivity to the quarries from the nearby roads. New road connectivity from the near road as well as some localized road improvement measures will need to be undertaken near the quarries and near the project site to enable moving of the large quantity of stones by road using truck. The potential quarry areas which have been zeroed in is at Khanivade in Palghar district (about 19 km southeast of Vadhavan). The quarrying of 73.55 million MT in Phase 1 of the project will change the topography of Khanivade quarry region permanently. The final selection of quarry will depend on the EPC contractor.

The following measures will be implemented to minimize adverse impacts on environment during quarrying:

- Quarrying will be done from approved/legitimate quarries to minimise impacts.
- Quarry operations will be restricted to daytime to reduce the impacts from increased noise and will be minimized to reach the threshold levels stipulated by CPCB at the nearest habitations.
- It will be ensured that quarry sites and borrow pits be of a regular shape and if possible, of equal size.
- If possible, their location would be at least 1.6 km away from the nearest habitation.
- Runoff water collected in the lowest pits will be drained into the nearest water body by a drainage system.
- Only rocky outcrops will be quarried and quarrying below the general ground level, surrounding the rock will be avoided.
- Some localized road improvement measures will need to be undertaken near the quarries and near the project site to enable moving of the large quantity of stones by road using trucks.

Borrow Areas

JNPA and the EPC Contractor has to ensure the sourcing of borrow material shall not lead to any potential impact to the local communities

- Borrow pits would be located along the natural drainage course and not across the natural drainage;
- Borrow pits will be in a series, so that they can be inter-connected leading the collected water to the lowest level of the pit, which will be of sufficient size to hold the discharge from the upstream pits. The bottom of each pit will be gently sloped towards the next pit

below in the series and the inter-connections will be done by pipes or open drains filled with broken stone, to prevent scouring of drains;

- Top fertile soil shall not be used for construction material

Transportation of Construction Material

Transportation of quantities of construction material for construction of berths, terminals area, buildings, etc. results in use of public infrastructure like roads, drainage, water and power supply which in turn results in congestion. In order to minimize the strain on the existing infrastructure in the region, JNPAwill take up the construction of road to the port connecting rail and road corridor to the NH 48.

Construction Workers Camp

There will be a requirement of about 7,000 to 8000 work force (excluding service providers) during the construction phase (about 48 months). With regards to the impacts due to construction worker camps, to ensure there is no strain on the existing infrastructure, the worker camps will be self-sufficient and would not rely on any local resource. This would also ensure that there is no conflict with the local population. To mitigate impacts from health hazards, sanitation facilities will be provided. Further, the worker camps will be located away from the coast and habitations.

Mitigation Measures

To mitigate impacts from transportation of construction material, existing roads will be strengthened wherever necessary.

- Temporary approach roads may be developed with prior permission from competent authority.
- Trucks with construction material susceptible for fugitive suspension will be covered with tarpaulin covers.
- Transportation management will be adopted for movement of dumpers transporting quarry stones and construction materials and traffic will be regulated
- Vehicles deployed will conform to emission norms (air/noise) of CPCB and have valid Pollution Under Control (PUC) certificates
- Dumpers and trucks will comply with standards for exhaust emissions and noise levels
- All vehicles used will be in good condition with all valid number plates and documents. Older than 15-year vehicles will not be allowed to use in any of the construction sites

- Worker camps will be adequately equipped with necessary facilities such as water supply, power supply, wastewater collection, solid waste collection and sanitation, fuel supply, etc.
- The contractor will be held responsible to clean all debris before leaving the construction site and also to make necessary arrangements with scrap dealers to sell off the waste scraps.
- The waste from labour camps and administrative activities during construction will all be disposed off through municipal facility.
- Domestic wastes generated from worker camps will be collected properly treated and disposed after complying with the norms stipulated by statutory authorities
- No borewells will be driven to meet the water requirements to avoid impacts on groundwater resources.

If there are any accidental spillages of hazardous substances on soil that may pose the risk of contaminating run off, such areas will be immediately remediated.

5.3.2.2 Impact Due to Road and Rail Corridor Development

A major extent of the planned road and railway alignment is covered with agriculture and barren land. Mostly the fertile agricultural soil will be impacted due to the conversion of land use from agricultural to transportation land.

The development that the proposed road/rail will induce a chain reaction towards change in land use. The change in land use will lead to an increased price of land by speculation and by the time the project materialises the price will be expected to be stabilised. The road, which is flanked by agricultural fields, will witness high price selling of these lands. The positive impact could be the reduced transportation costs and availability of high-class transportation facilities for cargoes.

The terrain in the entire study area is undulating with hillocks. There will be a change in the existing terrain features due to construction of rail and road connectivity.

Also, for road and rail connectivity the clearing and felling activities will lead to erosion of fertile soil. However, the alignment is proposed such that minimum felling activities can take place.

Compaction of soil will occur in the pre-construction stage (particularly during site clearance) due to movement of heavy machinery and vehicles. Transplantation of big trees in the acquired area if carried out shall involve very heavy machinery to uproot trees and haul them to the site of transplantation. Similarly, compaction will take place during setting up of construction camps and stockyards. However, this impact is applicable only till the end of short construction period. Compaction shall occur beyond the rail carriageway and within the vegetated area of the RoW by the movement of vehicles and heavy machinery.

Contamination of soil in the pre-construction stage may be considered a short-term residual negative impact. Soil contamination may take place due to solid waste contamination from the labour camp set up during pre-construction stage. This impact is normally significant at locations of construction camps; stockyards, hot mix plants, etc. However, since the road project size is too small, no such potential impacts anticipated. Contamination of soil during construction might be an important longterm residual negative impact. Unwarranted disposal of construction spoil and debris will add to soil contamination. This contamination is likely to be carried over to water bodies in case of dumping being done near to water body locations.

In regards with the road & rail corridor, the following criteria were adopted for identification of the suitable rail corridor alignment: Here avoidance was the main criteria used for mitigation of major impacts.

Minimum connecting distance to existing as well as proposed road and railway line

- To avoid passage through habitations, sensitive places such as hospital, school and places of worship
- Minimum crossings at canals and rivers
- Minimum land acquisition and minimal R&R
- Future expansion possibilities

Impacts to Ambient Air Quality: During the construction phase ambient air quality along the adjacent villages may get disturbed due to various construction related activities such as:

- Site clearance and use of heavy vehicles and machinery for construction activities
- Transport of raw materials, borrow and quarry material to construction site
- Earthworks
- Handling and storage of aggregates
- Asphalt mixing plant operations

These activities mainly generate dust and emissions such as CO, SO_2, NOX from construction machineries and also due to other vehicular movements during construction. During the operation phase the anticipated impacts on Air quality is due to the movement of vehicles used for transportation of cargo and transportation of other materials.

Impacts to Ambient Noise Level: During construction phase, there will be an increase in the Ambient Noise Levels due to the various construction activities and use of the large number of heavy machineries. However, these construction phase impacts are short term in nature, realised in the immediate vicinity and will cease upon completion of construction. This will occur along the construction corridor as well as at the secondary sites which include construction camps, asphalt mixing plant etc. During the operation stage, incremental noise level will be due to the increased traffic volume and cargo movements.

Impacts to Water Quality: During construction phase, anticipated impacts are due to spillage of construction materials such as cement, POL, bitumen, etc., falling into the water bodies and drainage channels from workshops, construction camps etc. During construction phase the natural drainage system may get disturbed and reduction in the capacity of the natural stream may occur. Runoff from the construction sites and labour camp can increase the risk of pollution in the natural watercourse if not handled properly. During operation phase, degradation of water quality during normal operations is not anticipated. Spillages, if any, can impact the water quality. Also, the entry of vehicles to streams/nallah/rivers for cleaning could be an impact during operation phase. Surface runoff will be expected due to paved surface.

Impacts to Land Use: The proposed road/rail alignment will traverse mostly on the agricultural/ barren land. During the construction stage, accidental spills of fossil fuel and other hazardous material can increase the risk of soil pollution. Contamination of soil may also take place due to solid waste generated from labour camps. Soil compaction will take place due to the movement of heavy vehicles and other vehicles. During operation phase degradation of soil quality during normal operations is not envisaged. Spillages if any can impact the soil quality.

Ribbon Development: The new port connectivity road of 33.4 km could trigger massive ribbon development if not carefully planned that could not only geo paradise the security of the port but also will bring in an ugly look to the new infrastructure.

Mitigation Measures

Mitigation measures to address adverse impacts on the air quality, noise quality, water quality, soil quality and land environment are listed below:

- Asphalt plants and RMC plants, crushers will be sited at least 1.0 km in the down wind direction of human settlement along the rail corridor.
- During and after compaction of the sub grade, water will be sprayed at regular interval in order to avoid fugitive dust generation.
- Vehicles carrying fine and coarse aggregate shall be covered with tarpaulin in order to avoid the spills.
- Pollution Under Control (PUC) certified construction machinery and equipments will be used and checked at regular intervals.
- Tree plantation along the Right of Way (RoW) also will act as a major sink of pollutant due to the plying vehicle through corridor.
- Ambient air quality will be monitored at regular intervals during construction and operations phase of the rail corridor.
- During the operation stage, dust generation will be minimum because most of surface will be covered by paved shoulder.
- Regular maintenance of the road, during the operation phase will reduce any negative impacts to an absolute minimum.
- Timely vehicle maintenance and use of unadulterated fuels shall be ensured.
- During construction, noise levels will be maintained below threshold levels stipulated by Central Pollution Control Board (CPCB) by selecting appropriate equipment, machinery and using enclosures.
- Procurement of machinery / construction equipment will be done in accordance with specifications conforming to source noise levels less than 75 dB (A).
- Well-maintained construction equipment, which meets the regulatory standards for source noise levels, will be used.
- Personnel exposed to noise levels beyond threshold limits will be provided with protective gear like earplugs, muffs, etc.
- Ambient noise levels will be monitored at regular intervals during construction and operations phases of the rail corridor.
- During operation phase noise levels will be significantly less because of smooth paved shoulders and presence of trees along the RoW.

- Noise attenuation will be practised for noisy equipment by employing suitable techniques such as acoustic controls, insulation, etc.
- Construction along the water courses will be carried out in the lean flow periods.
- Water especially groundwater will not be extracted from the local resources. Requirement of the water will be met from the ample available resource.
- Construction site will not be sited nearer to the surface water or groundwater resources.
- Control of the access of Vehicles to the water bodies will be ensured.
- Road safety will be strictly ensured to keep the accident quite low.
- Water quality will be monitored at regular intervals during construction phase of the project.
- All the topsoil up to 150 mm shall be blended with other barren land where applicable to convert into arable cultivable land and will be utilized for landscaping along the corridor.
- Restriction of the movement of vehicles and machineries in the cultivable land.
- Soil quality will be monitored during construction and operation phase of rail/road corridor.

5.3.2.3 Impact on Soil and Geology

Compaction of soil during construction of site roads, lay down area and temporary site offices; Erosion of unconsolidated, exposed and stockpiled soils during a monsoon period; Disturbance and dispersion of soils due to movement of construction traffic and equipment over unsealed tracks and exposed, unconsolidated soils; Contamination of soil due to spills or leaks of fuels, lubricants and / or chemicals stored and used on site; Contamination of soil due to leaks from wastewater; Contamination of soils due to poor storage and management of solid and liquid wastes prior to disposal; and Contamination of the soils due to leaks of fuels and lubricants from construction vehicles and plant (e.g. concrete batching plant).

These impacts might be permanent if not remediated.

The quarry area will require clearance from vegetation, as well as the execution of excavation works using heavy equipment. In addition to the quarrying activities inappropriate construction practices and soil protection measures may induce or accelerate erosion, leading to soil instability and landslides in hilly areas. Furthermore, contamination of soils may occur as a result of spillage of fuels, lubricant chemicals, sanitary wastewater, etc., as well as from leakage from inadequately protected solid waste storage facilities and sites.

Mitigation Measures - Geology and Soil

- Proper planning of works and work design (avoid some works in rainy season), to avoid or minimise erosion.
- Early establishment of cut-off trenches, storm water velocity inhibitors and comparable measures;
- Planting of vegetation on barren and/or sloping surfaces.
- Vegetation clearance shall be confined to the minimum area required for the project.
- Re-plantation shall be taken up followed by construction in another identified area.
- All the waste has to be collected and nothing to be dumped on land or water.
- Channel runoff from hardened surfaces to well designed and properly maintained drains.
- Special care should be taken not to cause spreading of erosion material over the non-project areas.
- Minimising areas that are cleared for construction.
- Collection of sewage/solid waste/construction wastes.
- Sewage/solid waste/construction wastes should be treated and disposed or sold to authorized recyclers as per the MoEF guidelines.
- Minimising areas that are cleared for quarrying.
- Solid non-hazardous waste to be transported to and dumped in a dedicated landfill in the area.
- Quarries generate large volumes of waste. Structures such as waste dumps and containment facilities should be planned, designed and operated such that geotechnical risks and environmental impacts are appropriately assessed and managed throughout the entire quarry cycle.
- In addition, proper sanitation facilities and bins should be provided in the quarry area for collection of sewage/solid waste.
- Hazardous waste should be handled by specialised providers (in accordance with regulatory permits) of hazardous waste management facilities specifically designed and operated for this purpose.
- Hazardous materials should be handled, stored, and transported so as to avoid leaks, spills or other types of accidental releases into soils, surface water, and groundwater resources.
- Possible dump of quantities of overburden or waste rock should be well managed in a way that protects human health, safety and the environment.

- Proper environmental operating practices should be assured through regular inspections and audits of the quarries.
- Proper planning of works and work design to avoid or minimise erosion in the quarries.
- Planting of vegetation on barren and/or sloping surfaces.
- Special care should be taken not to cause spreading of erosion material over the area.

5.3.3 Potential Impact during Operation

During operation phase, soil pollution may happen if solid and liquid waste not managed properly. Flooding may happen if drains are not properly maintained. The details are discussed below.

5.3.3.1 Discharges from Ships on Land

No discharge of wastewater/waste from the ships calling at Vadhavan port will be permitted into the port area. Facilities for discharge of waste oil will be provided at the port. The ships will have their own sewage reception/treatment facilities on board and hence no discharge of sewage will be done at the port. In addition, the ships are expected to discharge sewage in deep seas as per defined procedures for International ship movements. This will ensure the ships have their own storage capacities in their on-board sewage receptions to handle wastes generated during the period/days the ship is at the port. Ships shall conduct ballast water exchange at least 200 nautical miles from nearest land and in water at least 200 m in depth prior to calling at a port. Where ballast water exchange at 200 nautical miles to nearest land is not possible, exchange should take place at least 50 nautical miles from nearest land and in water at least 200 m in depth. Each ship shall have on board a ballast water record book which may be an electronic recording system. Port officers may inspect the ballast water record book.

5.3.3.2 Impacts due to Changes in Coastline/Shoreline

Coastal structures like a breakwater or a groin, when introduced into the sea interrupts wave and current induced littoral sediment transport in the direction of flow. The obstruction of sediment transport leads to sediment built-up and acts as platform for evolution of shoreline. The coast downstream of obstruction has deficit sediment supply thereby leading to erosion. These aspects are studied individually in the context of proposed developmental activities which is detailed in the following section.

For estimation of change in the coastline, the results show that the change in the shoreline due to the construction of Vadhavan is negligible. Model output for shoreline evolution after construction of breakwater is shown in figure below. Studies for simulation of shoreline changes indicated that the construction of proposed offshore breakwater of 10.1 km length will result in negligible deposition of sand behind the breakwater and will have negligible impact on the adjacent shoreline as well.

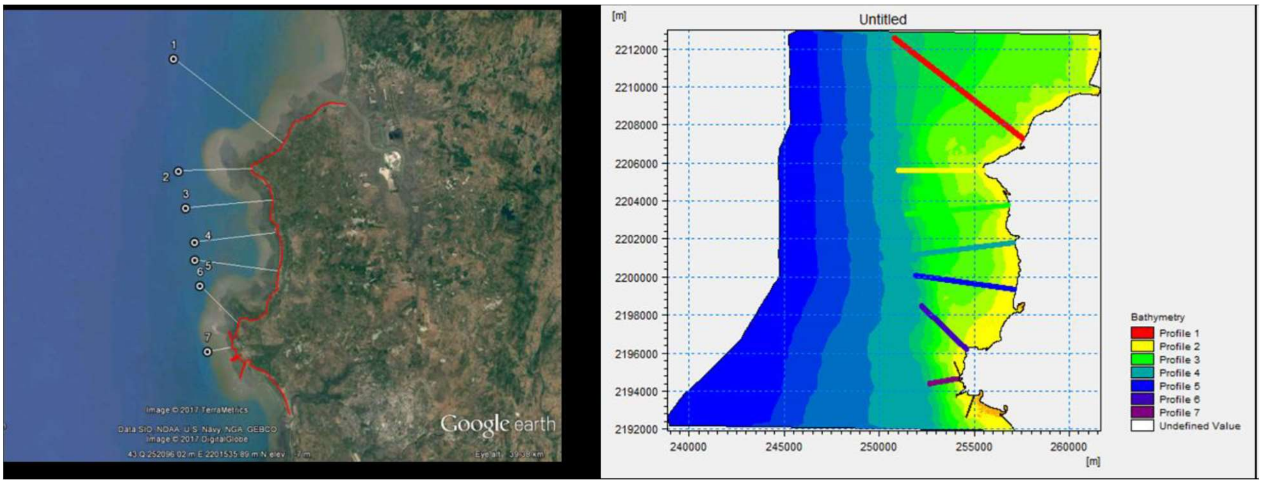


Figure 103 Cross shore profile locations

Table 140 Littoral Transport Rates (m^3) at the cross profiles

Profile No.	Northward	Southward	Net	Gross	Drift Direction
P1	102,950	50	102,900	103,000	North
P2	70,630	1,410	69,220	72,040	North
P3	104,750	3,450	101,300	108,200	North
P4	79,610	3,440	76,170	83,050	North
P5	130,850	1,350	129,500	132,200	North
P6	46,450	0	46,450	46,450	North
P7	32,625	1,815	30,810	34,440	North
P8	32,805	25	32,780	32,830	North

'-ve' Southward, '+ve' Northward for Net Drift

SHORELINE CHANGE ANALYSIS BY NCCR

Shoreline change analysis is carried out for long term (1973 to 2023) using Landsat-MSS (60 m), Landsat-TM (30 m), ResourceSat-I LISS-III (23.5 m), CartoSat-1 PAN (2.5 m), ResourceSat-II LISS-IV (5.8 m) and Sentinel-2A (10 m) satellite images.

The baseline layer was generated with a buffer distance of 300 m landward from the oldest shoreline, and seaward transects (perpendicular lines) were generated at every 20 m interval along the coastline. Shoreline change statistics is evaluated using the approaches in Digital Shoreline Analysis System v.4.0 (Thieler et al. 2009): Long-term (1973 to 2023) analysis calculated using the weighted linear regression (WLR) method which considers the uncertainty field to calculate the rates of shoreline change. A shoreline change assessment was carried out for long term (1973–2023) period to understand the changes on the shoreline. The rate of shoreline changes from 1973-2023, signifies that among the study area of 10 km, 2.06 km (20%) of the coast and, 0.34 km (4%) were observed to have moderate and high erosion during the 1973-2023 period.

Table 141 Estimation of Shoreline Change Analysis for 1973-2023

Shoreline Change Analysis (1973-2023)		
Status	**Long term**	
	Length (in km)	**%**
High Accretion	0	0
Moderate Accretion	0	0
Low Accretion	0.12	1.2
Stable	1.2	12
Low Erosion	6.36	63
Moderate Erosion	2.06	20
High Erosion	0.34	4
Total	**10**	**100**

Figure 104 Shoreline Change Analysis of long term (1973 - 2023)

OUTCOME & CONCLUSION

1. The maximum significant wave height in the port basin is 1.0m in the Final Master Plan Layout as compared to 2.5 m height offshore. Due to the presence of offshore breakwater, blockage of sediments along the coast is not anticipated. However, there could be a possibility of the formation of a salient behind the proposed port, which needs to be monitored.

2. The Tidal Hydrodynamic and Siltation study finalized the Master Plan Layout for favorable operation and maneuvering conditions with minimum effect on the morphology. The maximum current strengths at container terminals are within 0.15 m/s and flow approaches at an angle varying between 4° and 7° along oil berths and Other Liquid terminals. These hydrodynamic conditions allow the bypassing of sediments towards the North of the port area.

3. The shoreline morphology study reveals that a net transport of about 0.07 Mm^3 is transported just North of the proposed port area. Although Northerly transport is not fully hindered, maintenance dredging of the port can be utilized for nourishment in the North of the port. A minimum of 0.15 Mm^3 of sand shall be used for nourishment of the North which will be dredged from the port basin as a part of maintenance dredging.

4. The littoral drift and shoreline evolution comparing the original shoreline and proposed port indicates an insignificant effect on the adjacent shoreline.

5. The shoreline change analysis by NCCR suggests that a stretch of 2.4 km of the study area is in a moderate to high erosion state for long-term analysis. The construction of the port breakwater is likely to reduce erosion in the south.

5.4 Water Environment

5.4.1 Potential Impact Due to Port Location

Daily water demand for the Phase 1 development is estimated to be around 6.8 MLD. Out of this the potable water demand is 4.9 MLD which will accommodate the requirements for the port personnel, township with balance being the raw water.

As indicated in Chapter 2, the source of water shall be mainly from Kewadas reserviour. The plan is for drawing 15MLD of water from Kewadas reserviour and to treat the same at a treatment plant located at Vadhavan

5.4.2 Potential Impact Due to Construction

5.4.2.1 Surface Water

Based on the preliminary assessment, the daily demand for potable water will be around 1.8 MLD in the construction phase. The state water supply board (MJP) has confirmed that the Kewadas reserviour has ample space capacity of water for withdrwal for the port project apart from the supply to the local population. So, Vellayani lake is the source of water for construction phase.

Litter and construction waste carried by wind, dewatering runoff or periodic rainfall, effluent and fuel through accidental spills, inadequate storage and management, vehicle wash down and overuse of water for site road wetting.

There are a number of activities associated with construction of the proposed Project, which could have impacts on surface water:

- Poor control of run-off from site activities leading to siltation and eventual blocking of drains caused by excessive sand and silt in the storm water run-off.
- Pollution of surface water caused by improper handling and disposal of other types of construction site wastewater
- Contamination of surface water sources if wastes and wastewater from labour camp not managed properly
- Blockage of the creek by the reclamation or otherwise by solid structures may lead to ponding in the area behind the actual Port. The design should therefore cater for a free flow of the discharge water, even in the wet season
- Surface water regime may be altered due to potential changes to the drainage pattern.
- Water pollution may result from wastewater produced by the quarry activities and by the accidental spillage of fuel, lubricants and other chemicals used in the quarry process.

Mitigation measures

- Project Water Management Plan should be developed in order to secure the project sustainable water balance and in the project region in the construction phase, including as main water source the Kewadas reserviour and other artificial water sources in use as of today.
- A surface water monitoring program shall be implemented during the construction phase.
- Effective water conservation measure should be followed.
- Implementation of rainwater harvesting/ storm water management in the project region.
- Providing water and wastewater treatment facilities at construction camp.
- Regular monitoring of surface water for quality and quantity water needs should be limited through recirculation and reuse, implementing closed-circuit systems from sedimentation ponds to the quarrying process.
- Storm water should be separated from process and sanitary wastewater streams in order to reduce the volume of wastewater to be treated prior to discharge.

5.4.2.2 Groundwater

There are a number of activities associated with construction of the proposed project, which could have an impact on groundwater:

- Spillage or infiltration of oils, fuels and hydraulic fluids from plant maintenance and refuelling areas into the soil.
- New drainage structures due to the quarry activities might affect groundwater levels and quality.
- Where blasting is used in quarry, there is a potential for infiltration of nitrate and ammonia residues, in groundwater. This should be managed through appropriate blasting design and procedures, including ensuring the correct burning of explosives.

Mitigation measures

- Baseline review of the existing groundwater resources and current consumption in the project region.
- A study should be initiated to investigate the change in hydro-geological conditions, the available aquifers and safe yield levels.
- A groundwater monitoring program should be implemented during the construction phase.
- When (deeper) aquifers are exploited, the phreatic aquifer should not be affected.
- In addition, a water quality monitoring programme should be developed.

5.4.2.3 Impact on Marine Water Quality

Impact due to Stagnation of Wastewater in Harbour

Breakwaters and landfills may change current patterns and cause stagnation of water behind the structures. If domestic or industrial effluent flows into a port, stagnant port water may deteriorate through a dramatic increase of phytoplankton and a decrease of dissolved oxygen, resulting from eutrophication of water, caused by effluents containing nutrient salts. Anaerobic water leads to the generation of Hydrogen Sulphide (H2S) and can be identified by its odour. It has serious effects on organisms.

Mitigation Measures

The wastewater and sewage generated during construction at site and at labour camp will be collected in holding tank and periodically transferred to nearby Sewage Treatment Plant (STP). In case of non availability of nearby STP, septic tank with soak pits is recommended during construction phase.

Regulations on discharges of effluents into water and provision of sanitary treatment facilities are indispensable for reducing pollutants from hinterlands. In a polluted bay or port, it could be effective to dredge or cover contaminated bottom sediment capping to reduce the flux of pollutants from the sediment to the water.

Surface run-off from the construction site should be discharged via sand/silt removal facilities such as sand or silt traps and sediment basins. Channels, earth bunds, or sandbag barriers should be provided on site to direct storm water to such silt removal facilities.

Special provision will be made to select Contractor with proven ability in implementation of EMP provision for a contractor's wastewater management plan will be incorporated.

5.4.2.4 Impact due to Land Reclamation/Wastewater Generation

Generally, reclamation of low lying areas with capital dredged material is likely to affect groundwater quality due to intrusion of sea water. The proposed port is predominantly to be developed on reclaimed land and is separated from any crop land. Also, partly the port land proposed to be reclaimed is an intertidal zone which is saline in nature. The slope of port site is towards the sea and chances of intruding sea water into groundwater are envisaged to be negligible. Hence, no significant impacts are anticipated due to land reclamation on groundwater.

Mitigation Measures

Return seawater quality from the reclaimed area shall be monitored during reclamation phase. Groundwater quality of nearby villages will be monitored during construction phase.

In general, an adequate drainage system will be provided at the site with separate collection streams to segregate the storm run-off from roads, open areas, material storage areas, vehicle wash water and other wastewater streams. Suitable measures will also be taken to prevent the washing away of construction materials into the drainage system.

Contaminated storm water will be collected and conveyed to sedimentation tank for removal of grit.

5.4.2.5 Road & Rail Connectivity

Due to several intrusive rocks and other hard rock and recent rock formations the geology and hydrogeologiacl aspects need to be studied very closely to ascertain the water resources especially groundwater.

During Construction Phase

Water requirement will be moderate for proposed road construction as the entire length of the road. The peak water requirement for construction phase for roads could be a maximum of 10 m^3/day. This will not lead to any resource depletion in the area especially when the road itself is located along a water rich valley area. Both road and rail alignments passes through lineaments. (Lineaments are subsurface fracture zones which are usually good aquifers due to the several kilometres of linear connection to fractures in hard rock area).

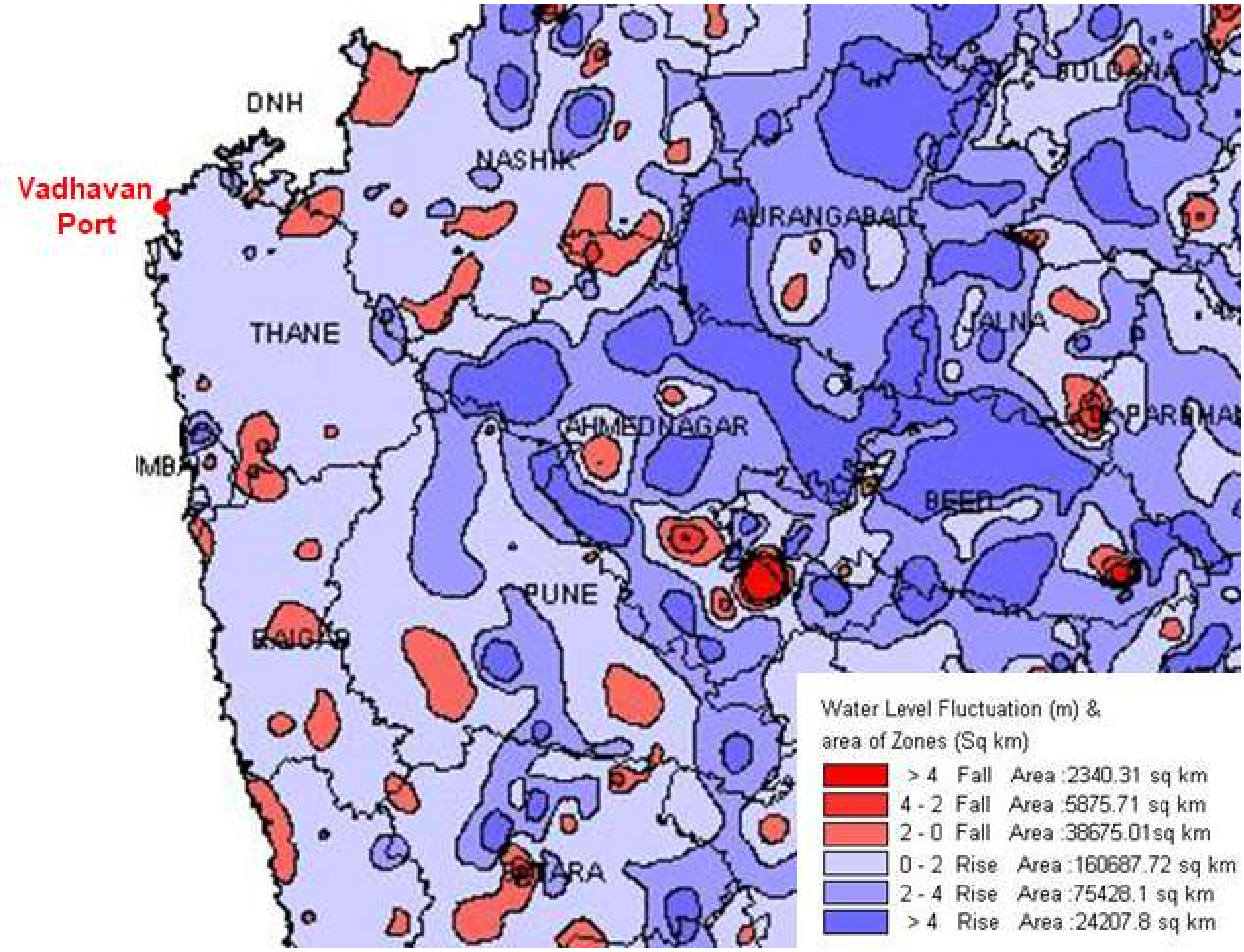


Figure 105 Exploitation of Ground Water in palghar district (2008-2019)
Source: Ground Water Yearbook Of Maharashtra And Unionterritory Of Dadra And Nagar Haveli (2019-2020)

The above figure indicates that the ground utilisation is well within the limits and infact rise in the water table has been noticed upto 2 m within the project region.

5.4.3 Potential Impact during Operation

5.4.3.1 Impact on Water Quality due to Cargo Operations

Since the proposed port is container, liquid and multipurpose port and no dusty cargo /dry bulk Cargo such as Coal and Iron Ore etc. will be handled at port and hence direct impact on water with cargo handling will be insignificant. Marine water may get polluted as a result of releases of contaminants, if any into the marine system including. The leakage/ spill of oil in port and its surrounded area will impact water quality.

Mitigation Measures

- Treated water will be discharged into sea water after meeting marine discharge standards prescribed by MoEF.
- Port operators should prepare a Spill prevention, control, and counter measure plan consistent with the IMO Manual on Oil Pollution Section II – Contingency Planning.
- All ship related waste with a potential to cause pollution to the marine environment should be disposed off according to the guidelines stipulated by the MARPOL Convention.
- Port authorities will apply appropriate procedures, in agreement with National and international regulations, for the handling and storage of hazardous cargoes and waste generated by handling and storage of this type of cargoes.
- Ships used for the project should be registered with ISH seaweb or a similar shipping register, obeying all international maritime conventions such as MARPOL.
- Good operational practices such as good positioning and protection of (fuel) stores, use of drip trays, proper maintenance of plant and equipment.
- Careful storage and usage of fuels, oils (and chemicals).
- Consider whether fuel storage is needed on-site, how much is to be stored and how.
- Check whether sub-contractors have adequate fuel storage facilities.
- Fuel and oil stores must be located away from the site drainage system and the shoreline. If this is not possible, ensure adequate measures are identified to prevent or contain any spillage (e.g., blocking drainage points).
- Oil and chemical-handling facilities will be located with consideration of natural drainage systems and environmentally-sensitive areas.
- Hazardous materials storage and handling facilities will be constructed away from active traffic and protect storage areas from vehicle accidents.
- Fuel dispensing equipment will be equipped with – breakway

- Hose connections that provide emergency shutdown of flow should the fuelling connection be broken by movement.
- All ancillary equipment (e.g., valves, hoses) should be contained securely within the bund when not in use.
- Ensure that tanks are correctly marked/labelled as to their contents and capacities.
- Keep a store of spill response equipment at the fuel facility and bowsers.
- Standard operating procedures that reduce or eliminate the chance of a spill, even in the case of equipment failure.
- Routine maintenance and testing schedules should be determined for all aspects of port operation particular attention paid to product storage and handling, and fuel transfer systems.
- General awareness of all workers should be increased through training and safety meetings with focus of Environmental Management systems and practices with "Zero Waste Tolerance" planned with an objective of achieve as much as we can.
- Port operator should be required to develop system for holding and collecting storm water runoff and surface runoff produced by site activities and its treatment before discharge.
- Wastewater should be treated up to the standards for discharge (Prevention and Control of Pollution) Act 1974).

5.4.3.2 Road & Rail connectivity

In general, the fully operational port with its entire infrastructure is going to build further pressure on the water resources due to the tourists and other port staff and traders dependency.

Road Alignment - Impacts: Travellers/tourists people have the habit of throwing waste material into the water bodies.

Rail Alignment - Impacts: The only major planned cargo for evaluation is containers. Other than the containers, the liquid cargo terminal is planned for this port. Therefore, some spillages are expected from either the liquid terminal as well as the incoming or outgoing container traffic.

Mitigation and Enhancement Measures

In order to avoid the littering of waste material into the water bodies / nallah; it is recommended to put out of sight the exposure of the water bodies from the road user by constructing a protective wall along the sides of the bridges / culverts. In addition to the proposed function, the protective side wall will also serve as noise barrier.

Rail Alignment: Although not directly impacted, retaining wall will be proposed to prevent seepage at any water body location. This will arrest any possibility of drying up of the water in the pond.

5.5 Marine Environment (Coastal Hydrology/ Bottom Contamination, Sea/ harbour water quality)

5.5.1 Potential impacts due to port location

5.5.1.1 Littoral Drift/ Sediment Transport

The location of a port may cause changes in current patterns and littoral drifts due to alteration of wave refraction, diffraction and reflection. The change of littoral drift may lead to erosion or accretion in shore zones. Altered currents or reflected waves may endanger small ships maneuvering near structures. The creation of a port may cause changes in river flow and waterfront drainage.

Any modification to this equilibrium in the form of new developments in the coastal zone leads to changes to the seabed and coastal morphology. In order to investigate the fate of suspended sediment in coastal and estuarine waters as well as the evolution of sea or river beds, sediment dynamics need to be studied thoroughly. It is a widely accepted practise to use numerical modelling tools to predict the sediment transport patterns in the vicinity of coastal projects and to assess its impacts like the amount of annual maintenance dredging or the behaviour shoreline, etc.

CWPRS carried out the sedimentation studies to estimate the likely siltation in various dredged areas i.e., berths pockets, approach channel, basin etc. of the harbour area. Siltation model was established using Telemac-2D. Hydrodynamics model described in the previous section was used to drive the sedimentation model. seabed soil samples collected at 8 locations and suspended sedimentation concentrations observed at one location near the project site were used to setup the model to replicate the existing conditions.

From the analysis of the seabed samples, it was concluded that the typical D50 size of the seabed soil is around 0.011 mm. As this size of the bed material was found to be in the same order as that of the suspended material whose D50 is around 0.008 mm, it was concluded that the deposited seabed material is due to settlement of material in suspension. As the suspended material is found to be cohesive, the erosional and depositional behaviour of the sediment is modelled using Krone and Parthenaides formulation. The factors influencing the siltation process are grain size, suspended sediments, its concentration, settling velocity, salinity, temperature, current strength etc. Siltation studies were carried out with the hydrodynamic conditions coupled with the sedimentation module for monsoon and non-monsoon season.

The model was calibrated for existing conditions derived from suspended sediment concentrations observed at site i.e., 400 mg/l for spring tide and 300 mg/l for neap tide. Various parameters which impact the sediment deposition and erosion were adjusted to obtain the calibration of the sedimentation model.

The calibrated sedimentation model was then introduced with the proposed layout and the model was run to estimate the siltation in the approach channel and port basin. The resultant sedimentation from the run given in the report is reproduced in the figure below.

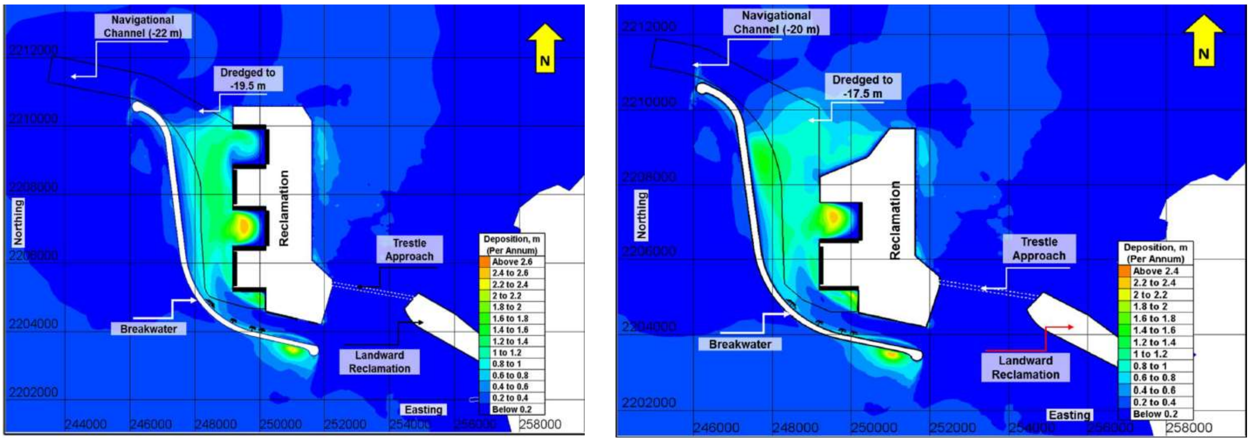


Figure 106 Annual siltation pattern for the recommended Master plan and Phase 1 layout

The total siltation in the dredged areas over the plan master plan is about 8.45 M cum per annum and 6.45 M cum per annum for Phase 1.

5.5.2 Potential Impact During Construction

Developmental activities such as capital dredging, dredged material disposal and construction of approach channel and cargo berths will result in disturbance to marine environment. During these activities, particularly dredging, localised and shortterm impacts on marine water quality are likely to occur due to increased turbidity from suspended sediment. Further, marine sediment quality indicates that it is free from any significant pollution.

As per the dredging and reclamation quantity estimates for Phase 1 development, it is expected to have a dredging-reclamation sand balance (i.e., sand required for reclamation purpose to be procured from dredging activity itself). In case of disposal of unusable dredge material, a dredge disposal site would be needed to dump the excess/unusable dredged material with least impact on the existing environment. Based on the prevailing site conditions, the disposal site has been identified.

5.5.2.1 Impact due to Capital Dredging and Disposal of Dredged Material

Based on the navigational requirements, estimates the various dredging and reclamation areas for the proposed port. Following table provides the various dredge depths and the calculated dredging volumes.

Table 142 Dredge Areas for the Vadhavan Port

S. No.	Dredge Area	Dredged Depths (m CD)	Dredge Volume (m3)	
			Soil	Rock
1.	Approach Channel	-20	717,648	-
2.	Turning Circle and Manoeuvring area	-17.5	2,261,410	2,263,990
3.	Berths pockets			
	– CT 1	-19.5	446,684	26,620
	– CT 2	-19.5	300,294	18182.2
	– CT 3	-19.5	143,853	161,395
	– CT 4	-19.5	102,246	537,364
	Total (cum)		**3,972,136**	**3007,552**
	TOTAL (Soil +Rock) (cum)		**6,979,688**	

5.5.2.2 Characteristics of Dredged Material

Based on the available data from geotechnical investigation carried out in this area, the primary characteristics of materials to be dredged as per the laboratory test results and dredging effort required is discussed below.

- The dredge levels vary from -20.0 m CD at the entrance channel to -17.5 m CD in the basin area with -19.5 m CD at the container berth terminals.
- In absence of sufficient boreholes at the berth location and channel, MBH-35, MBH-37, MBH-40, MBH-42, MBH-43, MBH-44, MBH-45, and MBH-47 have been considered for the present study. Out of these boreholes, MBH-43, MBH-45, and MBH-47 show the presence of weathered rock above dredge level. Weathered rock is encountered at -16 m

CD in MBH-45, -16.7 m CD in MBH-47 and -17.1 m CD in MBH-43. Hard rock is encountered below -27.1 m CD in MBH-43 hence dredging in hard rock is not anticipated.

- Core recovery values in weathered rock generally varies from 24 to 34% above dredge level and corresponding RQD values varies from Nil to 12%.
- Although values of rock strength are not available in above mentioned boreholes at shallower depths, based on our understanding of general geology in the area, weathered basalt is envisaged with rock strength varying from 6 to 51 MPa with an average of 19 MPa.

5.5.2.3 Criteria for Selection of Dredge Disposal Location

- Dumping ground should be located in sufficiently deep water, so that the sediment plume does not travel towards fishing harbour, recreational area, beaches, navigation channel and other environmentally sensitive areas (if any).
- Maximum distance of the dumping location should be such that the turnaround time to the disposal ground is minimal.
- Existing and proposed facilities close to the dumping grounds (if any) should not be affected by the proposed dumping.
- Construction and maintenance dredging near the port site will remove habitat and species living in it. Recovery (re-colonisation by species from the adjacent areas) will take place, depending on the scale of the impact and on the characteristics of the seabed, within various months up to several years. The impact must be seen in the proportion between land take and the area in which this land take occurs. The impacts will be localised and restricted to the port area and therefore limited.

The dumping area for the dredge spoil and the immediate surroundings will also be impacted. Mobilisation of suspended sediment and its consequent deposition (smothering) can damage or kill sessile organisms, especially filter feeders, by clogging feeding and respiratory appendages.
Suspended sediments can also cause irritation and abrasion to the surfaces and gills of fish and will cause them to avoid areas with high turbidity. The effect of suspended sediments on marine organisms depends on the concentration, duration of exposure and the sensitivity of various species.

5.5.2.4 Impact on Marine Water Quality

Marine water quality will be impacted due to dredging and disposal and also during construction of breakwaters and cargo berths during construction phase. Direct impact of these activities on marine water quality would be an increased turbidity due to suspended sediment and will be predominant during dredging.

Turbidity due to dredging operation varies with depth and lateral distance from the dredger location. During dredging, transport of sediment depends on velocity and fine material concentration. Very fine cohesive material will remain in suspension for a long time and is independent of hydrodynamic conditions. Due to above factors, there will be an increase in turbidity due to suspended sediment in water column. Thus, it can be inferred that dredging can cause a short-term and localised impact on marine water quality.

Apart from turbidity, the marine water quality could be affected due to aqueous discharge (oily wastes, sanitary wastes, etc.) from the dredgers, barges and workboats involved in the activities.

5.5.2.5 Impact on Marine Ecology

Vadhavan is located in Dahanu Taluka, which had been declared as an eco-sensitive zone via a notification of 20th June 1991. As mentioned earlier, the proposed project is planned on a reclaimed area in an offshore location and do not fall in the purview of the notification. However, it is important to note that development of support infrastructure like road and railway development would be planned in Dahanu Taluka. The proposed location is about 50 km away from the Western Ghat boundary.

Dahanu Taluka also reported to have rich marine biodiversity and supports hundreds of families primarily dependent on fishing. On the coastline, mangrove vegetation was found to be present covering exposed rock area.

Although the land requirement for port development is not envisaged but any development to provide for rail and road connectivity will require careful planning to avoid sensitive locations (habitation, vegetation etc.). Tree cutting is inevitable at this location for infrastructure development. Capital dredging and construction of approach channel, breakwaters and cargo berths will result in disturbance to marine ecology.

Pile driving, deposition of rubble, sand compaction and other construction work in water may cause increase in sediment concentration, which may also reduce sunlight penetration. Disturbance from construction activities may cause displacement of fishery resources and other mobile bottom biota.

Due to the rock dredging and development port at an offshore location, marine life will be impacted, however, damage to marine life would be minor and localized, which is reversible except the port location.

Disturbance from construction activities may cause displacement of fishery resources and other mobile bottom biota. Dredging removes bottom biota and dumping of dredged material covers bottom habitat, both of which may reduce fishery resources. Settlement of re-suspended sediments on fragile marine fauna and flora damages the ecosystem particularly coral reefs, which are formed by the extracellular product of symbiotic plants. The great number of coral polyps attached need dissolved oxygen for respiration and the plants need sunlight for photosynthesis.

Piles, concrete surfaces, rubble mounds and other similar structures in water could form new habitats, which may introduce undesirable species. If toxic substances and other contaminants are re-suspended through dredging or dumping, they may lead to contamination of fishery and shellfishery resources.

Turbulence – Changes in Dissolved Oxygen (DO) Levels: During dredging, oxygen-demanding compounds, nutrients and sediments from the seabed enter into water column. Since concentrations of oxygen-demanding compounds are normally much higher in pore water than in water column it will cause a drop (depletion) in oxygen concentration. Nutrients may stimulate primary production when light and temperatures are sufficient and may cause eutrophication problems when released in favourable conditions. DO levels in bottom sediments, which are usually low would increase during dredging period. Changes in DO levels and noise are likely to result in localised and short-term impacts on marine ecology.

Removal of Benthic Communities associated with Bottom Sediments: Dredging would result in removal of benthic communities associated with bottom sediments. During dredging, sessile forms are removed along with sediments and mobile species tend to move away and are likely to increase species diversity in areas adjoining dredging site. Further, it is observed that due to movement of mobile species and transfer of nutrients during dredging, there will be an increase in species diversity and density in areas adjoining dredging site. Land reclamation from the sea destroys bottom habitat and displaces fishery resources. Terrestrial fauna and flora may also be altered by the location of a port. Diminution of bottom biota is usually linked to a reduction of fishery resources, and occasionally to an increase of undesirable species. Deterioration of water quality usually gives rise to changes in aquatic biota: a decrease in the number of species; and an increase in the quantity of one or two specific species. Further deterioration may lead to the destruction of all kinds of aquatic biota. Diminution of plants in a shore zone within enclosed water may degrade its aeration capability and worsen water pollution. Mangroves in wetlands play an important role in providing habitat for terrestrial and aquatic biota and indirectly recovering water quality.

Mitigation Measures: To mitigate impacts on marine ecology, measures such as selection of equipment and dredgers, environmental monitoring and regulating activities based on monitoring results will be adopted. Careful survey of a fragile marine and coastal ecology is essential for appropriate planning of construction work, dredging, and disposal of dredged material.

- No construction activity will be allowed during the monsoon season so as to avoid breeding period of fishes.
- Use of silt curtains is recommended to confine areas of high turbidity during dredging and pile diving.
- Controlled dumping of the dredged material will be carried out beyond 20 m depths in the sea
- Areas with high fish yield or used by locals for fishing shall be avoided.
- All care shall be taken to avoid mangroves vegetation while construction activity. It is also proposed to plan and develop mangroves in the area identified and suggested by Forest Development.

Smothering Effect Due to Settling of Sediment: Settlement of the suspended sediments can result in the smothering or blanketing of sub-tidal communities and / or adjacent inter-tidal communities. Presently, the marine biota in Indian Coast is already subjected to considerable changes in turbidity due to large-scale littoral movement, which is a recurring regular natural phenomenon. Therefore, it would be able to withstand localised turbidity induced during the dredging.

5.5.2.6 Changes in Seabed Profile

Generally, construction of marine structures may alter the seabed profile. In the proposed development, marine structures include cargo berths, breakwaters etc. which in turn involve lowering of piles into the seabed. The changes in the seabed could be in terms of disturbance to the strata and localised sediment dispersion. The dispersed sediment tends to increase the turbidity of the seawater resulting in an impact on the food chain of the marine biota. The details of littoral drift and sediment transport which leads to changes in seabed profile are discussed.

5.5.2.7 Potential impacts on bottom contamination

Dredging and Land reclamation from the sea destroys bottom habitat and displaces fishery resources. The location of a port may accelerate sediment deposition in stagnant water behind structures and cause contamination of the sea bottom. Sediment deposition covers bottom biota and physical habitat. Pile structures shade the bottom and affect habitat. Eutrophication of water induces sedimentation of dead plankton and changes chemical characteristics of bottom sediments, resulting in an increase of organic matter, hydrogen sulphide, and mobilization of harmful substances.

Mitigation Measures

No discharge from the dredgers or work boats shall be allowed into marine waters. The dredging activity will be confined within the project site and the impact due to dredging will cease upon completion. The impact due to dredging can be minimised with the implementation of a dredge management programme.

Prior to commencement of dredging, a Dredge Management Plan will be prepared and implemented, which will include the following details.

- A schedule for dredging shall be prepared and list of DO(s) and DO NOT(s) shall be circulated among the people involved in construction activities
- It is proposed to check turbidity levels with baseline turbidity levels as a reference during dredging.
- Less intrusive dredging techniques shall be adopted to minimise turbidity
- It will be ensured that suitable dredging equipment is deployed to minimise the suspension of fine sediments at the dredging site.
- Dredging activity will be regulated during rough sea conditions.
- Waste Oil/ grease/ lubricants are categorized by MoEF&CC as Hazardous Wastes. All such waste will be collected and stored at a protected place and sold to a vendor authorized by MPCB or MoEF&CC.
- Use of silt curtains is recommended to confine areas of high turbidity during dredging and pile driving.

- To avoid impacts from dumping of dredged material the following measures shall be adopted:
  - Most of the quantity of dredged material will be used as reclamation material and for revetments.
- Limited material, which will not be suitable for reclamation, will be disposed off at an identified site beyond 20 m depths in the sea Areas with high fish yield or used by locals for fishing shall be avoided.
- Dumping activity shall not be carried out during monsoon season.
- It will be ensured that barges/workboats have slop tanks for collection of liquid/solid waste generated onboard. Discharge of wastes into sea will be prohibited.
- Spill control measures will be adopted while fuelling dredgers, barges, workboats, etc.
- Post dredging monitoring program will be carried out to assess effect of dredging and disposal on marine ecology
- Environmental Monitoring Programme comprising of monitoring of marine water quality, marine sediment quality and marine ecology will be initiated one week prior to commencement of dredging and will be carried out throughout dredging period.
- Dredging and dredged material disposal will be monitored for compliance with proposed mitigation measures.
- To reduce the potential for error on the part of the contractor, efforts should be made to monitor regularly the activities during dredging and disposal of spoils.
- Where appropriate, disposal vessels should be equipped with accurate positioning systems. Disposal vessels and operations should be inspected regularly to ensure that the conditions of the disposal permit are being complied with and that the crews are aware of their responsibilities under the permit.

This project requires contaractors EMP that includes Dredge/ Reclamation mangement plan based on his actual implementation plan. This has to be approved by JNPA or JNPA and appointed consultant.

5.5.2.8 Impact on Ecology due to Reclamation

The proposed port is to be developed on reclaimed land. Around 1448.00 Ha of land is planned to reclaimed for port operation. For this area reclamation, about 200 M Cum dredge material is being used. To meet 200 M Cum materials, it is envisaged to dredge 6.9 M Cum in the port channel and harbour basin. The additional material of around 170 M Cum over the required dredging quantity may be obtained by sourcing the fill material from marine borrow pit located offcoast of Daman at around 50-60km from port. The study of dispersion of silt during dredging from marine Burrow pit for reclamation was conducted by IIT Madras (October 2022) (report enclosed as Annexure – 9).

Simulation study has been carried out by IIT madras to study the impact of sediment transport from the marine burrow pit towards the coastal region of Vadhavan port. Following scenarios were investigated.

(a) Sediment loss from the drag head of Trailing Suction Hopper dredger (TSHD)

(b) Overflow from Hopper

Sensitivity study was carried out for 10%, 20% and 30% sediment loss.

IIT Madras concluded that the offshore environment is dynamic in nature with turbulent sea, high tidal range and associated strong currents, the concentration of the plume gets weakened post the dredging activity. The model simulation shows that the turbid plume does not reach the shore. Based on the above scenarios, it can be observed that, the plume trajectory of the dredged sediment does not move towards the coast, and they appear not to cause any impact on the shore and the marine environment.

Mitigation Measures during Reclamation

While reclaiming the area, bunds will be provided with a suitable overflow facility so that only clear water will be returned to the sea. Ecology in the vicinity of the port is not anticipated to be disturbed during reclamation.

5.5.2.9 Road & Rail connectivity

This is one of the most important impacts due to construction and operation of the road/rail connectivity to Vadhavan port. Both for the road as well as the rail alignments the entire alignment is new causing potential impacts to flora of the region. The entire impacts are portrayed in the environmental strip plans prepared for both road and rail connectivity as provided in chapter 5. Most of these strip plans were prepared by using high resolution Google imagery available for both alignment supplemented by other data available from various sources coupled with ground truth verifications. The entire land use along the alignment will be converted to Transportation land.

Impacts and Avoidance Measures - During Construction Phase

Flora and Fauna: During the construction stage due to the felling of trees, noise and smoke from the construction activities shall force the native animals and birds to migrate from the place.

Forest Area: Forest land has been identified along the proposed road and rail alignment and its impact are anticipated.

Tree Cutting: The proposed road and railway alignment are new links, in such cases trees along the corridor need to be felled and agricultural land will be converted into transportation land. However, the road and railway alignment constructions are limited within the proposed Right of way. Details of the trees impacted are given in the table below.

Table 143 Biological Impact Potential of Road and Rail Alignment

S. No.	Road and Rail Alignment	
	Imapcted Trees	Total No
	Chickoo trees, Palm and other wild trees	10179

Ca***ttle Grazing:*** There are no cattle grazing along the proposed road and rail alignment. Therefore, no impacts are anticipated.

Wild Life: No Wild life is observed along the proposed road and rail alignment.

Mitigation and Enhancement Measures

During Construction Phase

A tree plantation along the Right of way is one of the important planned mitigation measures. Uprooting the big trees and planting the trees in the suitable place is also one of the options. Proper care should be taken during construction to avoid contaminated runoff in to the nearby agricultural land or farms.

A comprehensive tree plantation plan covering all phases (preconstruction, construction and operation) of the project needs to be prepared by Environmental Management Unit of Vadhavan port.

As a part of totall loss of green cover port is commited to plant about 30 Ha based on the foot print impact of Vegetaion cover along the acquired land. This includes tree cutting, tree plantation schemes, available nurseries, cost of transportation and planting scheme and timings.

The EMP unit of Vadhavan port need to prepare an operational EMP (this is not part Contractors EMP as it is not part of Civil construction contract) covering all elements of compensatory and enhancement tree plantation programme. In addition, the landowners have been compensated from the loss of income from these plants considering the income from plants. For example, 100 coconuts from a fully grown tree per year will be compensated for the next 15 years or so. These people are also expected to plant an equal number of trees (not double) in their new rehabilitated area wherever they are rehabilitated depending up on the area available. But the horticultural crop loss is hardly compensated due to the prevailing socio economic conditions.

In order to cut the high beam light from opposite vehicles on the other side of the median a creeper planting scheme has been proposed to address the biodiversity issues. This project will try planting creepers along the median with the use of two parallel metallic wire fencing separated by 0.5 m. Alternatively barbed wire fencing roles with 0.5 m diameter can be used for growing creepers. For example plants shall not be vegetable or it shall not be fruit bearing like grape. The selected creeper species shall be unpalatable and flowering in nature. This has been planned to showcase the cause of biodiversity issues that even forest department neglect. In the name of forest fires all over the world, creepers are being systematically destroyed especially those that have no direct economic value. People in their gardens are selectively felling and destroying all such creeper plants. These protective measures will be documented for future use and showcase the activity planned and implemented by the port.

In addition to this both road and railway connectivity will have a strip plantation to prevent induced developments. While the plants for 34 km long road will have very selective flowering plants the rail alignment will be planted with plants which are always discarded by public because of very low economic value. This is also to show case the biodiversity for this international port Infrastructure project. There will be a multipurpose strip plantation on both sides of the railway alignment. The growth of the trees shall not create large scale canopy with suitable spacing to the neighbouring agricultural areas. Extreme ends on the 120.00 m wide RoW can be protected with barbed wire fencing on both sides with all required access for the building and properties intact.

With barbed wire fencing on outer part of the road all ribbon developments can be avoided. This is also an effective green barrier for noise attenuation.

All specific details for contracting and operational purpose can be included in the Operational Environmental Management Plan (EMP) to be prepared by Vadhavan port EMP Cell. Preparation of Operational EMP and Contractors EMP shall be completed just prior to construction phase when the EPC Contractor is appointed, and preliminary discussions are completed. In the case of rail alignment also except the median planting strip plantation on either side can be developed with the same tree species described for road section.

5.5.3 Potential Impact due to Operations

5.5.3.1 Impact on Marine Water Quality and Ecology in Harbour Basin

Due to Aqueous Discharges: During the operation phase, there will be continuous movement of cargo vessels and port crafts round the clock. There is a possibility of aqueous discharges from the cargo vessels such as dumping of ship wastes (sullage) / sewage, bilge water, solid wastes, etc. if not regulated.

Runoff from raw material storage, spills from bulk cargo handling, and wind-blown dust are possible sources of contamination of port water. Toxic or harmful substances may be included in runoff from sulfur, bauxite, phosphates, nitrogenous manure, coal, metal ores and other raw materials. Organic materials in runoff are decomposed to the inorganic form, spending dissolved oxygen and increasing the nutrient level in water. Accidental spills of toxic, harmful materials, oils or oily compounds, and other raw materials are also possible sources of contamination of water. Effluent from waterfront industries may include toxic or harmful materials, unsanitary wastes, oily wastes and other hazardous materials. Electricity generation may release heated water and sewage treatment facilities produce nutrient salts, organic matter and some hazardous materials.

Ships/vessels calling at Vadhvan port will not be permitted to dump the wastes /bilge water during the berthing period. However, during emergency, sufficient reception facilities will be provided to receive the residues and oily mixtures generated from ship operations according to provisions of the International Convention for the Prevention of Pollution from Ships, 1973/78 (MARPOL). In addition, reception facilities for garbage, waste oil and bilge water from the ships shall also be provided. The bilge water will be collected by authorised waste recyclers and taken for further treatment.

In addition, land-based sources of pollution such as runoff from the cargo berths, wastewater, sewage and effluents from the port operations would also affect the marine water and sediment qualities in the harbour basin, if disposed without proper treatment. To avoid impacts on the marine water quality it is proposed to prevent discharges from certain areas and regulate the discharges from other areas. Accordingly, storm water runoff will be directed into open concrete lined channels. The runoff from uncontaminated areas will be discharged directly into the sea. The runoff from berths and cargo storage areas will be intercepted and directed to collection ponds where the water quality will be tested and then discharged into the sea if the water quality meets the Marine water discharge standards. Only increase in oil and grease content may be expected in the water from these areas. Hence, the oil and grease content exceed marine discharge standards (10mg/l), it will be routed through Oil- Water Separator to bring down the Oil and Grease content.

Due to Cargo Spills during Handling: Spills are not anticipated to occur during normal operations, as the cargo will be handled by specialised ship-loaders/unloaders. In the event of accidental spills of cargo during transfer from / to the ships, the marine water quality, sediment quality and ecology in the harbour basin will be impacted.

Due to Oil Spills during Fuelling: Oil spills are not anticipated to occur during normal operations. In the event of accidental oil spills during fuelling of port crafts and accidental spillage of oil from ships visiting the port, the marine water quality in the harbour basin will be impacted. To minimise the impacts on marine water quality, the spills will be recovered.

Mitigation Measures

Ships visiting the port will comply with MARPOL convention and avoid discharges into the harbour basin.

Countermeasures against runoff are: (a) covering or enclosing raw material storage areas; (b) sprinkling water on raw material except anti-humid materials like grains or cement; (c) providing special equipment for cargo handling and transport.

A reversed slope apron is an effective means to avert rainfall from washirJoq away from the apron and pouring into the sea directly. The drains from the apron are led to a settling pond and released into the sea after settlement of suspended materials. Regulations on effluent and monitoring of water quality are essential for port environment protection.

To provide waste reception facilities at port in emergency, standard format of the advance notification form for waste delivery to port reception facilities and standard format for the waste delivery receipt following a ship's use of port reception facilities as recommended by Marine Environment Protection Committee, IMO will be maintained.

Collection ponds will be provided for containment/treatment of runoff from cargo storage areas and other areas liable for oil & grease pollution. When the oil and grease content exceed marine discharge standards (10mg/l), it will be routed through Oil- Water Separator to bring down the Oil and Grease content.

It will be ensured that the dumping of the maintenance dredge spoil would be uniform.

Along with the operational phase environmental monitoring, an additional Environmental Monitoring Programme comprising of monitoring of marine water quality, marine sediment quality and marine ecology will be initiated one week prior to commencement of maintenance dredging and will be carried out during the dredging period.

In case of any cargo spillage during transfer from/to ships, it will be attempted to recover the spill. Oil spill control equipment such as booms / barriers will be provided for containment and skimmers will be provided for recovery.

As the accidental spills will be in harboured waters, it would not spread spatially and the response time for shutting down the fuelling, containment and recovery will be quicker.

Spill contingency plan as a part of Disaster Management Plan will be prepared in accordance to the cargo to be handled Spill recovery/immediate response measures will be displayed at cargo handling areas, Material Safety Data Sheet (MSDS) of cargo (if applicable) being handled will be displayed.

Mock drills will be conducted at periodic intervals

During Operation Phase of road & rail corridor

During operational phase, no potential floral and faunal impacts are anticipated for both road and rail alignment. Maintenance of tree plantation including the compensatory plantation is the main activity for the first five years of operational phase of the project. JNPA will plant the trees in consultation with the forest department in degraded forest area as recommended by the forest department. The EMP cell of the Vadhavan port need to document all such planting, maintenance and survived plants/trees.

- Proper maintenance of the sapling planted along the RoW
- Frequent examination of the sapling survival
- Watering of the sapling in regular interval

Impacts to domestic and stray animals like dogs is also largely mitigated by the raised median and proposed creeper planting as discussed above. This structure will remain as a barrier for their fast movements.

5.5.4 Potential impacts on visual quality

The visual quality of a project area is affected by the creation of a port, port facilities, lighting, and other optical disturbances. The landscape may be changed into an artificial scene of industrialization. Some port facilities may give an unpleasant impression to people.

Mitigation Measures

The design of port should cause it to blend with its surroundings. Special attention to the colors of port facilities and landmarks helps improve port scenery. A green belt zone around a port may block an unpleasant view of the port and be a more pleasant sight.

5.6 Air Environment

5.6.1 Potential Impact During Construction

5.6.1.1 Impact due to Transportation of Construction and Cargo Material

Some of the project activities (site clearance, dredging and reclamation, construction of breakwaters, construction of port infrastructure, traffic during construction and use of heavy machinery construction of road and rail) will generate air pollutants like NO_2, SO_2, HC, CO, PM, VOCs, etc. This has the potential to cause temporary impacts on the air quality.

Air pollution can cause significant impacts on the environment, and subsequently on humans, animals, vegetation and materials. It primarily affects the respiratory, circulatory and olfactory systems in humans. In most cases, air pollution aggravates pre-existing diseases or degrades health status, making people more susceptible to other infections or the development of chronic respiratory and cardiovascular diseases. Because of the prevailing strong winds along the coastal region and the resulting dispersion the impact on air quality from pollutants would be reduced. Towards land ward side all is green with complete coverage of coconut and other trees (green barrier) will also nullify any air pollution impacts. In addition, adoption of suitable mitigation measures will ensure that these impacts are rendered insignificant.

The following activities may cause air pollution during construction phase

- Material sourcing at Quarry
- Material transport
- Equipment transport
- Stone crushing operations in the crushers;
- Handling and storage of construction material;
- Concrete batching plants;
- Asphalt mix plants due to mixing of aggregates with bitumen; and
- Construction and allied activities.

Mitigations Measures

Methods for controlling dust emission are water scattering in the construction site, use of proper transport methods, such as a conveyor belt, for excavated material and screens around the construction site. A green belt zone or open space between the construction site and the local community could be an effective buffer. Temporary pavement of roads in a construction site could considerably reduce dust emission.

- To reduce the impact on air quality, quarry material is planned to transport from respective quarries to Vadhavan Port. This material transportation route from quarry to Vadhavan is shown in chapter 4.
- Power supply from State Electricity Board shall be sourced for electrically operated construction machinery/equipment.
- The use of DG set would be limited to backup during power failure;
- Dust suppression systems (water spray) will be used near the earth handling sites, asphalt mixing sites and other excavation areas to reduce the wind-blown fugitive dust emissions.
- Earth moving equipment, such as bulldozer with a grader blade and ripper will be used for excavation work.
- Excess idling of construction equipment as well as vehicles to be prohibited.
- The labours shall be provided with clean fuel so that they neither cut the trees for fuel wood nor burn firewood.

- Vehicles and construction equipment will be fitted with internal devices i.e., catalytic converters to reduce CO and HC emissions.
- All stationary machines/ DG sets / construction equipment emitting the pollutants will be inspected weekly for maintenance and shall be fitted with exhaust pollution control devices;
- Vehicles and machineries will be regularly maintained to conform to the emission standards stipulated under Environment (Protection), Rules 1986.
- “No Objection Certificate (NoC)” for setting up of crusher, hot-mix plant and DGs will be obtained from Maharashtra Pollution Control Board;
- Ensure that all vehicles must possess Pollution under Control (PUC) Certificate and shall be renewed accordingly;
- All the roads in the vicinity of Port site and the roads connecting quarry sites to construction sites will be paved to minimize the fugitive emissions.
- Environmental awareness program/training will be organised to the personnel involved in developmental works
- If any of the road stretches are not paved due to some reason, then adequate arrangements will be made to spray water on such stretches of the road.
- Adequately sized construction yard will be provided at the site for storage of construction materials, equipment tools, earthmoving equipment, etc. In addition, temporary field offices and worker amenities will be provided at site. Appropriate spill control measures and labelling / handling procedures will be maintained.

5.6.1.2 Impact due to Quarrying

Quarrying needs blasting, drilling, digging, road transport, use of heavy machinery for hauling and loading, storage and handling of fuels, etc. This will generate dust and other air pollutants like NO_2, SO_2, HC, CO, PM. This will affect the ambient air quality. It will be contractor’s choice to choose the quarry site but avoiding nuisance for the public is required. Prior to commencing the works the contractor should establish the environmental baseline conditions in the specific area around the selected quarry. Monitoring right from the beginning of the production should indicate whether standards are exceeded and early action is required.

Khanivade Quarry: This quarry site is free from human settlements within 500 m distance. On the way to the 3km from the proposed dedicated road to port from the quarry site, from where the quarry is proposed to be transported to the Project site, human settlements are evident.

The proximity of the human settlements should be taken in consideration regarding air (among others) impacts. Particulate Matter (PM), including respirable suspended particulate matter (RSPM) is generated during all phases of exploitation and processing from fugitive sources (e.g. shovelling, drilling, blasting, transport, crushing, or stockpiling). The main sources of PM emissions include crushing–grinding, drilling, blasting, and transport. Impacts from PM emissions are related to its size (e.g. whether it is less than 2.5 microns in diameter), its main components (e.g. silica, silicates, carbonates), as well as to rock impurities and trace components. During the quarrying activities, it is expected that PM will be generated constantly and hence potentially impact the local air quality. Climatologic circumstances such as wind will determine the dispersion patterns. Rock impurities and components need to be checked and monitored by the contractor.

Furthermore, the ambient air quality is affected by the combustion by-products that are emitted by vehicles and other combustion sources installed in the quarrying sites. Toxic and nontoxic gases are normal by-products generated by blasting activities, regardless of the explosive materials used.

Mitigation Measures

Management of air quality at quarry site is important at all stages of the quarry cycle. The following measures are proposed:

- Blasting for quarrying shall only be carried out during calm wind conditions;
- A good blasting practice (like optimal blasting hole, suitable blasting methods) shall be adopted;
- Automated sprinkler system to be installed at quarry site to minimise the dust emissions;
- Quarry and construction materials shall be covered with sheets/enclosed during transportation and storage to avoid dust generation;
- Dust suppression techniques (e.g. wetting down, use of all-weather surfaces, use of agglomeration additives) for roads and work areas, optimisation of traffic patterns, and reduction of travel speeds;
- Exposed soils and other erodible materials should be re-vegetated or covered promptly;
- New areas should be cleared and opened-up only when absolutely necessary;
- Loading, transfer, and discharge of materials should take place with a minimum height of fall, and be shielded against the wind, and consider use of dust suppression spray systems;
- Hardened roads should be laid in the area to avoid dust generation due to vehicular movement;

- Solid wood barriers or wind screen fabric should be used around the perimeter of construction site to avoid impact on neighbouring communities due to dust generated from construction activities;
- Dust suppression techniques (e.g. wetting down, use of agglomeration additives) for roads and work areas should be applied;
- Good maintenance of vehicles and equipment according to a periodical repair/revision programme;
- Use of good quality fuel and lubricants;
- Daily cleaning of access ways in the neighbourhood of work sites (removal of earth and sand) to prevent dust;
- Collection and temporary storage of sanitary and cleaning wastes, as well as garbage, in containers;
- Only Vehicles having Government license and Pollution Under Control (PUC) certificate for transportation of construction and quarry materials should be used;
- Older than 15 year vehicles wll not be allowed to operate
- Transportation vehicles shall be properly and timely maintained and serviced regularly to control the emission of air pollutants in order to maintain the emissions of NOx and SOx within the limits to conform to the established emission standards/ regulations;
- Energy conservation measures can enhance efficient energy consumption patterns and consequently affect the GHG emissions impacts in a positive manner.

5.6.1.3 Impact due to Road/Rail Corridor Development

Due to the nature of the road (33.4 km) and rail (12.0 km) for this project, there will be air quality impacts along the project corridor. Construction stage impacts will be of short term but have adverse impacts on the construction workers as well as the settlements adjacent to the road and rail alignment, especially those in the down wind direction.

Dust Generation: Generation of dust is the most likely impact during this stage due to:

- Site clearance and use of heavy vehicles and machinery, etc.
- Procurement and transport of raw materials and quarries to construction sites
- Dust/ air pollution is likely to be generated due to the various construction activities including:
    - Stone crushing operations in the crushers
    - Handling and storage of aggregates in the asphalt plants

- Concrete batching plants
- Asphalt mix plants due to mixing of aggregates with bitumen; and
- Construction and allied activities

Generation of dust is generally a critical issue in road /rail projects and is likely to have adverse impact on health of workers in quarries, borrow areas and stone crushing units. Normally all these could be located away from the alignment. This is a direct adverse impact, which will last almost throughout the construction period. The Environmental Action Plan (contract documents) to be prepared by JNPA should lay emphasis on enforcement of measures such as provision of pollution masks, regular sprinkling of water to suppress dust along haul roads at quarries, crushers and borrow areas to mitigate this impact.

Exhaust gases Generation: Generation of exhaust gases is likely during the preconstruction stage during movement of heavy machinery, oil tankers, etc. This impact is envisaged to be insignificant during the preconstruction stage.

High levels of SO_2, HCs are likely from hot mix plant operations. Volatile toxic gases are released through the heating process during bitumen production. Although the impact is much localised, it can spread downwind depending on the wind speeds. The Environment Management Action Plan (EMAP) needs to ensure adequate measures especially for health and safety of workers such as providing them with pollution masks during working hours. Also, the contractor will be ensured that hot mix plants, stockyards, etc. are away from residential areas and residential quarters of all workers. Contractors also should be asked to provide regularly Pollution under Control (PUC) Certificate for their vehicle mounted equipments and machinery as per prevalent norms. If adequate measures are taken, then impacts from generated gases can be negligible.

Mitigation Measures

Dust Generation: If adequate measures such as sprinkling of water on haul roads around sites where clearance activities are on, covering material trucks especially those carrying sand and borrow materials etc, then the impacts can be reduced to a great extent. The main source of dust generation is due to site clearance activities, removal of trees and loading/unloading of construction material. To mitigate the dust generation, following suitable mitigation measures shall be applied:

- Sprinkling of water shall be carried out at construction sites.

- Asphalt plants, crushers will be sited at least 1.0 km in the down wind direction of human settlement and other sensitive receptors along the project corridor.
- During and after compaction of the sub grade/sub base water will be sprayed at regular interval in order to avoid fugitive dust generation
- Vehicles carrying fine and coarse aggregate should be covered with tarpaulin in order to avoid the spills on the existing road.

Exhaust Gas Generation: Emissions are anticipated from construction plants, vehicles, etc. In order to mitigate the exhaust gases, all the vehicles should be warranted with PUC Certificate proper maintenance of the vehicles shall be followed.

5.6.2 Potential Impact due to Operation

Operation of the port (container terminal, multi-purpose cargo, RORO, liquid) does not include bulk or uncovered materials exported from or imported to the terminal or stored on site. The sources of air pollutants from port operations include combustion emissions from ships' propulsion and auxiliary engines and boilers, mainly consisting of sulphur dioxide (SO_2), nitrogen oxides (NO_X), greenhouse gases (e.g. carbon dioxide [CO_2] and carbon monoxide [CO]), fine particulate matter [PM], and volatile organic compounds [VOC]), followed by combustion source emissions from vehicles, port equipment and land-based engines and boilers contributing similar pollutants. Volatile organic compounds (VOC) may also be emitted fuel storage and transfer.

However increased traffic on the access road has the potential to cause an impact on the air quality experienced by the residents along the access road; specifically, an increase in pollutants such as oxides of nitrogen and particulates. Concentrations of primary pollutants generated by road traffic decrease exponentially with increasing distance from the road. This means that 50 m from the road centre the concentrations of carbon monoxide, oxides of nitrogen, particulates and non-methane hydrocarbons (benzene and related compounds) are considerably less than half the levels at the central median.

Mitigation Measures

Operation of the port (container terminal, multi-purpose cargo, cruise) itself is not anticipated to result in any significant air quality impacts.

The following measures could mitigate the anticipated negative impacts on the ambient air quality during O&M phase.

- Project will implement “Cold ironing” to reduce pollution and also to reduce the diesel generated power consumption from the ship. Cold Ironing is basically using electrical supply from the port main to the ship for all purposes for the entire period of stay in the Vadhavan port.
- Similarly, most of the Cranes in the port will also use electric power.
- Transportation vehicles to be properly and timely maintained and serviced regularly to control the emission of air pollutants in order to maintain the emissions of PM, CO, NOx and SOx within the limits to conform to the established emission standards/ regulations.
- All static and mobile diesel-powered plant / generator sets to be used only during power cut;
- Use of good quality fuel and lubricants to be promoted. Moreover, low sulphur content diesel to be used as fuel for generator sets to control emission of SO_2.
- Generators, machineries and vehicles are to be serviced and maintained regularly to avoid generation of dust and other air pollutants.
- Regular verification of Pollution under Control (PUC) certificates of all the vehicles entering into the port area.
- Prohibition of use of more than 15-year-old vehicles for construction and operational phase
- Use of electric cars inside the port area for all transport requirements
- Developing air quality management procedures for ship operators, such as navigation of port access areas at partial power, achieving full power only after leaving the port area, limiting the practice of blowing soot from tubes or flues on steam boilers.
- Include vegetation screens alongside the port access roads and apply of speed restrictions in order to the dispersion of pollutants from roads.
- If the annual nitrogen dioxide concentrations (expected outcome of the air quality modelling) exceed internationally accepted standards for protection of human health port operator have to consider resettlement of the residents living adjacent to the port access road.
- Although entire land area of port side is a green belt wherever possible thick greenbelt in port and its associated facilities will be provided.

5.6.2.1 Impact due to Ship Emissions

During the operational phase, there will be an increase in the movement of traffic and hence, emissions from the moving vehicles will also increase. The exhaust from the DG set at the port, the tugs, launches, diesel operated small boats, dredgers etc will enhance a pollution load during operational phase. With the increase in the number of ships and boats, their operation and movement of cargo to and fro will also increase. These activities will increase the pollution load in the atmosphere.

The Annex VI of MARPOL Convention deals with the "Regulations for the Prevention of Air Pollution from Ships". It sets limits on NOx and SOx emissions from ship exhausts and prohibits deliberate emissions of ozone depleting substances. It also prohibits the incineration on board ships of certain products, such as contaminated packaging materials and polychlorinated biphenyls (PCBs). The vessels are required to comply with the regulations and should have the "International Air Pollution Prevention Certificate". JNPA port will take all appropriate measures to comply exhaust emission from vessels in accordance with MARPOL regulations and Euro Emission standard norms so as to reduce pollution load in the air environment.

Mitigation Measures

- Ambient air quality monitoring will be carried out regularly at selected locations in the predicted maximum impact zone in order to check and compare the predicted concentrations with the measured concentrations.
- Although Natural green belt exists, the Greenbelt of adequate width will be developed in all possible areas including Cargo storage areas and long the boundary of expansion project area to minimize the likely impacts due to air pollution.

5.6.2.2 Impact due to Cargo Handling and Storage

Since the port is envisaged as a clean green port, and no dust cargo will be handled at port, no significant direct impact on air quality is anticipated while handling and storage. Storage and handling of dry bulk cargo, as well as from onshore operation activities and vehicle traffic on unpaved roads, may also contribute to particulate matter emissions.

Mitigation Measures

- All static and mobile diesel-powered plant / generator sets to be used only during power cut;

- Regular verification of Pollution Under Control (PUC) certificates of all the vehicles entering into the port area.
- Project will implement "Cold ironing" to reduce pollution and also to reduce power consumption
- Similarly, most of the Cranes in the port will also use electric power.
- Prohibition of use of more than 15-year-old vehicles for construction and operational phase
- Use of electric cars inside the port area for all transport requirements

5.6.2.3 Impact due to Road/Rail Corridor Development

This will not be as severe; as the construction stage impacts will be confined to receptors close to the road and rail. Both the construction and operation stage impacts can be effectively mitigated if the impacts have been assessed with reasonable accuracy in the design stage itself.

Dust Generation: The negative impacts on air quality during operation stage shall not be significant as that of construction stage. This is due to the reduction of dust particles. No dust generation is envisaged during the operation stage as the entire road shoulders are proposed to be paved or compacted and all slopes and embankments shall be turned as per best engineering practices. During the operation of rail, no dust generation is expected. The air quality shall also improve due to the plantation activity carried out in the RoW during the end of construction phase.

Exhaust Gases Generation: The major impact on air quality will be due to plying of vehicles. The impacts on air quality at any given time depend upon traffic volume/rate of vehicular emission within a given stretch and prevailing meteorological conditions. Air pollution impacts arise from two sources: (i) inadequate vehicle maintenance; and (ii) use of adulterated fuel in vehicles. Enforcement standards to meet better vehicle performance in emissions and the improvement of fuel constituents can assist in improving regional air quality.

Air quality - Mitigation Measures

During the operation phase dust generation will be a minimum because most of surface will be covered by paved shoulder. Compensatory tree plantation along the Right of Way also will act as a major sink of pollutant due to the plying vehicle along through corridor.

A regular air quality monitoring programme should be defined and implemented for the port O&M phase.

5.7 Noise and vibration

5.7.1 Potential Impact due to Port Construction

5.7.1.1 Impact due to Port Construction Activities

Construction noise will result from operation of equipment including the dredger and associated tugs, piling equipment, tracked excavators, Lorries, dump trucks, and other earth-moving equipment, cranes, and generators / lighting equipment. The exact construction methods and plant utilised will depend on the EPC contractor. Noise nuisance during construction depends on the exact place of the receptor and of the source and the duration of the activity. However, in this area it is considered high, especially as the ambient noise level for the nearby settlements. All through the study period were in the range of 38 to 50 dB(A) Leq (day time) and between 39 to 51 dB(A) Leq (night time) which is below the IFC EHS General guidelines noise standard of 55 dB(A) Leq day time and 45 dB(A) for Leq night time.

The noise and vibration generated by piling in water if not controlled and monitored properly, can be transmitted considerable distances through the water and therefore have the potential to impact on marine mammals. There are no marine mammals present in the port footprint area and nearby premises.

Such noise pollution may cause nuisances to the population. Atmospheric conditions that may affect noise levels include humidity, wind direction, and wind speed.

Seawater is an efficient medium for sound propagation, particularly low frequency sound and therefore marine life over a wide area could be potentially affected. Underwater noise during the port construction will result from the equipment that are used for underwater activities, such as dredging, reclamation or the construction of the bund wall, piling and ship movements.

Mitigation Measures

The following measures could mitigate the negative impacts caused by noise emissions:

- Noise mitigation measures shall be in place prior to the commencement of any construction work.
- All contractors and subcontractors involved in the port construction phase should comply with the relevant international noise standards;

- Activities that take place near residential or sensitive receptors to be careful planned (restricted to daytime, taking into account weather conditions, etc.);
- Residents in the vicinity to be notified about construction schedules and activities;
- All plant and equipment to be fitted with silencers, mufflers, acoustic linings, or shields, as necessary.
- If necessary, measures to be taken to reduce noise emissions from the site shall include provision of screens or bunds to absorb noise and deflect it away from receptors;
- Before commencing any piling operations, the contractors shall be required to submit calculations to demonstrate that the appropriate standards will not be exceeded
- Timing and programming outside sensitive seasons (e.g. avoiding the migration seasons of marine mammals, etc.), especially concerning underwater noise;
- Apply a change management process to modify operations, if necessary to address noise issues;
- Vehicles and generator set to be serviced regularly and maintained properly to avoid any unwanted generation of noise or vibration from them;
- Employees working in noisy environment should be made to wear earmuffs/ear plugs to avoid any adverse impact of noise on them;
- Employees exposed to hand vibration while handling/operating of heavy machineries should compulsorily wear anti vibration gloves made up of visco elastic material;
- Shock absorbing techniques should be used to minimise the impact of vibration from heavy machineries;
- Heavy machineries and generators to be operated during day time only.
- A noise monitoring programme during construction should be implemented
- Vehicles older than 15 years will not be allowed to operate during construction and operational phase.
- Preferably battery operated very low noise generating vehicles will be used in the port premises during operational stage

5.7.1.2 Impact due to Quarrying

Noise pollution may result from the quarrying activities. The main noise sources are associated with drilling, breaking, crushing and handling, screening and transport. The blasting of rocks during quarrying (Khanivade) will generate additional noise, besides the regular quarrying machinery. The most significant vibration emission will be associated with blasting activities. Minor vibrations will be associated with use of rock hammers.

Contractor to make a Contractors EMP for all major aspects of pollution including for noise. Prior to commencing the works, the Contractor should establish the baseline conditions for noise in the specific area around the selected quarry.

Monitoring right from the beginning of the production should indicate whether standards are exceeded and early action is required.

Noise - Mitigation Measures

- All contractors should comply with the relevant noise standards;
- Activities that take place near residential or sensitive receptors shall be planned (restricted to daytime, taking into account weather conditions, etc.);
- Residents in the vicinity to be notified about construction schedules and activities;
- Where necessary, noise emissions should be minimised and controlled through the application of techniques which may include installation of sound barriers and optimisation of internal-traffic routing.
- Proper maintenance of equipment to be conducted;
- All internal combustion equipment to have properly functioning silencers or mufflers;
- Adequate choice of equipment;
- Apply a change management process to modify operations, if necessary to address noise issues;
- Vehicles and generator sets to be serviced regularly and maintained properly to avoid any unwanted generation of noise or vibration from them;
- Heavy machineries and generators to be operated during day time only;
- Blasting for quarrying shall only be carried out during calm wind conditions (November to May) to avoid extensive noise emissions to far stretched areas;
- A good blasting practice with specific blasting plans (like optimal blasting hole, suitable blasting methods) shall be adopted;
- Blasting in quarrying site (Khanivade) shall be carried out during day time only;
- Signage shall be kept in the blasting area (Kahnivade) to cordon off the blasting area from general public;

- Labourers working near the blasting area shall be provided with ear muffs.

5.7.1.3 Impact due to Dredging and Reclamation - Noise

Dredging is likely to occur 24 hours a day, seven days per week. While dredging activities will generate noise from a variety of sources, the primary sources of equipment noise would include the cutter suction dredger itself, with its associated pumps and generators and the tugboats used to position the dredger. Other equipment such as the crew boats and survey boats would not contribute substantially to the noise associated with the dredging activities. Additionally, noise will be generated by onshore plant used to spread the dredged materials and to assemble and periodically relocate pipelines.

Generally speaking, a weighted noise intensity from working engines at the noise source shall not exceed a continuous level above approximately 120 dB(A).

Underwater noise: Seawater is an efficient medium for sound propagation, particularly low frequency sound and therefore marine life over a wide area could be potentially affected. Underwater noise during the Port construction will result from the equipment that are used for underwater activities, such as dredging, reclamation or the construction of the bund wall, piling and ship movements. The noise and vibrations generated by the underwater activities can potentially be transmitted to considerable distances through the water and hence cause negative impacts on the marine mammals. Conditions that determine the transmission of noise emissions and vibrations are current pattern and strength and the hydrological/geomorphologic circumstances.

Noise - Mitigation Measures

- Where necessary, noise emissions should be minimised and controlled through the application of techniques which may include installation of sound barriers.
- Optimising dredging activity and duration.

5.7.1.4 Impact due to Road/Rail Corridor Development

Traffic both along the Rail and road will be primarily due to port development and in Phase 1, one or two container trains run per day. Nevertheless, there will be some level of Noise quality impacts along the project corridor in construction. Construction stage impacts will be of short term but have adverse impacts on the construction workers as well as the settlements adjacent to the road and rail alignment, especially those in the down wind direction.

Noise created during construction activities may force birds to temporarily migrate to others places. During the construction stage, crusher, DG sets and mixture machine and diversion of traffic will lead to rise in noise level, ultimately results in increase in the ambient noise quality. However, the impacts during construction are short-term in nature and will cease on completion of the construction.

Noise - Mitigation Measures

The noise generated from construction activities of road and rail corridors is temporary and cease upon completion of construction phase. However, the Contractor should adhere to good machineries and must take all precautions to control noise pollution. The Diesel Generator (DG) sets should be erected with approval of SPCB with good enclosures for controlling noise.

5.7.2 Impact due to Port Operation

Impacts during operations mainly will result from the port terminal activities such as vessel loading/unloading, container handling and access road/rail traffic that will result from container traffic arriving and departing through the port business day.

Seawater is an efficient medium for sound propagation, particularly low frequency sound and therefore marine life over a wide area could be potentially affected. The day-to-day terminal activities such as vessel loading / unloading, container handling etc. will cause additional underwater noise emissions. These are however not expected to be significant.

Noise Mitigation Measures

- Detailed consultations with the residents along the access road should reveal those potentially affected by terminal operations, specifically traffic. These might be offered relocation or compensation.
- Acoustic fencing might be installed along the edge of the access road should the traffic-generated noise levels be significant to warrant mitigation measures
- Apply a change management process to modify operations, if necessary to address noise issues when they occur.

- Vehicles and generator set to be serviced regularly and maintained properly to avoid any unwanted generation of noise or vibration from them.
- Employees working in noisy environment should be made to wear earmuffs/ear plugs to avoid any adverse impact of noise on them;
- A regular noise monitoring programme should be defined and implemented for the port O&M phase.

5.7.2.1 Impact due to Road/Rail Corridor Development

Road and rail noise depends on factors such as traffic intensity, the type and condition of the vehicles/trains plying on the road/railway line, acceleration/deceleration/gear changes by the vehicles depending on the level of congestion and smoothness of road surface (IRC: 104-1988). The baseline noise levels monitored at various locations along the candidate road indicate the baseline levels is exceeding the permissible limits for residential and rural areas and exceeds in some commercial areas. This is mainly because of the high density of road network and the traffic plying on them and towards sea the coastal wave actions also add up to the noise levels. Even the night, noise levels recorded at the various locations are close to or higher than the noise levels allowed during daytime.

Mitigation Measures

Considering the very low traffic growth scenario noise barriers are not required in any of the locations along the Road as well as the rail corridor. However, in case after several years if this is found necessary then following are the mitigation measures suggested:

- Requirement of noise barrier wall, minimum height of 2.0 to 3.0 m can be constructed on either side of the rail corridor whereever found necessary. During the design of elevated structures, wind load need to be considered for computing the height of noise barrier wall.
- Proper maintenance of the rail track and rail wagon, by frequent lubrication to avoid frictional noise.
- Allowing the rail to travel with an optimum speed.

Figure 107 shows a noise barrier for the road. This is only required where the settlements/ cluster of houses (or Silence zones) are present. No such areas are noticed so far along the entire alignment. No solid noise barriers are found necessary due to very low traffic expecting for the first fifteen years. During this period of low traffic, only strip plantations (also called Green noise barrier) of 10 m width. The specific details of the multipurpose strip plantations are provided in following figure. In a green noise barrier the individual leaves will act as noise attenuators. The smaller the size of the leaves, the better the attenuation. Similarly, the more the number of these small leaves, the better the noise attenuation.

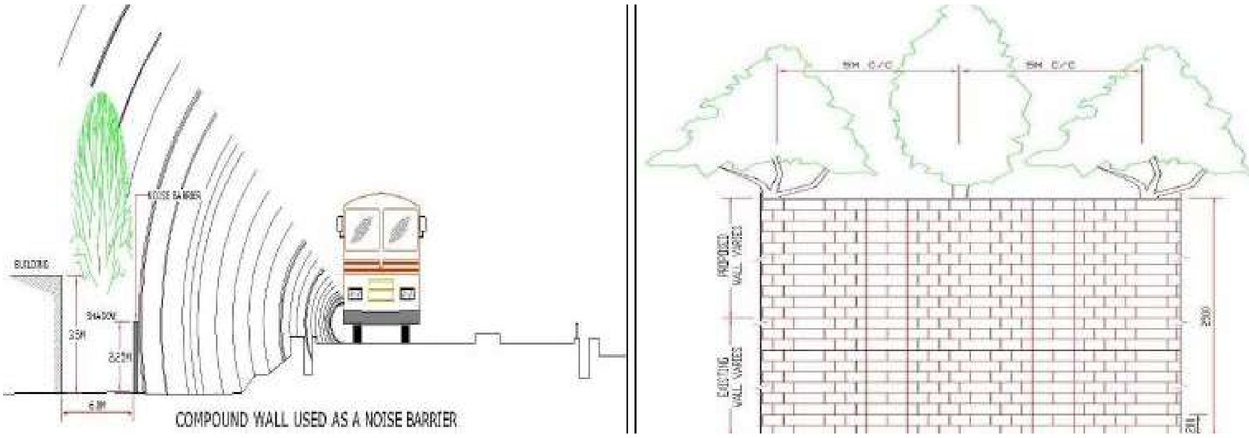


Figure 107 Noise Barriers for Road Connectivity

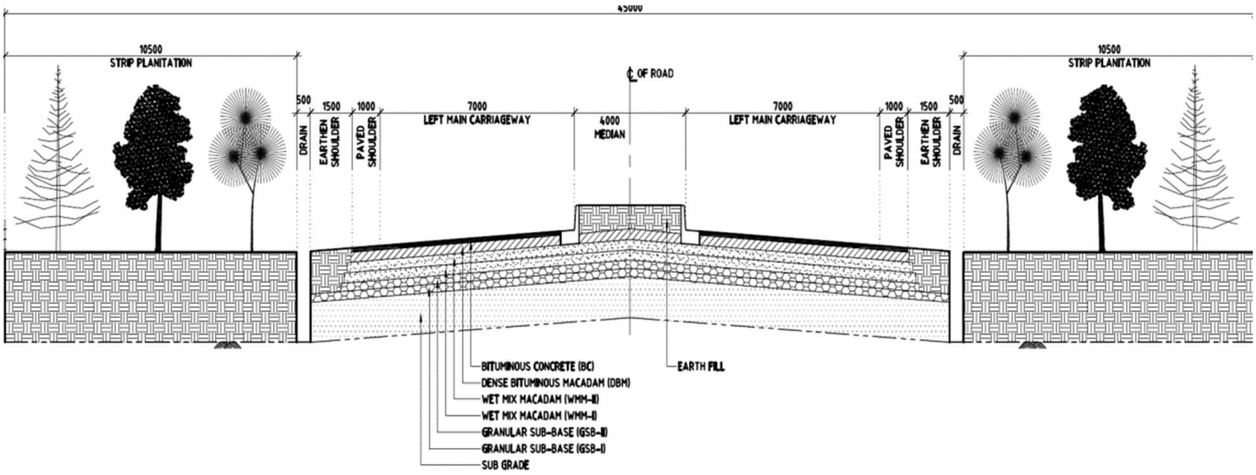


Figure 108 Green Noise Barrier for Road Connectivity

Underwater noise

Seawater is an efficient medium for sound propagation, particularly low frequency sound and therefore marine life over a wide area could be potentially affected. The day-to-day terminal activities such as vessel loading / unloading, container handling, etc. will cause additional underwater noise emissions. These are however not expected to be significant.

5.8 Waste management

5.8.1 Potential Impact due to Port Construction

5.8.1.1 Construction and Other Wastes

Construction will potentially generate the following wastes: green wastes from vegetation clearance, excess construction materials, including offcuts and packaging; hazardous wastes; oils, fuels and other chemicals generated by onsite maintenance and repair of construction equipment and machinery; Excavation materials; food wastes from construction personnel; site office wastes; and human waste; poor construction procedures that generate excessive wastes increase construction costs and results in disposal of otherwise valuable resources.

In the study area no sanitary landfill is foreseen. Therefore, there is a moderate risk to the soil quality, surface and groundwater and marine environment.

5.8.1.2 Hazardous Materials Management

Hazardous wastes (oil, chemicals, lubricants, paints, compressed gases, and varnishes, etc.) generated during the construction phase should be dealt with separately from non-hazardous waste.

5.8.1.3 Quarrying

Among others, solid waste will result from the clearing of trees and bush, from rock waste and removed topsoil. Other waste might originate from the destruction of structures, or from garbage dumped along the road and from household wastes from the construction workers. Rock impurities and trace components might cause hazardous wastes and should be managed appropriately.

5.8.1.4 Dredging and Reclamation

Most of the dredge spoil (80%) will be used for the reclamation, some spoil generated needs to be disposed-off, but sediment contamination at this point of time was not detected.

Mitigation Measures/Solid Waste Management

The port Waste Management Plan for construction and operation phase should be developed defining adequate measures for solid waste collection, segregation, reuse and disposal.

The sewage/solid waste/hazardous wastes to be treated and disposed or sold to authorised recyclers as per the MoEF guidelines.

- Port operator should prepare a Waste Management Plan defining adequate measures for solid waste collection, segregation, reuse and disposal during construction.
- Proper sanitation bins to be installed in the port area for collection of sewage/solid waste/construction wastes on site.

- Solid waste generated during the construction process to be separated and recycled where possible / appropriate.
- Burning of waste on site should not be permitted. All waste, which cannot be recycled on site, should be collected and taken off site for recycling / reuse or disposal to an official/municipal waste disposal site after consultation with local authorities.
- A 'scavenging boat' should be available at all times for collection of windblown rubbish within the harbour basin itself.
- All rubbish, waste materials and debris shall be systematically cleared from working areas as they accumulate; all such materials should be cleared at the end of each working day.
- If removal of waste materials at the end of the working day is not possible, the materials should be covered with tarpaulin or similar.
- Waste materials not removed directly from the site shall be temporarily stored at designated points and covered, pending removal from the site.
- All working areas and site roads to be kept clear of mud, water, silt and other materials at all times. If earth, mud, or other debris is deposited on roads, it shall be immediately removed.
- Hazardous waste should only be handled by legitimate enterprises and following good international practices and applicable local and international regulations (Bazel and Rotterdam Convention)
- For the purpose of an highly efficient EMP implementation pirticularily solid waste management the entire port and associated infra facilities have been divided in to 10 units (refer Chapter 10). The ultimate objective of the EMP is to create an awareness of **'Zero Tolerance'**.

5.8.1.5 Impacts due to Road/Rail Corridor Development

Solid waste from the road and rail corridors during construction will be mainly domestic scraps and wastes from the construction camps and construction spoils from construction sites.

Solid waste Management - Mitigation Measures

The solid waste and garbage will be cleared at regular intervals and disposed of in pre-identified areas.

- Small amount of construction debris will be disposed of in suitable pre-identified dumping areas in tune with the local condition to avoid land degradation and water logging due to indiscriminate dumping.
- Dumping areas shall be covered with topsoil and subsequently plantation shall be done over the same.
- Regular inspection of haul roads, construction site shall be carried out to ensure regular and timely removal of construction debris to the dumping site.
- A locally employed and trained scavenger team is required for day long operations.
- The fishing Harbour need lot of improvement works. These improvements with a ten-year life period could be a battery of toilets and bathing places, improved roads with proper covered drains with check points for solid waste removal, highly hygienic eating places, work area for fisherman to do petty jobs on the fishing nets, POL shops and repair support facility shops, health clinic, etc.
- This needs to be prepared in the form of a master plan and get approval from all stakeholders with or without changes and modifications.
- The conceptual plan includes four ‘X’ rows of toilets/bathing rooms for men and women. The maintenance will be planned in shifts. Only four rows of toilets will be operable in each month, so as to carryout maintenance at other four rows of toilets/bath rooms. This will help to maintain- toilets clean and hence providing hygienic surrounding. To confirm a sustainable operation without fail. This block includes water harvesting and septic tanks.
- Operational EMP to be prepared by JNPA need to address these issues holistically once after EPC contractor is in place.

5.8.2 Potential Impact during Port Operation

The amount of solid waste produced by the operational activities in the proposed port may be quite substantial. Wastes originating at the port may include inert solid waste from cargo packaging and from administrative offices, as well as hazardous or potentially hazardous waste associated with vehicle and equipment maintenance operations (e.g., used lubricating oils and engine degreasing solvents). Wastes originating from ships may include oily sludge, inert materials such as food packaging, and food waste. Among others, substantial amounts of solid waste will result from the terminals’ daily and periodic activities, including the cleaning of storage tanks. The quantity of municipal solid waste generated from canteen and administrative areas is estimated at about 2000 Kg/Day, of which 60% will be bio-degradable and 40% non-biodegradable. These wastes will generate odour and health impacts and ground and surface water contamination, if not managed properly.

Solid Waste- Mitigation Measures

The port Waste Management Plan should be developed defining adequate measures for solid waste collection, segregation, reuse and disposal.

- Port operation activities solid waste shall be adequately collected and managed by Contractor (as one option) in accordance with the relevant Indian laws, IFC PSs and IFC EHS guidelines for Waste Management Facilities.
- In accordance with the requirements of MARPOL 73 /78 and its annexes IV and V, appropriate facilities shall be provided for the reception of all wastes arising from ships. These should include facilities for the following basic categories of ship-generated wastes:
- Oily waste (usually oil mixed with larger quantities of seawater, also fuel residues and sludge).
- Garbage (originating from crew and passengers, maintenance of the ship, cargo and fishing activities).

5.8.1.2 Solid Waste - Impacts due to Road/Rail Corridor Development

The solid waste mainly comes from the road users. They might throw all the unwanted materials present with them like plastic bags, water bottles and some other materials, etc., while passing through the road. Such materials get accumulated on the road or may lie along roadside which can obstruct the easy movement of vehicles sometimes.

No solid waste is expected / generated along the proposed rail alignment as this is specifically dedicated corridor for port container cargo only. No passenger traffic is expected along the alignment.

Solid Waste - Mitigation and Enhancement Measures

The solid waste generated during operation phase is not significant as the proposed road and rail corridors are dedicated to Vadhavan port. However, dustbins shall be provided along roadside so that the road users can use them for disposal of waste materials if any. Signboards can be installed at desired locations along the roadside propagating people about the environment to keep neat and clean. Maintenance of the quality of the fishing harbour is very important. This cannot be achieved without adopting the fishing harbour by the port. The operational EMP need to address the prevailing solid waste issue holistically.

5.8.3 Impact on social conditions/Impact on fishery

No displacement of any house or any habitation hence no rehabilitation and resettlement will be required. No land acquisition is required for port area as the port is planned off the coast of Vadhavan by reclaiming the land. Land acquisition is only required for rail and road is less than 1000 acres. Thirty percent of which is forest land and government land. For forest land the required procedure will be followed to acquire it. Even in this land to be acquired no house or habitation or drinking water source is adversely affected.

Mitigation / Recommendations

1. Socioeconomic mapping of the villages within 10 km of project site, total number being 25 has been made & accordingly scheme for skill development and opportunities will be developed. The team of officials from JNPA visited each of these 25 villages and held meeting with the villages to inform them about the proposed project.
2. Socioeconomic mapping for total 16 villages falling on the road and rail alignment (out of these 5 villages are common in both port and rail – road alignment) have been completed for life intervention development opportunities.
3. With respect to Fishermen data collection and survey was made through CMFRI but some fishermen communities did not cooperated in the survey and therefore CMFRI has submitted their report without taking into account the views and information of these fishermen.
4. For alternate method of fish culture, JNPA with the assistance of CMFRI undertook training project of Open Sea Cage Culture by arranging their training at CMFRI research center at Karwar.
5. JNPA also took the help of an NGO “Abhinav Janseva” for liasoning & informing the local about the proposed project. NGO organized 3 medical camps particularly focusing on treatment of cancer incidences which are somewhat higher in the area. These camps were held on November 2017, December 2017 and January 2018. About 900 patients were screened.
6. JNPA in the interest of fishermen’s welfare decided to construct a cold storage, ice factory and auction hall in Dhakati Dahanu but despite the best efforts from Commissioner of Fisheries, the fishermen association did not dissolve their differences for this work.

5.8.4 Impact on socio-economic conditions

It is envisaged that during operation stage impacts are mostly positive in nature. Once the project is operational, the project has several benefits to the immediate affected community and society in large. The following positive impacts envisaged from the project:

- Employment generation for locals
- Development of road and rail connectivity
- Business opportunity due to ware-housing, cargo handling (stevedoring), transport requirements.

In addition, under Corporate Social Responsibility initiatives will be undertaken in consultation with the local administration and local population to benefit local population and environment. B The key thrust areas for CSR activities will be:

- Environment
- Primary Education
- Health Care
- Employment Skill & Job Trainings
- Environmental Services and climate resilience.

Table 144 - Environmental Impacts and Mitigation Measures - Construction Phase

Sr. No.	Environmental Parameters	Impact Attributes	Degree of Impacts	Mitigation Measures	Implementing Organization
1	Physiography	Disturbance in relief feature	Mild	– Will be achieved by systematic planning and designing of the project activities.	Promoter, Client, etc.
2	Land resources	Change in land-use for rail & road	Mild	– Will be achieved by systematic planning and implementation.	Promoter, Client, etc.
3	Human resources	No adverse impact	Negligible	– Will be achieved by systematic planning and resources.	Promoter, Client, etc.
4	Ecological resources – Flora & Fauna	No impact anticipated to threatened or endangered plant species. Mild impact on marine species which will be mitigated.	Mild	– Cutting of larger girth size trees are avoided by suitably adjusting the road / rail alignment, if required. – Replantation of trees will be done with the indigenous plant species as per the guidelines of MoEFCC – Greenbelt shall be developed around the site.	Promoter, Forestry Dept. involving NGOs and local people.
5	Environmental aesthetics values	Removal of trees shall have impacts on landscape & aesthetic values of the area	Mild	– Loss of vegetation will be kept minimum as far as possible during site clearance. In case of any loss the same will be compensated by rehabilitation and restoration of the tree species that shall be affected.	Promoter through prospective contractor
6	Utility & infrastructural facilities	Removal of utility line like electrical poles, telephone poles, transformer, HT & LT lines, if any	Nil	– --	--
7	Sub-surface hydrology	No wells and hand pumps are existing in project area	Negligible	– Whenever possible, care is taken to avoid its relocation by judicious engineering road design.	Promoter through prospective contractor

Sr. No.	Environmental Parameters	Impact Attributes	Degree of Impacts	Mitigation Measures	Implementing Organization
				– Temporary alternative water sources will be provided in case drinking water means are affected.	
8	Religious places	--	--	– --	--
9	Geology	Not much affected	Negligible	– Systematic planning and implementation during the construction and dredging. Reclamation will be done with systemic planning and least disturbance to the natural geology.	Promoter through prospective contractor
10	Surface of water	Contamination from solid wastes and sewage generated due to construction labour camp Surface runoff from the ship terminal and parking facility.	Mild	– Installations of lavatory for construction workers out of CRZ area and provision for composting the domestic refuse.	Promoter through prospective contractor
11	Air quality	Short-term deterioration of air quality due to generation of fugitive dust. Dredging activities and other construction activities leading to fugitive emission.	Moderate	– Trucks carrying soil, sand, stone, will be covered to avoid spilling. – Fugitive dust sources will be sprayed with water to suppress dust. – Emissions from vehicles & machinery will be checked regularly & maintained properly to confirm to National and State Emission Standards Barriers during construction activities such as dredging will be installed.	Promoter through Prospective Contractor (PC)

Sr. No.	Environmental Parameters	Impact Attributes	Degree of Impacts	Mitigation Measures	Implementing Organization
12	Noise level	Increased noise levels due to project activities, dredging, blasting etc.	Moderate	– All the equipments will be duly lubricated, maintained in good working condition to minimize noise levels. – Stationary construction equipments will be placed as far as possible from dense habitation. – Green belt barrier. – Provision of protection devices (ear plugs) to be provided to the workers operating in the vicinity of high noise generating machineries.	Promoter through Prospective Contractor (PC)
13	Ecological resources – Flora & Fauna	According to IUCN red list data of threaten species 4 species was recorded as Near Threaten. But these 4 species was observed at Chinchani beach which is 5 km away from the project site.	Moderate	– Necessary steps will be undertaken to reduce the impact on the reserve forest areas that support majority of the avian diversity	Promoter through Prospective Contractor (PC)
14	Land use	Mild impacts on local land use is anticipated	Mild	– Proper management planning will be achieved.	Promoter through Prospective Contractor (PC)
15	Construction workers camp	Impacts on community health	Mild	– Supply of safe drinking water to the construction camp. – Provision of adequate drainage system to avoid undesirable water logging. Provision of hygienic facilities to construction workers camp is made. – A system of regular disposal of domestic waste & sewage.	Promoter through prospective contractor (PC)

Sr. No.	Environmental Parameters	Impact Attributes	Degree of Impacts	Mitigation Measures	Implementing Organization
16	Accident hazards and safety	Short term impacts from road accidents. Impacts from accidents during handling and use of Construction machinery.	Mild	– Proper traffic diversion and management during construction. Construction Safety measures will be employed. – Proper warning signs will be used at construction site. – Workers will be provided with PPE's – Regular Training will be given to the Workers for Safety	Promoter through prospective contractor (PC)

Table 145 - Environmental Impacts and Mitigation Measures - Operation Phase

Sr. No.	Project Related Issues	Actions to be Taken	Responsible Organisation
1	Prevention of Road side Squatters or indirect Urban Sprawls	➢ Involve land use planning agencies like the Revenue Department at all levels during operation stage. ➢ Plan and control development activity. ➢ Removal, cleaning of squatter and temporary hutments of construction workers once construction activities has been completed.	P & C in consultation with the Grampanchayat.
2	Road Safety and Traffic Management	➢ Adequate number of proper & legible signs will be installed along the road. ➢ Prepare and administer a monitoring system on road/ accidents.	P & C in consultation with Traffic Police.
3	Air Quality	➢ Monitor periodically ambient air quality at selected sites. ➢ Confinement and absorption of the pollutants at source by creating vegetation along the length. ➢ Enforcing different control measures to check pollution (e.g. catalytic converters, unleaded petrol, proper serving etc.) ➢ Provision of green belt areas	P & C in consultation with MPCB

Sr. No.	Project Related Issues	Actions to be Taken	Responsible Organisation
4	Noise level	➢ Monitor periodically ambient noise level at selected sites. ➢ Minimization of use of horns near sensitive locations/ silence zones with the help of sign boards at proper places. ➢ Provide noise barriers with plantation.	P & C in consultation with MPCB
5	Water Quality	➢ Monitor periodically water quality for establishing the change of water quality, if any, and assessing its potentiality of surviving aquatic flora and fauna and for irrigation use.	P & C and MPCB
6	Soil Characteristics	➢ Periodic monitoring of soil quality at specified distance for assessing contamination by vehicular spills, operation of machineries, handling of chemicals ➢ Checking the overflow of spillage from the carriageway by promoting growth of vegetation cover along the road shoulders and preventing overflow to green belt.	P & C and MPCB
7	Maintenance of Avenue trees	➢ Plantation will be undertaken by the concession company on an aggressive note along the whole stretches on the both sides of the road. ➢ No mangroves will be cut or affected due to port construction. The port layout is planned in such a manner that mangroves will be unaffected.	P & C in consultation with authorities and forest Department
8	Human Health and Safety	➢ Vulnerable stretches, which are prone to accidents, will be identified. ➢ Adopt Safety measures and other control measure during Operation of the facility. ➢ Installing proper road signs, marking along the whole stretch in the form of cautioning, informatory and mandatory signs of gantry mounted overhead sizes. ➢ Installing fire safety measures, electrical safety measures, Personal protective Equipments and other work-safety measures. ➢ Incorporation of On-site Emergency Preparedness, Off-site Emergency Plan, Disaster Management Plan	P & C in consultation with MPCB. Public Health Department.

5.8.5 Fisheries based Livelihoods

- New fish landing centre is a part of phase-I port layout and will be constructed based on CSR provisions for a cost of INR 160 million (Rs 16 Crores).
- Improve the living conditions of those economically displaced by the Project;
- Aim to maintain or restore catch per unit of effort or catch per unit of cost;
- Design and implement, in a timely manner, culturally sensitive and economically sustainable income restoration measures;
- Provide measures and support for livelihood diversification;
- Identify and provide special assistance to people who are especially vulnerable to economic displacement impacts;
- Conduct consultation processes that achieve free, prior, and informed participation; and
- Monitor and evaluate to ensure that livelihood restoration measures are meeting the needs of affected people and to identify the need for and implement corrective measures.

Table 146 Mitigation Measures during Construction and Operations

S. No.	Type of Impact	Eligibility Project affected fishermen	Compensation/ Mitigation	
			Construction Phase	Operationtion Phase
1	Loss of beaches	--	--	--
2	Loss of fishing grounds in the marine area for breakwater, approach channel and exclusion zone	Fishing households who lost access to the impacted fishing grounds. This will include; Boat and gear owners; Crew members; and Labor for loading and unloading.	One-off cash compensation	A fishing harbour with all the required infrastructural facilities (i.e., landing terminals, road network, fish processing as well as auction area, ice plant, transportation facilities, drainage and solid waste management facilities) should be constructed.
3	Loss of income	Fishermen (including gear owners, boat owners, crew members, labor) using the beaches of Vadhavan in the project footprint area for shore seine, boat	Cash compensation for transitional loss of income till the new fishing harbour is ready or access to alternate beaches is provided.	Preference shall be given to eligible candidates from the affected fishermen households for jobs/ employment subject to vacancy and suitability and/ or training shall be provided for making suitable candidates

S. No.	Type of Impact	Eligibility Project affected fishermen	Compensation/ Mitigation	
			Construction Phase	Operationtion Phase
		launching and catch landing. Fishermen fishing in the area affected by the project.		employable and the Company shall provide jobs. Training in best fishing practices and techniques. Organize programs in fisheries science/ management, supply boat construction training, materials, and power equipment, provide training, tools, and parts for equipment maintenance and repair, provide training and gear for improving fishing techniques, provide training in Best Management Practices (BMPs)
	Damage to, and loss of gear, equipment and boats	All fishing households Experiencing damage of their property (fishing gear, boats etc.) because of Project activities	Compensation at replacement cost for loss of equipment, gear and boats and reimbursement of cost of repairing damaged gear, equipment and boats.	Compensation at replacement cost for loss of equipment, gear and boat and reimbursement of cost of repairing damaged gear, equipment and boats.

5.8.6 Impact Assessment of Proposed Sand Mining on the Marine Fisheries and Fisher Community of Daman Union Territory

Physical Effects

• Transport and settlement of fine material suspended by the dredging activity

Excavation method adopted in this project utilizes a TSHD. Unlike in the case of other dredgers including a cutter suction dredger, a grab or a bucket dredger, the increase in turbidity is less in the case of a trailing suction dredger. The absence of any cutting or excavating action will reduce the amount of turbidity generated at the point of dredging. There would however be an outwash plume resulting from hopper overflow. This will be controlled by limiting the dredging activity to areas of sandy bed. Unlike the high turbidity caused by sediment plume under normal condition in the river system outflow. The contribution to turbidity from this dredging activity is not expected to contribute significantly. There will, however, be some increase in turbidity during dredging operations. The dredging operation is discontinuous and will allow time for settlement between trips.

• Implications for coastal erosion

As the dredging operation is taking place at 22-25 m depth at a distance in excess of 50 km from the coastline, there will be no impact on coastal erosion. The temporary increase in depth will be around 1 metre and will be spread over the entirety in three season in three years of operation. This increase in depth will have no impact on the wave regime at this depth and consequently have no impact on the sediment transport process onshore. The waves experienced along this coastline are also not capable causing any measurable movement of bed sediment at a depth of 25 metres. Thus the sediment being removed from the bed does not form a part of the sediment budget of the shoreline which determines whether the beaches are stable.

• Likely Effects on changes in waves and tidal conditions

The dredging is spread over a 60 km^2 areas and average depth of removal is less than 1 metre. The seabed topography is such that there will be no measurable impact on wave and tidal conditions.

• Likely Effects on the water quality

No new soil type will be exposed as a result of dredging. The only impact will be a marginal and temporary increase in turbidity at site. Any impact will be insignificant and of a temporary nature.

Biological Effects

The biological impact will be the short-term impact on the productivity of the proposed sand mining area. Mostly sandy bed in the area to be excavated indicates a relatively low productivity compared to the other areas with fine sediment on the surface. The shortterm increase in turbidity will also affect a decrease in productivity. This temporary increase in turbidity could be diminished by the sporadic use of the trailer suction hopper dredger, which must be regulated to extract in a given area only once. The impact on the fisheries productivity could be lessened using best practice guidance during the dredging operations. In view of the total available area of nearshore for fisheries productivity, the affected area is only an insignificant fraction. However, impacts could be decreased even further if the sand could be mined from the smallest possible area within the designated grid area.

Predicting the disturbance of mobile species such as fish and other marine organisms is particularly difficult because there are few studies that have directly investigated disturbance in relation to marine aggregate extraction or suggested that significant impacts occur (ICES, 2016). Mobile species are also likely to be influenced by other impacts or anthropogenic activities outside of the sand mining area again making difficult to predict impacts between marine aggregate extraction and mobile species (ICES, 2016). Majority of the bony fish produce large number of floating eggs and the larvae which hatch from them drift in the surface currents.

Todd *et al.* 2014 reviewing the impact of dredging on marine mammals concluded that sediment plumes are generally localized and marine mammal reside often in turbid waters, so significant impacts from turbidity are less critical. The period of time required for seabed topography to recover is often site specific and dependent on the unique combination of local conditions (Wan Hussin et al., 2012).

Recommendations by ICAR-Central Marine Fisheries Research Institute, Mumbai Regional Station, ICAR-CMFRI

- The offshore sand borrow method is the most environmentally acceptable method of obtaining the required fill material. The site is selected with a view to achieving the smallest and least persistent environmental impact as possible. The method of dredging, the area of dredging and times of the dredging operations have all been selected with this in view.
- Lanka Hydraulic Institute Ltd. (2000) studying in offshore sand mining reported that the impact of removal of 1 m of bed is not expected to create a significant physical impact, the maximum possible impact will be from the temporary raising of the turbidity levels during dredging operations. The loss of productivity in the dredged area will be temporary. The inconvenience and restrictions imposed on small scale fishermen have to be minimized. The distance and depth at which dredging takes place will ensure that this activity will in no way have an impact on coastal stability.
- As the marine borrow pit location far away from the coastal region approximately 50 - 60km with high tidal range and associated strong currents, the concentration of the

sediment plume gets weakened immediately during the dredging activity. This was validated by model simulation studies of IIT Madras. The model simulation shows that the turbid plume does not reach the shore. Based on the above scenarios, it can be observed that, the plume trajectory of the dredged sediment does not move towards the coast, and they appear not to cause any impact on the shore and the marine environment.

- Project proponent should allocate a reasonable amount of funds to monitor long term effects of dredging operation on the ecosystem.
- Fishermen affected during the operation period of dredging need to be compensated against the non-accessibility of fishing ground by the fishers. In case of trawl and gillnet fishing operations, diesel cost has to be compensated if they are moving to new fishing ground.
- Guidelines for Management of Marine Sediment Extraction may be followed strictly to prevent any harmful effect on fisheries and their dependent community.
- Proposed mitigatory measures should be followed stringently in order to prevent the impact of dredging activity on productivity and fisheries of proposed sand mining area.
- A number of commonly accepted and proven practices are available for mitigation of specific effects associated with offshore extraction of sand mining. These practices reduce the potential for deleterious/ detrimental effects on the environment of the proposed sand mining area.
- Sea bed at site is completely flat and does not contain any reefs or habitats such as seagrass bed, coral reef etc. as evinced by the detailed bathymetric survey.

5.8.7 Impact on fisheries both in Maharashtra and Daman

The study was conducted by Zoological Survey of India.

The borrow pit is located in deep waters at a depth of 20-25 m which is ~50 km from the Daman coast, where there is no/ minimum fishing activity as most of the fishing in Daman is carried out in the nearshore waters and targeted at Lobster species viz. *Panulirus homarus* and *Panulirus polyphagus*. As such, there that no traditional fishing reported to be carried out in the proposed dredging area. The ccommon marine fishing practices in the region are by set bagnets (SBN) called as '*dol*' net and by '*gillnets*'. The fishermen of Daman are reported to use mechanized vessel for deeper water fishing with purse seine mostly targeted pelagic fishes like oil sardine, Indian mackerel, large carangids, Clupeids, Perches, Ribon fish and Pomfrets, occasionally for Seerfish, Tunnies and Crustaceans.

Although the proposed burrow pit area is not a potential fishing ground for such species or other commercially viable fishes, however, the proposed burrow pit being located off Daman and around the project location, there are active fishing grounds, are likely to impact the fishing practices and livelihood of fisherfolks, as this area is reported to be ease fishing area for the fisherfolks of north Maharashra coast and Daman. Therefore, during the sand mining and dredging period, there is likely to be loss of common area and loss of fishing area, although temporary in nature. Further, there will be loss of income and with the decreased fishing areas, there will be chances of increasing conflicts over fishing space. Simultaneously, due to loss of fishing time and increased operating cost (fuel) to reach far fishing grounds and return, there will be economic compression on the fisherfolk depending on this area for fishing as their livelihood. These aspects need to be considered by the proponent for sustainable and alternate ways to compensate.

The environmental impacts of dredging are mainly confined to a radius of a few hundred metres or may even remain restricted to the dredging area. The main physical impacts of dredging activities relate to removal of sedimentary material, alteration of bottom topography and re-deposition of sediment, both in the directly affected zone and in neighboring areas.

To avoid impacts of dredging on the marine fauna including macrobenthos, certain aspects must be taken into consideration. The type of dredging employed can affect the time course of recolonization. Because most of the macrobenthos lives in the top 30 cm of the sediment, the number of animals removed is directly related to the surface area of extraction (van Dalfsen and Essink, 2001). Pranovi et al. (1998) demonstrated that, with dredging that penetrates only 7-13 cm into the sediment, the fauna can recover after 15 days, but if the penetration is 20 cm, recovery does not start until after 60 days, depending on whether the organisms live on the surface of the sediment or in deeper zones. Therefore, in the present case, the proposed dredging depth may determine the recovery of faunal composition of the area.

The seasonal timing of dredging activities is crucial as their impacts can be minimal or disastrous depending on time. Therefore, periods related to reproduction or larval recruitment (usually breeding season) should be avoided. The least harmful season will usually be the late winter months and early summer.

The impact of dredging and mining activities can influence areas outside the immediate boundaries of site, affecting communities differentially. This can be brought about by lateral transport of some of the material by various means viz. spillage, current transport etc. In recent years, greater consideration has been given towards identifying mitigation measures to reduce the impact of sand extraction which are translated into appropriate authorized limit. To ensure that such authorization is effective in minimizing environmental disturbance and that predictions regarding the extent and significance of effects are sound, a monitoring programme warranted for the area. Monitoring is required to document both pre and post-extraction conditions at the project site and to determine whether unacceptable impacts are occurring, or if conditions that could lead to an unacceptable impact are developing, within and in the vicinity of site. Monitoring will also be appropriate to determine whether authorization is being properly implemented, and to improve the basis on which future dredging applications are assessed by improving knowledge of field effects.

The impact due to dredging and sand mining on biodiversity of the area are broadly as below.

Impact 1: The effect of increased turbidity levels on primary production:

Increased Suspended Sediment (SS) levels will possibly have a moderate negative impact on localised (dredging site) primary production over the short term. This will have the effect of a chain reaction with regards to the food web, but based on the small area of the site in relation to eastern Arabian Sea, any impact can be considered to be of low significance.

Impact 2: The effect of increased turbidity levels on the fish community:

It is possible that aspects such as breeding, hatching rates, larval survival, feeding and escape responses may be affected by the turbidity levels. However, the dredging process is being temporary in nature, such impact will be short term and localized and may not affect substantially to the ecosystem. Also, the absence of rare or endangered endemic fish species in the vicinity of the disposal site, means that impacts that may occur would be moderate, localised, short term and of low significance.

Zoological Survey of India in its technical report concluded that there is no significant nesting/ breeding grounds for any endemic or threatened marine species observed in the proposed sand mining area

Mitigation and Management

(1) Dredging of immediate offshore bottoms as well as shallow estuarine habitats

Dredging activities in proposed burrow pit area during the sand extraction phase will apparently destroy the seabed. There are few studies on the effects of dredging that can be attributed entirely to dredging activities in isolation. However, it is suggested that dredging activities may not be conducted during fish breeding period. It will be beneficial and minimize large-scale losses of species, as will minimizing dredging-related sedimentation around feeding and breeding as well as sensitive habitats used by marine fauna.

(2) Pollution Control

Serenity of the dredging area to be maintained and it should be totally free from solid waste and any other form pollutants emanating through vessel movement as well as onshore, offshore operations. The Environmental Management Plan should empathetically cover this aspect while designing for the construction and even during operation of the sand mining activities.

(3) Temporary halting of dredging / sand mining activities

It is suggested to halt dredging / sand mining activities to the possible extent especially during fish breeding period which is active breeding and spawning period for many marine organisms. Activities as far as possible to be avoided during night hours which will pave a movement of turtles, dolphins and other nocturnal fauna may be using this shallow area their feeding and breeding.

(4) Reduction of underwater noise pollution

The main sources of underwater noise pollution are shipping, dredging, and seismic surveying. Measures to reduce the noise from shipping vessels include modifying propellers and/or hulls and performing regular maintenance, vibrationally isolating machinery, implementing ship speed restrictions and incentivizing the use of fewer, larger vessels etc. These measures should be the part of the approval process while allowing the ship to enter into the burrow pit exaction area.

As per the recent study of Indian Institute of Technology, Madras for the proposed burrow pit, as the marine burrow pit location far away from the coastal region approximately 50 km to 60 km with high tidal range and associated strong currents, the concentration of the sediment plume gets weakened immediately during the dredging activity. The model simulation shows that the turbid plume does not reach the shore.

Based on the above scenarios, it can be observed that, the plume trajectory of the dredged sediment does not move towards the coast, and they appear not to cause any impact on the shore and the marine environment. Therefore, the impact should be temporarily in nature during the dredging and sand mining operation and also restricted to biodiversity of proposed burrow pit area, which is expected to recovered within six month to five years period.

5.8.8 Impact of Marine Biodiversity at Shankodhar Point, Dahanu Taluk, Maharashtra

The study conducted by NIO (June 2023) on documented the biodiversity at Shankodhar point over a period of two days during the low tide. Though only 12 species of fauna and one species of flora was recorded, the number of organisms within the given area were abundant supporting the fact that Shankodhar point is biologically rich. The rocky outcrops at Shankodhar point serves as a habitat for variety of organisms including the barnacles, molluscs, hydroids, and corals. Presence of molluscs egg capsule mass over the rocks indicates that this site could be the breeding ground for those organisms. In addition, there are numerous tide pools and tide channels which provide additional niches for more marine organisms. Majority of rocks were smothered with a thin tube like structures which are found to be inhabited by Tanaidacean crustacean. However, the origin and formation of these tube like structures on the rocks needs further investigation. In addition to this, a school of three dolphins were sighted in the subtidal area of the Shankodhar point indicating the presence of cetaceans in the vicinity of Shankodhar point. The dolphins couldn't be ident ified due to short sighting time. The diversity described in this report is consistent with the previous report submitted by CSIR-NIO, RC-Mumbai, with an addition of few other species. The presence of crustose coralline algae over the rocks is a positive sign since CCA is the preferred settlement substrate for majority of the sessile benthic organisms. Among other organisms recorded at Shankodhar point, the solitary cup coral Paracyathus profundus is listed under Schedule I list of protected animals under the Wildlife Protection Act (1972).

- Land reclamation may alter the coastal hydrology which in turn could affect the larval dispersal, availability of food resources, and migration of marine mammals.
- In case of dredging and further dispersion of sediments towards the Shankodhar point, the tide pools in Shankodhar point might be filled with excessive sediments which in turn can impact the benthic communities through smothering and reducing the absorption of light for photosynthesis.
- Increased turbidity and sedimentation might affect the fish community present in the area, with impacts including behavioural changes, where species will avoid area of impact, reduced foraging behaviour and physiological changes, where more suspended sediments can reduce ability to absorb oxygen, with prolonged exposure leading to reduced growth and development.
- Movement of vessels and discharge of ship waste might possibly introduce pests which could settle in to that region and threaten the native species.
- Dispersal of leachates containing harmful chemicals such as Tributyltin from the vessels towards Shankodhar point can affect the Molluscs community which were abundant in this region. Tributyltin is a common ingredient of antifouling paints and it is known to affect the spatfall and shell development in the molluscs (Alzieu and Portmann 1984). On the other hand, increased load of suspended sediments has been shown to affect the mucus production by the gastropod Haliotis iris (Raea 2013). The mucus secreted by gastropods helps in crawling and coat external part of gastropod body.
- Oil spill, if any, and its dispersion towards the Shankodhar area will have deleterious impact on marine organisms. For example, oil spill and accumulation of oil has been shown to reduce the density and species number of molluscan community in the intertidal reef flats (Garrity and Levings 1990).
- Underwater noise generated due to vessel movement, dredging, and construction might result in temporary behavioural changes of marine organisms especially cetaceans, the most common change is simply avoiding the area. Other possible impacts include temporary and permanent loss of hearing.

Recommendations by NIO

Continuous monitoring of the ecological characteristics of the habitat during and after the port construction, dredging, and land reclamation to assess the changes in the water quality, coastal hydrology, bottom contamination and diversity & abundance of marine organisms.

Deployment of artificial reefs as a measure of compensation for the loss of fishing grounds, if any, due to dredging and land reclamation.

Marine mammals such as dolphins were sighted near Shankodhar point. Induct a marine mammal observer in to the ships to monitor the movement of marine mammals and ensure a safe distance between the moving vessels and mammals by limiting the speed of the vessels.

Include measures recommended in the EIA and other studies to (i) prevent water pollution; (ii) limit disturbance of sediment, and (iii) limit the movement of barge/vessel movements.

Underwater noise can be minimized by using bubble curtains which can reduce the noise emission up to 95% and ensure that marine mammals reliant on sound wave communications are not distressed.

The work time can be reduced to minimize the sediment disbursal during adverse weather conditions.

Establish 'no wash zone' based on the local hydrodynamics between the port and Shankodhar point to prevent the introduction of marine pests due to washing/cleaning of ship hulls and release of ship waste.

All vessels coming to the port shall be checked for the presence/absence of invasive species on the hull.

5.8.9 Evaluation of Impacts

The Environment impact of the project has been discussed in this chapter and the potential of the impact is mainly under the construction and operational phase. The type and magnitude of the impact is entirely site specific.

5.8.10 Impacts from Project Location

Project location plays an important role in prevention of adverse impacts and to minimize the mitigative measures. These measures can be classified as follows:

1. Through Engineering Design
2. Through project Scheduling
3. Through Tree Planting
4. Through Rehabilitation & Resettlement Planning or through property constructed and maintained labour camps.
5. Through post construction by providing facilities other Government, Departments and agencies to watch, monitor, enforce environment standards. All this is presented in individuals tables.

5.8.11 Evaluation of impacts Matrix

Evaluation of impacts has been done for following issues namely:

1. Environmental Impact due to project location
2. Environmental Impact from construction camps
3. Environmental Impact from road construction phase
4. Environmental Impact from Operation phase.

These impacts have been evaluated and are enumerated in following Table

Table 147 Evaluation of impacts

Sr. No.	Attributes	Proposed Development Impact Marks	Mitigative measures
1	Physiography	2	Proper soil engineering and foundation designs and structural protection.
2	Land resources	0	The proposed port will be constructed on reclaimed area at intertidal zone of Vadhavan. Thus Land resources will not be used for this project
3	Human resources	1	Will be achieved by systematic planning and resources.
4	Environmental aesthetics values	1	Proposed project will cause changes in the existing Land use of the site, however, enhancement in the environmental settings envisaged.

Sr. No.	Attributes	Proposed Development Impact Marks	Mitigative measures
5	Utility & infrastructural facilities	0	No such structures within the project area.
6	Sub-surface hydrology	1	Whenever possible, care is taken to avoid its relocation by judicious engineering road design. Temporary alternative water sources will be provided in case drinking water means are affected.
7	Religious places	0	No such structures within the project area.
8	Geology	1	Will be achieved by systematic planning and resources.
9	Water Quality	2	Sewage Treatment Plant (STP) and Effluent treatment plant (ETP) during operational phase.
10	Air quality	2	Provision of adequate monitoring during operational phase, no changes in this line during construction period due to proper mitigative measures.
11	Noise level	2	Proper noise control management plan during construction period, noise barriers in terms of thick vegetation proposed.
12	Ecological resources – Flora & Fauna	3	Necessary steps will be undertaken to reduce the impact on the marine and terrestrial Flora fauna
13	Construction workers camp	1	Supply of safe drinking water to the construction camp. Provision of adequate drainage system to avoid undesirable water logging. Provision of hygienic facilities to construction workers camp is made. A system of regular disposal of domestic waste & sewage. Adequate precautions for Health and Safety of workers against COVID-19 Situation shall be followed
14	Accident hazards and safety	1	Proper traffic diversion and management during construction. Construction Safety measures will be employed. Proper warning signs will be used at construction site.

Note: The total negative impact is only 17 where severe most could have been 5 x 14 = 80. So negative impact is 21% to positive impact is 79%. As the total negative impact of the project is only 21%, therefore, it can be concluded that the proposed project will have minimal impact on the environment.

CHAPTER 6 - ENVIRONMENTAL MONITORING PROGRAMME

6.1 General

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 in the post-project phase.

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 projects Operation. The data so generated also serves as a data bank for prediction of post-project scenarios in similar projects.

Environmental monitoring during the construction phase shall comprise checking:

- Appropriate permits, certificates, authorizations and
- Compliance with the EMP and governmental regulations

This can be ensured through use of checklists for:

- Site Establishment.
- Monthly Audit.
- Site Closure.
- Environmental Management Plan implementation monitoring during the construction phase.

Monitoring Checklists are given below:

Table 148 - Project Start-Up Checklists

ENVIRONMENTAL ASPECTS	YES/NO	COMMENTS
Personnel on site are environmental aware of various issues of interest		
Telephone numbers of emergency services are available on site		

ENVIRONMENTAL ASPECTS	YES/NO	COMMENTS
Solid waste management system has been established at both construction site and labor camp		
Wastewater management system has been establish at both construction site and labor camp		
Necessary firefighting equipment is available and in good working order.		

Weekly Checklists

ENVIRONMENTAL ASPECTS	YES/NO	COMMENTS
Construction camp is neat and tidy and the laborers facilities are of the acceptable standard.		
Waste collection and removal system is being monitored.		
Sufficient firefighting equipment is available at the construction site and is in good working order.		
All construction vehicles are in good working order and have a valid PUC certificates.		
Dust control measures (wherever necessary) are in place and are in working efficiently.		
Noise control measures (wherever necessary) are in place and are effective in controlling erosion.		
Erosion control measures (wherever necessary) are in place and effective in controlling erosion.		

Monthly Checklists:

ENVIRONMENTAL ASPECTS	YES/NO	COMMENTS
Environmental Management is reviewed in the monthly review project review meeting at site.		

ENVIRONMENTAL ASPECTS	YES/NO	COMMENTS
All new personnel on site are imparted training on Environmental Awareness.		
Construction activities are undertaken according to the approved method statements.		
Fuel flammable material storage areas comply with general fire safety requirements.		
Public complaints have been recorded and dealt with the satisfactory manner.		

Site Closure Checklist:

ENVIRONMENTAL ASPECTS	YES/NO	COMMENTS
Contractor has cleared everything not forming the part of the permanent works.		
Re-vegetation has been satisfactorily completed.		
All areas disturbed during construction have been brought back to the near original condition in accordance with the conditions.		

6.2 Areas of Concern

From the monitoring point of view, the important parameters are ambient air quality, noise marine water quality, etc. An attempt is made to establish early warning system, which indicates the stress on the environment, suggested monitoring parameters and programmers are described in the subsequent sections.

6.3 Water Quality

The chemical characteristics of the water quality should be monitored as well as the biological, parameters must be checked for its life sustainability. The parameters to be monitored are as follows:

Physico-chemical parameters

- pH
- Salinity
- Conductivity
- TDS
- Turbidity
- D.O.
- BOD
- Phosphates
- Nitrates
- Sulphates
- Chlorides

Biological parameters

- Light penetration
- Chlorophyll
- Primary Productivity
- Phytoplanktons (No. of species and their density)
- Zooplanktons (No. of species and their density)

6.4 Soil Quality

The soil sample is collected in and around the site to establish the baseline characteristics of the study area. Soil sample is collected using the auger from the depth of 60 cm from the project site. Soil sample collected from the project site is analyzed for the physical and chemical characteristics and is reported.

Sediments

Physio-chemical parameters

- Texture
- pH
- Total Kjeldahl Nitrogen
- COD
- Sodium
- Potassium

– Phosphates
– Chlorides
– Sulphates

Biological Parameters

– Benthic Meio-fauna
– Benthic Macro-fauna

6.5 Ambient Air Quality

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 one season. Monitoring can be conducted twice a week for 4 consecutive weeks. The parameters to be monitored are PM_{10}, $PM_{2.5}$, $S0_2$, NOx, CO, Pb, NH_3, C_6H_6, O_3, As, Ni, B-(a)-P.

Operation Phase

Micrometeorology

An essential part of air quality monitoring would be to establish a small automatic Meteorological observation station to record daily continuous synoptic data. Arrangements for recording temperature, humidity, visibility, wind direction and speed, cloud cover, rainfall and meteorological phenomena like storms would be required to be established at the terminal site. The ambient air quality monitoring will have to be conducted at three locations; Air quality could be monitored for one season. 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}, $PM_{2.5}$, $S0_2$, NOx, CO, Pb, NH_3, C_6H_6, O_3, As, Ni, B-(a)-P. The ambient air quality monitoring during project operation phase can be carried out by project staff. Sufficient provision has been earmarked for purchase of monitoring of: Ambient air quality and micro- meteorological instruments and equipments.

6.6 Noise

Personnel involved in the 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 per year

Neighborhood (up to radius of 1 km)

It is recommended that during project operation phase, monitoring of sensitive areas like schools and Medicare centers be conducted within a distance of 1 km radius of the site to ascertain noise levels at receptors.

6.7 Summary of Environmental Monitoring Programme

The project management should always go for a rational approach with regards to environmental monitoring. This includes judicious decision making in consultation with responsible agencies such as Maharashtra State Pollution Control Board (MPCB) or reputed environmental consultants for appropriate changes in the monitoring strategy, changes in the sampling/monitoring frequency, sampling location, monitoring parameters and any new/additional requirements. The efficacy of the mitigation measures being followed during construction and operational phases can be assessed and the measures can be revised, made more stringent and reinforced based on the monitoring results.

The environmental monitoring program for construction as well as operation phases shall be implemented by JNPA and concessionaire. Besides the monitoring, compliances to all Environmental Clearance conditions and permits from MPCB/ MoEF & CC shall be monitored and reported periodically. The likely significant impacts and mitigation measures will also be monitored.

The summary of Environmental Monitoring Program for implementation during Project construction and operation phases is given in following table.

Table 149 - The Summary of Environmental Monitoring Program for Implementation during Project Construction and Operation Phase

Environmental Components	Parameters to be monitored	Frequency of Monitoring	Location	Standards Methods for Sampling & Analysis	Compliance
CONSTRUCTION PHASE					
Air	$PM_{2.5}$, PM_{10}, SO_2, NOx, CO, HC	Continuous monitoring, 2 times a week for 24 hours	3 – 4 including project site	Fine Particulate Samplers for PM10, PM2.5, Respirable Dust Sampler for SO2 and NOX, CO	NAAQ Standards, 2009

Environmental Components	Parameters to be monitored	Frequency of Monitoring	Location	Standards Methods for Sampling & Analysis	Compliance
				analyser/portable CO meter for CO and portable HC meter for HC	
Surface water /Marine water	pH, DO, BOD, O&G, Salinity, Electrical Conductivity, TDS, Turbidity, hosphates, Nitrates, Sulphates, Chlorides and heavy metals (Zinc, Lead, Cadmium, Mercury)	Once every Months both for low tide and high tide periods during construction period	Two (02) • Project site • Monitoring within 5 km area of proposed trenching/ construction activities	Bottom sampler (Nishkin Sampler) and analysis by Using standard methods	Primary water quality standards for coastal water (SW –IV)
Noise	Leq (Night), Leq (day), Leq (24 hourly)	Once in a month during entire construction period	8 – 10	Portable hand-held sound pressure level meter.	CPCB Standards
Ecological Environment (Coastal)	No. of species and density: • Phytoplankton • Zooplankton • Benthos • Fisheries	Once in a month both for low tide and high tide periods during construction period	Two (02) • Project site • Monitoring within 5 km area of proposed trenching/ construction activities	Plankton net of diameter of 0.35 m, No.25 mesh size 63µ and analysis by using standard methods	Baseline data
Bed Sediment	Texture, size, O&G, Heavy Metals (Zinc, Lead, Cadmium, Mercury)	Once every six months	Two (02) • Project site • Monitoring within 5 km area of proposed trenching/ construction activities	Peterson's Grab Sampler and analysis by using standard methods	Baseline data
OPERATION PHASE					
Air	$PM_{2.5}$, PM_{10}, SO_2, NOx, CO, HC	Continuous monitoring, 2 times a week for 24 hours	3 – 4 including project site and With 2 km radius of the proposed construction activities	Fine Particulate Samplers for PM10, PM2.5, Respirable Dust Sampler for SO2 and NOX, CO	NAAQ Standards, 2009

Environmental Components	Parameters to be monitored	Frequency of Monitoring	Location	Standards Methods for Sampling & Analysis	Compliance
				analyser/portable CO meter for CO and portable HC meter for HC	
Stack Emission	$PM_{2.5}$, PM_{10}, SO_2, NOx, CO	Once in a month	One (01) i.e. DG set at Project site	Standard Stack emission methods	Emission Limits for New Diesel Engines (upto 800 KW) For Generator Sets Gensets) Applications, Rule 2(C) of The Environment (Protection) Second Amendment Rules, 2002
Fugitive emissions	Methane and non-methane hydrocarbons	Gas detection System	Onshore receiving facility		
Noise	Leq (Night), Leq (day), Leq (24 hourly)	Once in a month	8 – 10	Portable hand-held sound pressure level meter.	CPCB Standards
Surface water /Marine water	pH, DO, BOD, O&G, Salinity, Electrical Conductivity, TDS, Turbidity, hosphates, Nitrates, Sulphates, Chlorides and heavy metals (Zinc, Lead, Cadmium, Mercury)	Once every Months both for low tide and high tide periods	3-4 • Project site • Monitoring within 5 km area of proposed trenching.	Bottom sampler (Nishkin Sampler) and analysis by Using standard methods	Primary water quality standards for coastal water (SW –IV)
Ecological Environment (Coastal)	No. of species and density: • Phytoplankton • Zooplankton • Benthos • Fisheries	Once in a month both for low tide and high tide periods	3-4 • Project site • Monitoring within 5 km area of proposed trenching.	Plankton net of diameter of 0.35 m, No. 25 mesh size 63µ and analysis by using standard methods	Baseline data

Environmental Components	Parameters to be monitored	Frequency of Monitoring	Location	Standards Methods for Sampling & Analysis	Compliance
Bed Sediment	Texture, size, O&G, Heavy Metals (Zinc, Lead, Cadmium, Mercury)	Once every six months	3-4 • Project site • Monitoring within 5 km area of proposed trenching.	Peterson's Grab Sampler and analysis by using standard methods	Baseline data

6.8 Monitoring and Compliance Reporting

As a part of environmental monitoring programme, following compliance reports shall be submitted to MPCB and Regional Office of MoEF.

- Half yearly compliance reports in respect of the stipulated prior environmental clearance terms and conditions for duration of April-Sept, and , Oct-March of every Finanacial year.
- Environmental statement for the financial year ending March 31, to MPCB on or before September 30, every year.
- Format for maintaining records of hazardous waste if any in Form 3 as per Hazardous Waste (Management, Handling and Trans-boundary movement) Rules, 2008.
- Format for maintaining hazardous waste imported and exported in Form 10 as per Hazardous Waste (Management, Handling and Trans-boundary movement) Rules, 2008.
- Safety data sheet for hazardous chemicals shall be maintained as per schedule 9 of MSIHC rules, 1989 (amended 2000).
- Format for maintaining notification of major accident in schedule 6 as per MISHC rules, 1989 (amended 2000).

6.9 Plantation Monitoring Programme

Environmental Management team will monitor the following activities of greenbelt development:

- Development of nursery
- Treatment and sowing of seeds
- Watering
- Transport of seedlings
- Planting of seedlings
- Fencing of plantation area
- Weeding and soil working
- Pruning (trimming of plant)
- Replacement/ Inter planting
- Watch and ward of plantation

During operation phase periodic monitoring of plantation growth, manuring, watering, pruning, and replacement will be performed in order to properly maintain vegetation, greenbelt and green cover.

6.10 On-site Mock Drills Requirements

On-site mock drills are very important as it helps employees to be aware of the safety procedures and how to react during the time of crisis. Conducting mock drills at regular intervals enhances preparedness and checks the viability of environmental/ disaster management plan. Mock drills are essential for the following reasons helps

- In revising/ improving the environmental/ disaster management plan
- To evaluate whether the responsible officials are trained efficiently for the unforeseen event
- In evaluating whether the emergency equipment are being maintained at port premises

To ensure efficient environmental/ disaster management, JNPA shall conduct periodic on-site mock drills in case of occurrence of the following activities:

- Fire
- Natural calamities (cyclones, floods, tsunami, earthquakes)
- Collision of vessels calling at port
- Oil spill
- Bomb threats
- War alerts/ terrorist attacks
- Power break down

Mock drills will involve fire department, police, municipal authorities, hospitals, Port users and other department/ agencies that are mandated to provide emergency support. Documenting the outcome of mock drills is an important aspect as this helps in revising the existing plan more efficiently.

CHAPTER 7 – ADDITIONAL STUDIES

7.1 RISK ASSESSMENT

7.1.1 Concept of Risk Assessment

The concept of risk assessment and its engineering application has been well acclaimed since more than a decade. A variety of major accidents have focused attention on the dangers of risk exposure for human health and environment.

Risk analysis provides numerical measures of the risk that a particular facility posses to the public. It begins with identification of potential risk involving events and determination of the impact of each event. The consequences of each event are than calculated for numerous combinations of weather conditions and wind directions these consequence predictions are combined to provide numerical measure soft the risk for the entire facility.

Risk for a particular facility is based on the following variables:

- Multiple accident outcomes
- Population disturbance
- Site-specific meteorological data

"Risk analysis is a tool which helps to translate hindsight (accidents) into foresight (planning), showing ways and means (improved engineering, procedure and supervision) to prevent the calculated accident from happening.

Visualize failure scenarios for the structures, handling equipment and estimate distances safe from damage.

7.1.2 Leaks And Spillages

It will be of prime importance to protect the marine and terrestrial ecosystem during the operations of crafts. The various possibilities of leakages and spillages of the fuel includes following probabilities

1) Spillages of fuel during re-fueling
2) Leakages of fuel during navigation
3) Leakages of fuel from storage tanks

4) Leakage or spillage during ship/Barge washing process

7.1.3 Spillages of Fuel during Re- Fuelling

The crafts will require fueling its operation depending upon its trips two end fro. There will be a possibility of spillage of fuel during re-fueling process. This may lead to disturbance in the shore ecosystem in a temporary manner. The spillage portion will be although small one, it may affect the natural marine life to save extent. To avoid such accidental spillage, following measures shall be adopted

- Proper routine checks shall be performed on the pipeline used for re-fueling, various pumps, motor valves etc.
- Safety audit shall be performed yearly to account for the performance of the re- fueling system.
- Chemical foam system shall be kept accessible to spray on the spillage.
- Oil-water separator shall be installed.
- Area of spillage will be contented using HDP or PE pipes.
- Oil Spill Contingency Plan will be followed.

In case of such a spillage oil-water separator shall be immensely used to recover the oil spread on the surface of seawater. In case, of major spillage, containment technique shall be employed immediately and oil shall be recovered without further spreading it on the sandy shore. Therefore, the major methods to be adopted for the oil spill closed to the shore shall be;

i) Containment technique

ii) Scavenging

iii) Mechanical removal

iv) Dispersion technique

v) Use of absorbing material

Incase Oil spill accident, the below given mitigative measures shall be taken in order to preserve the mangroves from damage due to oil spill:

- Booming and skimming of oil on the water surface in mangrove creeks

- Pumping of bulk oil from the sediment surface, depressions and channels
- Water flushing of free oil from sediment surface and mangroves into areas where it may be collected
- Use of absorbent materials, with subsequent collection and disposal.
- A detailed oil spill contingency plan enclosed as annexed

7.1.4 Leakages of Fuel during Navigation

There is a possibility of fuel being leaked from engine room because of various reasons. It may even happen during a collision and fuel/oil may spread on larger area in the sea. To prevent such accidental leakages, proper mechanical maintenance shall be carried out during the routine surveys as mentioned above. In case of such an event the craft shall be very well equipped with recovery system. These leakages can lead to water pollution leading to damage to mangroves, fishes, spawning problems, distraction of marine eco-culture, odor problem, and effect on marine bio-diversity.

Various mitigation measures will be enforced depending upon type of oil, quantity of spread, distance from the shore, etc. such as:

i. Scheming the surface with a suction device
ii. Absorbent technique
iii. Gelling method
iv. Sillking method
v. Emulsification / dispersion

7.1.5 Leakages of fuel from storage tanks

There will be possibility of minor/major leak from the storage tank. It may be due to faulty materials of construction, faulty erection, etc. Periodical checks shall be carried out of the tanks to find minor leakages, which may not be detected, in the routine course. Proper care should be taken to avoid the leakage of such materials into the sea. In case of such events following emergency measures shall be taken:

i. The marine terminal building shall be well equipped with oil containment facilities.

ii. There shall be a small drainage system near the fuel storage tanks, which can carry the leaked oil to the oil-water separator. The storage area is channelized with storm water drainage with inbuilt oil & grease traps at various locations which shall separate oil discharges from the run-off water.

iii. Absorbent and dispersion techniques made available near the fuel storage tanks.

iv. Intercepting drains will be provided around the site of construction and designated places for the machines where refueling and change of lubricants shall be carried out, in order trap any oil & grease discharge from the same.

v. The used oils and lubricants will be collected in drums from the equipment such as Diesel engines, compressors etc and will be send to the firm which is MPCB authorized and registered with MPCB, for recycling.

vi. These gases would be stored in enclosed tanks (Bullets) and would be routed through secured pipelines to consumers such as Automatic Panel Welding Machine, KOIKE machines etc the regular checks of gas cylinders and gas systems is carried out to prevent any gas leakages.

vii. Proper channeling from all over the seaward side of the project side will be done such as to avoid any such spillage/ leakage to enter the sea-water.

7.1.6 Leakage or spillage during ship/Barge washing process

Since the proposed Vadhavan project will require number of barges and ships to carry out the dredging as well as reclamation work there is a possibility of spillage during the ship/Barge washing process from the ship parking facility. These Spills/barges can further contaminate the land as well as water, if it is not properly channelized. However, proper mitigative measures are taken in order to avoid any such spillage/ leakage during the workshop processes.

i. The intercepting drains passing from the area are installed with oil & grease trap to entrap the oil spills, the remaining water will then be sent to sedimentation tank where it will be further treated for oil spills and pollutants. The treated water will be reused within the plant.

ii. Awareness amongst the workers regarding safe handling techniques and safety measures will be made through various workshops and seminars.

iii. In case of any accidental spill, all processes will be brought to halt.

7.1.7 Risk Analysis Study

- Identification of potential physical hazards which could trigger loss causing events such as fire and explosion, leakage of flammable materials etc. from the proposed facility.
- Identifying the Maximum Credible Loss Scenarios (MCLS) for the vulnerable areas in the storage areas in the facility for assessing the magnitude and severity of the impact of various failure scenarios in terms of damage to property and injury to personnel.
- Recommendations for risk reduction shall be made on the basis of the above for minimizing, if not eliminating various hazards and providing information on improvement of safety systems, where necessary.
- The major risk is envisaged from the storage yards, fueling of cargos. The leakage in piping, pumps and electrical fault can lead to hazardous event.
- A complete Risk Assessment will be done and the mitigative measures as well as safety measures will be proposed for the same.

7.1.8 Onsite Emergency Plan

Assessing the adequacy of available resources to take care of emergencies as identified in the risk analysis study. Providing recommendations on the infrastructure, communication system and other facilities such as first aid, security, fire fighting etc. in view of effective handling of the emergencies identified. Specifying the roles and relationship amongst personnel from the facility and outside agencies for effective handling of the emergencies. Identification of assembly points and escapes routes for evacuation. Preparation of an Onsite Emergency Response Plan Document is envisaged. The stages of On-site Emergency Plan include:

1. Outline Emergency Response Team.
    - Designated person in charge.
    - Key responsibility of each individual.
    - Telephone numbers for key people.
2. Risk Evaluation on preliminary hazards
    - Type, Quantity and Storage method of Hazardous materials used at site along with MSDS.
    - Location of possible Hazards (Process, Storage-yard, Transfer, Piping, etc.)\Type of Accidents.

- Special handling requirements, fire fighting procedures as per MSDS.
- Safety measures to be taken and installed if any.

3. Details regarding
    - Location of Key-personals.
    - Emergency Control room, if provided.
    - Emergency Telephone numbers.
    - First-aid Kit and Fire Extinguisher locations.
    - Warning alarm, safety and security.
    - Precautions during design and Engineering.
    - Continuous surveillance.
    - Details of Hospital and Fire-brigade facility.
    - Procedures for notifying family members of injured employees.
    - Procedure for reporting emergencies.
4. Awareness amongst workers for
    - Knowledge of chemicals used (property, toxicity, handling methods, etc)
    - Use of fire-fighting equipment and first-aid.
    - Mock-drill for Hazards and Disasters.
    - Use of personal protective equipment.
    - Procedure for reporting emergency.
    - Knowledge of alarm systems.
    - Manuals for each Operating system.
5. Control Plans
    - Emergency Control plans.
    - Safe time to resume work after an emergency.
    - Control measures for any spillage, leakage, explosion, etc.

7.1.9 Life Saving Appliances and Arrangements

It is one of the important aspects towards the mitigative measures to be adopted on the craft. It is also recommended to have safety appliances and arrangements even at ship terminal facility, in case of emergency for the craft during its navigation. Various life saving arrangements/appliances shall be made available for such eventualities. The major issues to be tackled for the life saving or rescue operations will be during any eventualities arising out of collision or submergence of the craft. In case of such eventualities various lifesaving appliances such as embarkation ladder, float free launching pads, spaces for laundry emersion suit inflammable appliances shall be made available on the craft. In addition to this life saving appliances an effective ladder communication system shall be made available on the crafts.

- In the event of noting such as event at the marine terminal control room to allowing life saving appliances kept ready.
- Rescue boat, which is design to rescue person in distress and to marshal survival craft.
- Retrieval rescue team for the safe recovery of the survivors and evacuation.
- Retro reflective material for detection of damaged craft in poor tight conditions
- Embarkation ladder to permit safe access at the survival craft.
- Live saving appliances such as thermal, protective aid emersion suit radio life saving appliances radiotelegraph installations in lifeboats shall be made available.
- Life buoys compiling with the requirement and regulation shall be kept ready and accessible during emergency life jackets etc shall be accessible
- Trained personnel with experience of rescue operation shall be provided on board on rescue boat.
- In case of addition to the rescue boat craft with all novel life saving appliances it is recommended that to take help of Coast Guards and also naval helicopters to search the exact site of accident.

7.1.10 Occupational Health and Safety

Specific occupational health and safety issues relevant to proposed project primarily include the following:

- Physical hazards
- Chemical hazards
- Confined Spaces

- Exposure to Organic Inorganic Dust
- Exposure to Noise

The main sources of physical hazards at ports are associated with cargo handling and use of associated machinery and vehicles. However, this shall be taken care of by applying all the terminal related norms and standards. The workers and vehicles passageway shall be kept separate. Avoiding entry of workers as far as possible in the area of ship loading and unloading activity and areas where grab is operational.

The chemical hazards are related to inhalation of fumes during fueling refueling or other emissions from the cargo. This can be eliminated by providing adequate personal protective Equipments to the workers working in such areas of exposure.

The workers working in Confined spaces shall follow the General EHS Guidelines for working in confined spaces. They will also be provided with relevant personal protective equipment.

Noise pollution can cause due to one of the various activities at the terminal or parking facility. However, proper mitigative measures are out-lined for control of noise at the Facility. Onsite medical facility will be provided in case of any hazard or casualty during the operational phase. Fire safety measures shall be incorporated and implemented. Periodic health check-up of all the workers shall be carried out.

7.2 DISASTER MANAGEMENT PLAN

7.2.1 Introduction

The important aspect in emergency management is to prevent by Technical & Organizational measures, the unintentional escape of hazardous materials out of the facility and minimize accidents and losses. Emergency planning also demonstrates the organizations commitment to the safety of employees and public and increases the organizations safety awareness. The format and contents of the Disaster Management Plan (DMP) have been developed taking into consideration the guidelines, and other accepted industry good practice principles formulated as a result of lessons learned in actual emergencies requiring extensive emergency response. This master document is to be studied in advance and used for training purpose also. This master document will be upgraded once in every three years by reviewed annually.

7.2.2 Objectives of DMP

The objective of DMP is to describe the facility emergency response organization, the resources available and response actions applicable to deal with various types of emergencies that could occur at the facility with the response organization structure being developed in the shortest time possible during an emergency. Thus, the objectives of emergency response plan can be summarized

- Rapid control and containment of the hazardous situation.
- Minimizing the risk and impact of event / accident.
- Effective rehabilitation of the affected persons and preventing of damage to property.

In order to effectively achieve the objectives of the emergency planning, the critical elements that form the backbone of the DMP are

- Reliable and early detection of an emergency and careful planning.
- The command co – ordination and response organization structure along with efficient trained personnel.
- The availability of resources for handling emergencies.
- Appropriate emergency response actions.
- Effective notification and communication facilities
- Regular review and updating of the DMP
- Proper training of the concerned personnel.

Responsibilities

Responsibility for establishing and maintaining a state of emergency preparedness belongs to the DC. He is responsible for maintaining distribution control of the plan, and for ensuring that the plan and applicable implementing procedures are reviewed annually. The Fire Safety In charge is responsible for the training of personnel to ensure that adequate emergency response capabilities are maintained in accordance with the plan. He is also responsible for ensuring the adequacy of the conduct of drills, as outlined in the On-site Disaster Management Plan. All employees of various departments are responsible for carrying out their responsibilities, as defined in this Plan.

7.2.3 Identification of Emergencies

- Various emergencies that may be expected at the port area

- Leak / Spill and fire and explosion at the chemical jetties of hazardous chemicals.
- Spillage while bunkering by vessel
- Spillage due to collision in channel
- Fire on berth / approach trestle / storage / buildings
- Medical Injury
- Sabotage
- Civil disturbance
- Hostage situation
- Severe Weather
- Earthquake
- Accidents in the channel.
- War situation/ Air strike.

7.2.4 Functions of Disaster Management

Controlling spread of accidental effects with minimum damage to men, material, machine and structures.

- To inform relevant agencies and request for help.
- To rescue victims and provide succor.
- To protect other and safely evacuate.
- To inform nearby inhabitations.
- To identify the affected persons and inform their relatives.
- To provide authentic information to news media and other.
- To preserve relevant records and equipment needed as evidence in any subsequent inquiry.
- To rehabilitate the affected areas and allot specific assignment to available manpower.

Classification of Accident

Level I	: Operator Level
Level II	: Local / Community Level
Level III	: Regional level
Level IV	: International level

Critical Targets

Disaster Management Plan is prepared after identifying the objects likely to be affected in the event of emergency. The target of fire includes personnel if emergency occurs at service platform during discharging of vessel and tank farm on shore.

Control Room (CR)

A control room will be established at a location away from likely spots of accidents and shall be easily accessible. Better location will be near the room from where all unloading operation are conducted and controlled.

7.2.5 Emergency Plan For Berths and Vessel

Terminal Emergency Plan

This plan will be drawn up in consultation with authority, fire brigade, coast guard and police etc. The plan will include:

- Specific initial action to be taken by those at the location of emergency (to notify time, position source and cause of spill) to control room and Coast guard.
- Immediate action to combat Oil –pollution.
- Evaluations of situation by on scene controller regarding threat posed by spill and identify threatened resources.
- Details of Communication system available siren code.
- An inventory including location details of emergency equipment.
- Sound alarm-terminal fire fighting staff to fight fire.
- Mobilize fire-fighting equipment.
- Electric power to switch off - emergency lighting to switch on.
- The ships calling at terminal will be advised of the terminal's emergency plan particularly the alarm signals and procedures to summon assistance in the event of an emergency, on board.

Rough Weather

The rough weather operations will be controlled in three stages

- Green Status - the operations of loading / unloading will be carried out as planned.
- Yellow status - This is an alert stage indicating possibility of rough weather, still operations can be continued with all emergency precautions.

- Red Status - Emergency situation or rough weather; operation will be suspended - Activities controlled by In charge of emergency operations. The vessel / tanker are to be unearthed to safe anchorage or will be advised to proceed to sea.

First Aid & Fire Fighting Services

The proposed project will have full-fledged medical facilities as well as fire fighting facilities available in the area.

Fire fighting system

General

The fire fighting system shall be designed to be capable of both controlling and extinguishing fires. The fire fighting system for berths and terminal areas will be a fresh water system with a separate pump house with pumps which will draw water from the respective fresh water tanks. A centralised fire station will be provided for attending to all calls which will house two mobile fire tenders. One fire tender will be provided with snorkel attachment. Alarm system should cover all buildings and have central monitoring/control as well as local.

Fire equipment Room:

- Fire buckets
- Manual Fire Sirens
- Foam branch pipes
- Mechanical foam generator
- Foam compound
- BA set
- Gum Boots
- Helmets
- Hose length (15 Meters)
- DCP fire extinguishers
- Foam fire extinguishers
- Fire suits
- Dispersant chemicals
- Double female couplings
- Male coupling
- Diffuser
- Water Curtain
- Jet Branch Pipe
- Canister Gas Masks
- Portable foam / water monitor
- DCP Unit
- Mobile foam generator
- Safety Shower

Fire equipment

Diesel engine fire water pumps.

- 1 – HP Jockey pump electrical
- Fire blankets (water jel)
- Smoke detectors in fire pump house
- Hand tool set
- Water curtains nozzles – 2 Nos
- AFFF foam
- DCP fire extinguishers
- Trolley mounted DCP fire extinguishers
- CO2 fire extinguishers
- Foam fire extinguishers

7.2.6 General Fire fighting guidelines at the Oil Jetty

1. Stop all loading / unloading operations and close valves.
2. All fire fighters will be apprised of the chemicals and POL products normally handled at the jetties. A set of MSDS is available at the fire station.
3. As a general rule all fire fighting will be carried out from a distance of 60 meter (Average heat radiation experience of 2kw/m2). If the fire fighters are required to go closer to the fire then fire suits / close proximity suit must be worn. If necessary, water cover could be provided to the fire fighters going closer to the fire.
4. The water curtain along the edge of the berth will be activated for fire / leak / spill emergency at the berth.
5. Fire floats, and any available tug should be immediately put on alert.
6. All emergency equipment should be placed beyond the over pressure distance of about 60 meters (Average overpressure distance for 1.0 psi experience) to avoid damage to them.
7. The remote water / foam monitor should be operated to control the fire at the jetty. If properly used the fire will be immediately controlled.
8. All security staff should also have access to respiratory protection as they may not be able to leave their post.
9. External help should be obtained as soon as it is felt that the emergency is grave.
10. Guards will keep note of all incoming aid equipment.

11. After the emergency is over the Deputy Conservator/Harbour Master will assign a senior management team to verify that there is no longer a threat of further fire / leak / spill, to assess damage and initiate repairs as needed.
12. Any emergency at the chemical jetties or at the dry cargo berths will be informed to the Deputy Conservator/Harbour Master, who will activate the DMP if necessary.

Dry bulk berths and stackyard

It is proposed to install Fire Hydrant System, which shall be designed to give adequate fire protection for the facility based on Indian Standard or equivalent and shall conform to the provisions of the Tariff Advisory Committee's fire protection Manual. Fire hydrant system is proposed at the following areas, which are classified as ordinary hazard areas.

- Berths
- Stackyards
- Wagon Loading Station

The fire hydrant system is designed to ensure that adequate quantity of water is available at all times, at all areas of the facility where a potential fire hazard exists. Each hydrant connection will be provided with suitable length of hoses and nozzles to permit effective operation.

Container and multipurpose terminal

The fire fighting system shall be designed to give suitable fire protection for the containerised/breakbulk cargo and container handling facilities in the terminal and shall conform to the provision of Tariff Advisory Committee’s fire protection manual. The firefighting system shall be a combination of water hydrants, fire alarm system and fire extinguishers.

Cargo Handling

Cargo falling from height

Cargoes like iron ore, quartz and steel scraps are high density cargo. There is a possibility of cargo falling from height during cargo operations. Cargo may either fall from the conveyor belt of the ship loader or from the discharging grab on to the deck of the ship. People working on deck can get injured badly if hit by the sizeable lumps of the bulk cargo. It can be as bad as death. Cargo operation should always be monitored by responsible officers and care should be taken that no unwanted personnel are present on the working area of the deck. Persons who are involved in the cargo operation should wear protective clothing including hard hats, safety shoes and highly visible vests.

Cargo care - steel cargoes are easily damaged by salt water. Before loading, test hatch covers for water tightness and repair the covers if leakage is found. Test with ultrasonic hatch cover testing equipment. After loading and closing hatch covers, apply cross-joint wedges before hatch skirt cleats. For further information on maintenance of cleats and closing of ships' hatch covers, see the club's publication 'A Master's Guide to Hatch Cover Maintenance'. Additional protection, such as sealing foam and tape, can be applied along hatch cover cross-joints in exposed areas of the ship and especially on No.1 hold if the ship does not have a forecastle. Avoid loading ballast in wing tanks when holds contain steel. Ballast should be carried only for trim and stability purposes, and propeller immersion • fit dehumidifiers in holds when steel is loaded in winter or cold conditions for discharge or passage through areas in summer/warm conditions. Dehumidify holds as the outside air temperature rises. Make sure dehumidifier cabling does not compromise the integrity of the hold or pose a fire hazard. Lead dehumidifier drains directly to hold bilges, which should be pumped dry regularly. Keep records of bilge pumping operations • during the voyage, control the dew point in the cargo hold by ventilation or by dehumidifying the air • take daily dew point temperatures of hold and outside air with a wet and dry bulb thermometer. Ventilate when the dew point of outside air is less than the dew point of hold air. This will normally occur when cargo is loaded in warmer conditions for delivery to a port, or passage through an area, with colder conditions • keep detailed records of hold and outside air temperature, at the load port, during the voyage and at the discharge port. Record times of hold ventilation and of heating fuel in tanks adjacent to holds loaded with steel • when testing steel surfaces for chlorides (salt) with silver nitrate, a resulting milky solution shows the presence of chlorides. It does not necessarily show that sea water entered the hold either through hatch covers or the hull

Dust from working cargo: Dust is one of the most common hazards in bulk carriers. Many bulk cargoes are dusty by nature. Dust particles are small enough to be inhaled and if inhaled can have disastrous effects on health. Anyone working on the deck can be exposed to high levels of dust.

Dust can cause sneezing and irritation of the eyes. Where possible it is always best to avoid exposure to cargo dust however if exposure cannot be avoided protective face masks should be worn. Those involved in cargo operation and need to be present on deck when a dusty cargo is being loaded or discharged and anyone sweeping cargo with a brush or with air should wear a suitable respirator. Filters should be renewed when soiled. Deck machinery should be properly protected as they can be adversely affected by dust.

Cargo Liquefaction: Liquefaction is a phenomenon in which solid bulk cargoes are abruptly transformed from a solid dry state to an almost fluid state. Many common bulk cargoes such as iron ore fines, nickel ore and various mineral concentrates are examples of materials that may liquefy. Liquefaction occurs as a result of compaction of the cargo which results from engine vibrations, ship’s motion and rolling and wave impact that further causes cargo agitation.

Liquefaction results in a flow state to develop. This permits the cargo to slide and shift in one direction thus creating free surface effect and reducing the GM thereby reducing stability. Shipper’s declaration should be thoroughly examined by the chief officer before loading any bulk cargo. He must make sure that the moisture content of the cargo to be loaded should not exceed the transportable moisture limit to avoid liquefaction during the voyage. Often shipper’s declaration turns out to be faulty. Spot checks can also be carried on board ships to check the moisture content.

Structural damage: Heavy cargoes place high loads on the structure and structural failure is therefore probable. High density cargoes occupy a small area for a large weight that is they have a low stowage factor. It is therefore important that the tank top has sufficient strength to carry heavy cargoes like iron ore, nickel ore, bauxite etc . The load density of the tank top should never be exceeded. Tank top strength is provided in the ship’s stability booklet. Exceeding the maximum permissible cargo load in any of the holds of a ship will lead to over stressing of local structure. Overloading will induce greater stresses in the double bottom, transverse bulkheads, hatch coamings, hatch covers, main frames and associated brackets of individual cargo holds. Poor distribution of and/or inadequate trimming of certain cargoes can result in excessive bending and sheer forces.

Oxygen depletion: Sea transportation of bulk cargoes of an organic nature such as wood, paper pulp and agricultural products may result in rapid and severe oxygen depletion and formation of carbon dioxide. Thus apparently harmless cargoes may create potentially life threatening conditions. The cargo holds and communicating spaces in bulk carriers are examples of confined spaces where such toxic atmospheres may develop. Several fatal accidents can occur when people enter unventilated spaces. The IMSBC code lists the following cargoes as potentially oxygen depleting direct reduced iron, sponge iron, sulphide concentrates, ammonium nitrate based fertilisers, linted cotton seed. Various gaseous products are formed including carbon monoxide, carbon dioxide, hydrogen sulphide and hydro carbons. Entry of personnel into enclosed spaces should be permitted only when adequate ventilation and testing of the atmosphere is done with appropriate instruments. Emergency entry may be undertaken with SCBA. Some cargoes also use up oxygen within the cargo space. The main examples are rusting of steel swarf cargoes. Some grain cargoes may also deplete the oxygen content in the cargo space.

Fire: Bulk cargoes are deemed to present a great deal of fire hazards. Many bulk cargoes have a tendency to heat due to the oxidation process taking place during the voyage. Common cargoes like, sulphur, cotton, fishmeal are liable to spontaneous heating. Dust created by certain cargoes may constitute an explosion hazard. Sulphur dust can readily ignite causing an explosion. Friction between cotton bales can cause spontaneous combustion and produce heat. Fire precautions should be strictly observed on bulk carriers. The ship as carrier is obliged to care for the cargo in an expert manner to ensure it is discharged in the same state in which it was loaded. The IMSBC code will be consulted for the safe stowage and shipment of solid bulk cargoes. Suitable precautions and good seamanship should be adopted to minimise and overcome the hazards of bulk cargoes.

7.2.7 Identification of Major Hazards

The hazards occurring at Proposed Project can be broadly classified as natural and man-made hazards. Some of the hazards existing at site are as follows:

- Earthquakes
- Fire
- Tsunamis

Earth Quake

An earthquake is a sudden, rapid shaking of the Earth caused by the breaking and shifting of rock beneath the Earth's surface. This shaking can cause buildings, dams and bridges to collapse; disrupt gas, electric, and phone service; and sometimes trigger landslides, flash floods and fires; all these are possible scenarios at Proposed Project. Buildings with foundations resting on unstable soil and slopes are most at risk.

The greatest danger for people in an earthquake exists directly outside buildings, at exits, and alongside exterior walls. Ground movement during an earthquake is seldom the direct cause of death or injury. Most earthquake-related casualties result from collapsing walls, flying glass, and falling objects.

Fire

Fire is the most probable emergency scenario at proposed project. Fire can be caused in buildings and installations as electrical fire, chemical fire (leakage of liquid cargo), Fuel fire (HSD storage tanks) or fire in buildings. To handle this scenario an onsite emergency plan has been developed by the security team and is currently operational.

Tsunamis

Tsunamis are generated by large and rapid displacements of water, mainly from sudden and large scale changes in the configuration of the sea floor associated with fault displacement or gigantic underwater landslides, which could be mainly due to earthquakes.

Earthquakes generate tsunamis by vertical movement of the sea floor as in normal faulting or thrust faulting. If the sea floor movement is horizontal, tsunamis are not generated as in strike slip earthquake. Sometimes they are triggered by marine landslides into or under the water surface, also generated by volcanic activity and meteorite impacts, but such events are extremely rare. Tsunami hazard along a coastline is therefore a combination of all the potential sources of tsunamis that lie in the neighboring sea or ocean. Tsunami waves travel at a speed of approximately 700 km/ hr in 4000 m of water. In 10 m of water the velocity drops to about 36 km/hr.

7.2.8 Emergency Response Measures for Natural Hazards

Natural Hazards cannot be prevented. However, with mitigation measures the effects/damages could be reduced.

Response in case of Earthquake

Response procedures for worker

If indoors:

- Take cover under a piece of heavy furniture or against an inside wall and hold on.

If indoors:

- Stop the process and move away from machinery, equipment, etc.
- Avoid moving around until the shaking stops.

If outdoors:

- Move into the open, away from process area, office building and utility wires.
- Gather at the Evacuation point mentioned during the safety drill and await instructions.

If in a moving vehicle:

- Stop quickly and stay in the vehicle.
- Once the shaking has stopped, proceed with caution.

After be prepared for aftershocks.

- Although smaller than the main shock, aftershocks cause additional damage and may bring weakened structures down. Aftershocks can occur in the first hours, days, weeks, or even months after the quake.

Help injured or trapped co-workers.

- Give first aid where appropriate. Do not move seriously injured persons unless they are in immediate danger of further injury. Call for help. Use Emergency numbers.
- Stay out of damaged buildings, machinery, equipments.
- Get your entire process area checked with Safety officers
- Use the telephone only for emergency calls.

Emergency Response Procedure

1. Initiate the Quick Response Team and First aid team for earthquake response
2. Give a long siren for earthquake warning
3. Inform the necessary authorities for aid
4. Ensure no personnel or residents are stuck beneath any debris

5. Ensure that all residents and personnel standing outside near the buildings are taken to open areas.
6. Close the entry gate to restrict any incoming traffic
7. Inform Electrical department to shut off the utilities.
8. Ensure that the first aid ambulance and fire tender vehicles are mobilized
9. Ensure that emergency telephone number is only used for this purpose
10. Check the utilities and storage tanks for any damage.
11. Inform structural engineers to check for any damage to the Dam structure

Response in case of Fire

- On sighting a fire, the first person should immediately inform the control room.
- If the fire is small engage in extinguishing the fire using the nearest fire extinguisher or retrieve the property that may be damaged.
- Guide staff to the emergency assembly point.
- The control room will immediately inform the first aid centre and the quick response team, which has trained fire-fighting personnel. Mobilize the fire tender.
- The Quick Response team will immediately move to the point of fire and take all necessary steps to stop the fire. If the fire is not controllable and spreads to the other area then immediately inform the security post who would in turn inform the district authorities and call for external help.
- First aid team will provide immediate relief to the injured personnel at the scene of incidence. The patients would then be evacuated on priority to the dispensary or hospital based on their condition.

Instructions for an Individual in case of fire

- Get out of buildings as quickly and as safely as possible. If outdoors stop all processes and inform the control room using emergency alarm system and Emergency numbers.
- Use the stairs to escape. When evacuating, stay low to the ground. Evacuate and assemble at the assembly point decided previously.
- If possible, cover mouth with a cloth to avoid inhaling smoke and gases.
- Close doors in each room after escaping to delay the spread of the fire.
- If in a room with a closed door.

- If smoke is pouring in around the bottom of the door or it feels hot, keep the door closed.
- Open a window to escape or for fresh air while awaiting rescue.
- If there is no smoke at the bottom or top and the door is not hot, then open the door slowly.
- If there is too much smoke or fire in the hall, slam the door shut.
- Call the security from the nearest phone
- Inform security gate if there are any persons trapped in the house or injured.
- Stay out of damaged buildings.
- Check that all wiring and utilities are safe.

Response in case of Tsunamis/Storm Surges

a) Structural measures:

1. Construction of cyclone shelters
2. Plantation of mangroves and coastal forests along the coast line acting as Bioshields
3. Development of a network of local knowledge centers (rural/urban) along the coast lines to provide necessary training and emergency communication during crisis time
4. Construction of location specific sea walls and coral reefs in consultation with experts
5. Development of well designed break waters along the coast to provide necessary cushion against cyclone and tsunami hazards
6. Development of tsunami detection, forecasting and warning dissemination centres
7. Development of a "Bio-Shield" - a narrow strip of land along coastline. Permanent structures, if any in this zone with strict implementation of suggested norms. Bio-Shield can be developed as coastal zone disaster management sanctuary, which must have thick plantation and public spaces for public awareness, dissemination and demonstration.
8. Increasing the river dike height, increasing the height of the coast by filling up of coastal sand of the same place.
9. Identification of vulnerable structures and appropriate retrofitting for tsunami/cyclone resistance of all such buildings as well as appropriate planning, designing, construction of new facilities like
   - Critical infrastructures e.g. power stations, warehouses, oil and other storage tanks etc. located along the coastline.

- ❖ All other infrastructure facilities located in the coastal areas.
- ❖ Public buildings and private houses.
- ❖ All marine structures.
- ❖ Construction and maintenance of national and state highways and other coastal roads.

b) Non-Structural Measures

1. Coastal regulations Zone Act – Strict implementation.
2. Aggressive capacity building requirements for the local people and the administration for facing the disasters in wake of tsunami and cyclone, 'based on cutting edge level'
3. Developing tools and techniques for risk transfer in highly vulnerable areas
4. Conserving and developing Natural Bioshields (Mangroves) and shelterbelt plantations (Casuarina)
5. Maintaining natural sand dunes.
6. Maintaining and promoting beach development.
7. Having diverse livelihood options.
8. Launching a series of public awareness campaign throughout the coastal area by various means.
9. Training of local administration in forecasting warning dissemination and evacuation techniques
10. Awareness generation and training among the fishermen, coast guards, officials from fisheries department and port authorities and local district officials etc., in connection with evacuation and post tsunami storm surge management activities. Regular drills should be conducted to test the efficacy of the DM plans.

7.2.9 Identification and Assessment of Hazards

Storms, Floods and fires are potential disasters for such Projects. Their likelihood of occurrence and the resulting risk of damage should be incorporated into the design analysis of each project facility.

Table 150 Summary of the Disasters Preparedness Plans

DISASTER	DESCRIPTION	RESPONSE PLAN	STAGES
Hurricanes and storms	Depending on the magnitude storms can damage the infrastructure of the project area to varying extent, thereby affecting its operation	Hurricane Preparedness Plan Secure insurance coverage.	Alert, Response Recovery
Earthquake	The proposed site is not in an earthquake prone area. Thus less chances of earthquake are envisaged.	Building and construction shall adhere to the earthquake efficiency norms.	Planning, Response, Damage Assessment and Recovery.
Fire	Fire outbreaks also vary in size and location and cause irreparable damage to the infrastructure.	Fire Prevention and Preparedness Plan Install fire fighting equipments Electrical work will be done by certified electrician. Provide proper Insurance coverage.	Response, Planning Fire Drills, Damage Assessment.
Oil Spills and leaks	Oil or fuel spill due to accidents or leakages pose a serious impact to the sensitive environment.	Spill Contingency Plan All petroleum products stored in bunded areas.	Report and Response, Recovery
Climate change	This natural occurring phenomena can pose a risk to the project if not adapted in time.	Contingency Plan	Alert, Response
Medical	Medical emergencies can occur at any moment and therefore requires a quick and coordinated effort to respond to the need.	Medical Emergency Plan First aid equipment and staff trained in CPR.	Response, Recovery

7.3 DISASTER MANAGEMENT, RISK ASSESSMENT & MITIGATION PROCEDURES FOR ROAD & RAIL CONNECTIVITY

The primary requirement for making disaster management plan is the reliable and upto date information about topography and socio-economic and climatic conditions of this region. This will help in identifying the areas vulnerable to environmental and manmade hazards. Risk is involved in every aspect, and the construction of road and rail projects are no exception. A risk is defined as the combination of probability of an event and its impacts on project objectives. The adverse impacts due to gas tanker explosions, fire hazards, major road mishaps, floods, cyclones, earth quakes etc. occur due to avoidance of hazard. Elimination of the risk (avoidance of accidents) is given prime importance and NHAI has introduced road safety provisions during the design of roads with the help of Road Safety Manual. Some of these are listed below:

• Traffic signs and pavement markings

• Removal of junctions and direct access points on main roads

• Safety barriers/delineators hard shoulders on main roads

• Improved median openings with stacking lanes

• Separate provisions and direct access point

• Underpasses and other grade separators at congested junctions

• Service roads in towns and villages for segregating local and highways traffic.

• Maintenance of means of safe access and egress

• Safe use, handling, storage and transportation

7.3.1 Risk Control Measures and Hierarchy of Risk Control

The next stage in the risk assessment is the control of the risk. The basic principles that govern the identification of and protection from hazards, in order of priority, are:

a. Remove

b. Reduce

c. Protect

Thus the contractor, having identified the risk and ranked it according to severity, has to first take steps to remove the risk itself. If this step leaves behind some residual hazards, then the attempt has to be to reduce it to acceptable levels. Only in the last resort is the worker to be issued with personal protective equipment (PPE) so that he/she can function in an unsafe environment.

General precautions to be maintained by the Contractor:

Ensure health, safety, and welfare of all workers while at work, including:

a. Maintenance of safe systems and without risks to health

b. Safe use, handling, storage and transportation

c. Information, instruction, training and supervision for health and safety

d. Maintenance of means of safe access and egress

e. Safe working environment

f. Provision of Safe articles for use and without risks to workers

g. Necessary tests and examination for the use of articles before works

h. Adequate information for the use of articles in factory

i. Elimination/minimization of risks to health and safety wherever necessary

j. Application of suitable methods for prevention and accumulation of dust and fumes

k. Exhaust system for extracting toxic fumes and dust

l. Fencing system for every dangerous and moving part; all moving parts shall be enclosed

m. Striking gear and devices for cutting off power in an emergency

Safe working speeds not to be exceeded for any revolving machinery.

7.3.2 Road Side Safety Measures

General

The Central Government through the MoRT&H / NHAI and other State Agencies (Transport & Highways) has put sustained efforts to evolve appropriate methods and approaches for preventing road accidents and injuries.

Still Road safety is a concern for all the stakeholders and the road users. Traffic fatalities increased by about 5% per year from 1980 to 2000, and since then have increased by about 8% per year in recent years.

This is attributable partly to an increase in the number of vehicles on the road, and partly to the absence of a coordinated official policy to control the problem. Many of these traffic injuries and deaths take place in constructions zones on all roads and highways.

In addition, a significant number of workers associated with construction and maintenance of roads also get injured and killed every year. This increasing trend in injuries and fatalities has been recognized as a public health problem of significance by the Central Government and other various State Government authorities and public at large.

To ensure long term road safety and rail construction safety, suitable engineering measure should be considered essential for adoption so as to help in improving safety leading to reduction of accidents.

Objective

To achieve the objectives of safety of road users and protection of workers, the following are to be ensured:

• Proper training to the workers at the time of induction

• Deployment of trained and experienced staff and workers at site.

• Protection of workers on site through strict enforcement of safety plans / standards,

• Implementation of applicable and adequate safety measures at site through proper fencing, barricading, safe access to work zone, lighting and use of Personal Protective Equipments (PPE) & other safety tools and equipments.

• Ensure smooth, safe and uninterrupted traffic flow on the project highway at all times during construction.

• Give adequate information / warning sufficiently in advance about the situation that affects the project highway through proper signage's, Demarcations, deployment of marshals etc.

• Ensure safety of road users against the hazards due to Diversion

• Road Condition

• Low Visibility

• Vehicle breakdown on carriageway

• Repair & Maintenance work etc. on carriageway or for any other reason resulting in disturbance in free flow of traffic.

• Avoid risk of damage/ disturbance to the properties adjacent to the project highway.

Guiding Principles

The guiding principles for safety in construction zones are to:

1. Warn the road user clearly and sufficiently in advance;

2. Provide safe and clearly marking lanes for guiding road users;

3. Provide safe and clearly marked buffer and work zones;

4. Provide adequate measures that control driver behavior through construction zones.

Planning & Design Phase

• To identify and include traffic control requirements in the contract specification, work program and method of construction.

• To design the Traffic Control Plan in detail, with regard to types, location and layout of traffic control devices for submission to the road authority for approval.

Construction Phase:

• To install the temporary traffic control devices safely in accordance with the approved Traffic Control Plan.

Close out Phase:

• To remove all the traffic control devices safely and reinstate the permanent traffic scheme.

Design Phase for road construction:

- Desirable stopping sight distances as per IRC SP 73-2015 and IRC SP 84-2014 should be followed.
- Transition of 1 in 20 to be provided for the change in width. New Jersey type Concrete crash barriers are recommended in urban areas or wherever required as per site conditions along with anti-glare screen for avoidance of headlight glare.
- Lateral clearance to be kept at least 1.5m width from the edge of the carriageway without any obstacles.

- Hazard markers with reflectors will be given. Frangible lighting columns and sign posts are proposed for minimizing the severity in case of collision.
- In constrained situations where deep road side drains with depth of 1.0m or more exist (including those along the central median), these will be covered by concrete or steel gratings, and should be protected by W-beam crash barrier.
- For the safety of traffic operation, local traffic would be separated / segregated from the through traffic plying on the main carriageway by provision of 5.5m /6m wide service roads with safety fence, railings, etc. where required.

Road Signs and Markings

Traffic Control Devices, Road Safety Devices and Road Side Furniture shall comprise of road signs, road markings, object markers, hazard markers, studs, delineators, attenuators, safety barriers, pedestrian guard rails, boundary stones, km stones, etc. Guidelines given in IRC: 8, IRC: 25, IRC: 26, IRC: 35, IRC: 67, IRC: 79, IRC: 103 and Section 800 of MORTH Specifications are recommended for providing these items.

Some of the commonly encountered roadside obstacles are bridge piers, abutments and railing ends, roadside rock mass, culverts, pipes and headwalls, cut slopes, retailing walls, lighting supports, traffic signs and signal supports, trees and utility poles.

All signs and markings should be of retro-reflective type only.

• All curves with R < 750m delineated on outer side of the curve from both the Directions by chevron signs. (For RHS curve it will be on shoulder and for LHS curves it will be on median)

• All embankments with height 3m or more will have W-beam metal crash barriers with delineating reflectors on them.

• In low embankments and flat curves, where crash barriers are not provided, these should be delineated by 1.5m high reflectorized delineators.

• One-way reflective road studs provided on edge lines and lines on the approach to an intersection or a high level bridge/culvert/ROB etc. with high embankment.

Safety Audit

Safety Audit is an important aspect of the project report preparation. It is carried out at every stage of the DPR preparation i.e. feasibility Stage, Preliminary Design Stage and Final Stage to ensure that the safety is not compromised at any stage. The basic aim for safety audit is to identify areas of major concern, including black spots and accident prone stretches and to propose measure to be taken for improving the engineering design with respect to safety aspects.

Construction Phase

For Safety of workers:

Following safety rules and regulations are recommended for safety of workers;

- No drugs, alcohol or alcoholic beverages are permitted on work site
- Proper provisions for sanitation, health care and solid waste disposal facilities to avoid possible transmission of communicable diseases.
- Work will only be carried out if an authorized person has ordered it.
- All connection for electricity, water supply and other temporary facilities made by authorized persons only and will be in accordance with legal and contractual requirements
- Workmen would be given safety induction before work commences.
- First Aid training programs would be given to certain identified workmen, who in turn would provide first aid to the workmen at site, when needed.
- During night hours, workers must be provided with fluorescent jackets and safety helmet with reflective tapes.
- Adequate barriers are provided to protect the workforce
- Adequate temporary lighting is provided wherever it is required.
- Adequate measures to be taken for the supply, use and storage of bituminous materials.
- Suitable precautions to be taken for underground & overhead cables.

For Safety of User

The Contractor shall obtain materials from quarries only after the consent of the Forest Department or other concerned authorities is obtained. The quarry operations shall be undertaken within the purview of the rules and regulations in force.

The material, equipment and machinery would be stocked / parked in places sufficiently away from the achinery would be parked at appropriate places with red flags and red tights on during night.

• Adequate measures are implemented to prevent operatives, tools, materials, etc. from falling onto live carriageways.

• Speed limits are set, marked, and enforced

7.3.3 Mitigation Plan For Traffic Safety

The guiding principles for safety in road construction zones are to:

• Warn the road user clearly and sufficiently in advance

• Provide safe and clearly marking lanes for guiding road users;

• Provide safe and clearly marked buffer and work zones

• Provide adequate measures that control driver behaviour through construction zones.

Roads with construction sites have higher accident rate, when compared with similar sections of road without construction sites.

Safety Plan at Construction Zone

The policy under these guidelines is to keep the closure of the roads to a minimum and to ensure that traffic is delayed as little as possible by the construction operations. Highest regard is to be given to traffic safety as well as to provide a safe working environment to the workmen. Before starting the construction work, which will influence traffic, the contractor has to get the legal permission of the road traffic authority and local police about the means and extent of securing the construction zone. The traffic management strategies to be used at construction zones should ensure that traffic safety is an integral and high priority element of the project. This can be ensured by avoiding inconvenience to traffic control elements and traffic.

Advance Warning Zone

• The "Advance Warning Zone", is the area to warn the road user of the approaching hazard and to prepare them for the change in driving conditions. It is essential for traffic control in the construction zone. It should provide information on:

• The presence of the hazard through the "Road Work Ahead" sign, accompanied by the distance to the hazard;

• Any change affecting traffic arrangements (such as a reduction in the number of lanes and/or in the speed limit) within the traffic control zones;

• Extent of the hazard (for example; the length of restriction); and for general information;

• The type of hazard.

The advance warning zone is also where the reduction in speed of vehicles should be notified. The drivers should be advised to reduce their speed so as to achieve the desired approach transition zone. The information in this zone is conveyed through a series of traffic signs along the length of the zone.

Approach Transition Zone

The transition zone is the area in which the traffic is guided into the altered traffic flow pattern around the working zone. This is one of the most crucial zones as far as safety aspects are concerned because most of the movements involved are merging/turning movements. The transition zone has two components: The Approach Transition Zone and Terminal Transition Zone.

At other construction zones, it may be necessary to divert traffic away from the original carriageway and the design of the temporary road geometry through the transition zone should take into account the following factors:

• the turning radius of the longest vehicle that generally uses the road should be the ruling radius for curves;

• where changes in vertical profiles are required these should enough to allow safe passage of animal drawn vehicles (if these are present in significant numbers);

• The zone should have good drainage to avoid any ponding on the road surface; sources of dust should be minimized. This is not only essential for good visibility but also for clearance maintenance of signs and barricades in the zone

The traffic is taken across the transition zone mostly with the help of signs, barricades, channelisers and pavement. Very often the road width available through the transition and working zones is quite insufficient for simultaneous passage of both the up and down traffic signals. In both the cases a waiting area with a properly demarcated stop line has to be provided for the vehicles.

Working Zone

The working zone is where the actual construction is being undertaken. It contains the work area and a working space, as well as lateral and longitudinal buffer zones to create the safety zone to protect both the workforce from wayward vehicles entering the area of actual work and the road users from construction equipment.

Speeds should continue to be controlled in this zone because of the close proximity of moving construction plant and site operatives.

The path of the traffic must be very clearly delineated through the traffic control zone to avoid vehicle intruding into the work area. Delineators and channelisers must be used effectively for this purpose. Where the work site uses machinery with revolving booms like cranes or excavators the intrusion of moving parts must be taken into account when determining the lateral clearances for the buffer or safety zone.

Terminal Transition Zone

The terminal Transition Zone (TTZ) provides a short distance to clear the work area and to return to normal traffic lanes. It extends from the downstream end of the work area to the sign indicating the end of works.

A downstream or closing taper may be placed in the TTZ. It may be useful in smoothening the flow of traffic. However, it may not be advisable when the trucks carrying material move into the work area by reversing from the downstream end of working zone. The length of the downstream taper may be 25-30m.

Sign Placement

The correct positioning and size of signs will ensure that it can observed and recognized, thereby providing the driver with more time to react and take action. The following principles should govern the positioning of signs:

• Their location should have clear visibility;

• They should be so placed that driver would have adequate time for responses.

• As a general rule, signs should be placed on the left-hand side of the road. Where special emphasis is required, duplicate signs should be installed on the left and right side of roadway

• In case of hill roads, the sign shall generally be fixed on the valley side of the road unless traffic and road conditions warrant these to be placed on the hill side;

• Roll up signs mounted on portable supports may be placed within the roadway itself.

• Roll up signs may also be mounted on or above the barricades

• The signs should be covered or removed when they are not required.

Traffic cones and cylinders

Traffic cones are 500mm, 750 mm and 1000mm high and 300mm to 500mm in diameter or in square shape at base and are often made of plastic or rubber and normally have retro-reflectorized red and white band. Their advantages are that they:

• cause minor impediments to traffic flow and capacity,

• are well recognized and understood, without damaging vehicle when hit,

• can be easily stored and transported ,

• can be fastened to the pavement and self-restoring when hit.

Their disadvantages are that they have minimal respect of drivers, can be equally penetrated displaced and knocked over and require special treatment for night times. Cones and cylinders are easily blown over or displaced unless their bases are loaded with ballast or anchored. It may, therefore be sometimes necessary to double the cones in order to provide added weight, use the cones with special weighted bases, use heavier weighted cones or use weights such as sand bag rings to provide increased stability but this weight should not present a hazard.

Barricades

a. Barricades are intended to provide containment without significant deflection or deformation under impact and to redirect errant along the barrier. They are designed to be easily relocated and have four specific functions to:

• Prevent traffic from entering work areas, such as excavations or material storage sites;

• Provide protection to workers;

• Separate two-way traffic; and

• Protect construction such as false work for culverts and other exposed objects.

b. Barricades can be portable or permanent. Portable barricades should be stable under adverse weather conditions and appear substantial but not so much as to cause excessive damage to the vehicle if they are struck. Types-I and II are portable whereas Type-III is permanent (2001: Guidelines for Safety Construction, Indian Road Congress, IRC: SP: 55:2001 p 19-22).

Flagman

The control of traffic through work area is an essential part of road construction and maintenance operations. Flagmen with hand signaling devices such as flags and sign paddles play crucial role in this direction. Red Flags, STOP, SLOW paddle and lights and are used in controlling traffic through work area.

7.3.4 Worker And Work Zone Safety

Hazardous materials handling, storage, and use

General responsibility of the Contractor during construction activity;

The Contractor has to maintain evidence to show he has performed the following tasks:

• Identification of major accident hazards in construction activities.

• Taken adequate steps to prevent major accidents and to limit their consequences

• Provide workers with information, training, and equipment, including antidotes

• Notification of major accidents

• Undertake full analysis and send information to Labour Directorate and the concerned Ministry

• Not to undertake any construction activity without submitting safety report to the authority 3 months before commencing activity

• Furnishing a further report if the Contractor makes any change in construction activity.

• Preparation of an up-date on-site emergency plan to deal with major accidents with names of responsible persons and those authorized to take action

• Every worker to be informed of emergency plan.

• Maintaining information about persons outside the worksite and the nature of accident hazard to which they are exposed and the safety measures to be adopted

• Maintenance of Safety Data Sheet of all the materials that are being used in the construction activities and providing this information to the workers

• Container of hazardous chemicals to be clearly labeled about contents, manufacturer, and physical, chemical and toxicological data

• Provision of adequate steps to contain contaminants and prevent accidents; and provide workers with safety information, training and equipment

• Proper labeling of all hazardous materials

• Packaging, labeling, and transport shall be done in accordance with Motor Vehicles Act, 1988

• Reporting of polluting accidents to the State Pollution Control Board.

General operating instructions that shall be maintained by the Contractor at any construction site are:

• Drivers entering site shall be instructed to follow the safe system of work adopted on site. These shall be verbal instructions or, preferably, written instructions showing the relevant site rules, the site layout, delivery areas, speed limits, etc.

• No passengers shall be carried, unless specific seating has been provided in accordance with the manufacturer's recommendations

• Working on gradients beyond any equipment capability shall not be allowed

• Prevention of dumper and dump truck accidents should be managed by providing wheel stops at a sufficient distance from the edges of excavations, spoil heaps, pits, etc.

• The manufacturer's recommended bucket size must not be exceeded in excavators

• If excavators are operating on a gradient which cannot be avoided, it must be ensured that the working cycle is slowed down, that the bucket is not extended too far in the downhill direction, and that travel is undertaken with extreme caution. A large excavator must never be permitted to travel in a confined area, or around people, without a banksman to guide the driver, who should have the excavator attachment close in to the machine, with the bucket just clear of the ground. On wheeled excavators, it is essential that the tyres are in good condition and correctly inflated. If stabilizing devices are fitted, they should be employed when the machine is excavating

• When the front shovel of the 1800 backhoe loaders is being employed, the backhoe attachment shall be in its "travel" position, with the safety locking device in place

• When operating the backhoe in poor ground conditions, the stabilizers tend to sink into the surface of the ground, reducing stability. Therefore, frequent checks shall be made for the stability of the machine. The loading shovel should always be lowered to the ground to stabilize the machine when the backhoe is employed.

• The netting operation of the skip wagons should be carried out prior to lifting the skip to reduce the risks of working on the rear platform

• If a tractor dozer is employed on clearing scrub or felling trees, it shall be provided with adequate driver protection

• When two or more scrapers are working on the same job, a minimum distance of at least 25m shall be kept between them

• In case of hydraulic breakers, hydraulic rams and hoses shall be in good working condition

• All wood working machines shall be fitted with suitable guards and devices such as top guard, riving knife, push stick, guards for drive belts and chains, and emergency stop switch easily accessible by the operator

• Every moving and dangerous part to be securely fenced, and regularly examined to prevent contact with the worker

• Examination/operation of machinery to be done only by trained/certified adult worker wearing tight fitting clothing.

• Provision of suitable devices shall be available for cutting off power in emergencies from running machinery

• All parts such as lifting machines, chains, ropes and lifting tackle shall be properly maintained and examined every 12 months

• The lifting machines, chains, ropes and lifting tackle shall not be loaded beyond marked safe working load

• Crane should not approach within 6m of the working place

• Safe working speeds of revolving machinery should not to be exceeded

• Floors, stairs and means of access shall be of sound construction, properly maintained, free of obstructions, and provided with handrails

• Fencing should be provided for working at heights

• Pits, sumps, openings in floors, etc shall be securely covered / fenced

• Provision of escape, fire extinguisher and adequate training to the workers in case of fire

• Safety Officers to be appointed where more than 1000 workers are employed

• Compulsory disclosure of information regarding dangers, detailed health and safety policy, and emergency plan to the workers.

7.4 OIL SPILL CONTIGENCY PLAN:

7.4.1 Introduction to Oil Spill Contigency Plan:

OIL SPILLS ARE, unfortunately, common events in many parts of the Countries. Most of them are accidental, so no one can know when, where, or how they will occur. Spills can happen on land or in water. Preventing oil spills is the best strategy for avoiding potential damage to human health and the environment. However, once a spill occurs, the best approach for containing and controlling the spill is to respond quickly and in a well-organized manner. A response will be quick and organized if response measures have been planned ahead of time.

The proposed development of port will institute and develop a Spill Contingency plan in the interest of the Cargo movement, Cargo handling equipments, cargo movement and standby generators. This plan will basically cover any hydrocarbon/ Oil spill and/or leak that could occur, the appropriate response strategies, resources required for response and training and effectiveness of the plan. Since each spill is different, it is not practical to develop a spill response procedure that will encompass every situation. Such understanding coupled with training will enable those involved in the response effort to determine the best practical procedures given the various conditions.

7.4.2 Objectives of Oil Spill Contigency Plan:

The primary objective of the Oil Spill Contingency Plan (OSCP) is to:

Minimise the potential effects on terrestrial, marine and shoreline environments that could result from a marine oil spill, occurring within the ports, port waters and port facilities.

This objective is to be achieved by:

- Minimising the spread of oil spilt on the sea surface;
- Recovering spilt oil on water;
- Protecting key marine and coastal resources from impact by oil;
- Cleaning oiled shorelines;
- Choosing spill management strategies, which are efficient and do not, themselves damage the environment.

Objectives of the Marine Response:

The objectives of the Marine Response Strategies are to:

Protect the marine environment by containing spilt oil close to the spill site, and to recover it;

Protect the shoreline and coastal resources by;

- containing and recovering spilt oil on water;
- deflecting oil away from sensitive shorelines;
- dispersing oil, which is likely to impact sensitive shorelines.

Monitor the movement and behaviour of oil on water.

Priorities

In any spill response, human health and safety are the first priorities. In particular the following must be considered:

Fire and explosion hazards

Small boat safety

The priorities in the Marine Response are to:

- Contain and recover the oil as close to the source as possible;
- Protect any threatened resources based on predicted trajectory;
- Contain and recover any oil that has escaped the primary control operations;
- Recover any oil that has pooled along the coast in bays or coves;
- Safely dispose of recovered oils and debris.

Objectives of Shoreline Response:

The objectives of the Shoreline Response Strategies are to:

- Protect sensitive shorelines from the impact of oil by the use of booms in order to:

  - Minimise any immediate environmental effects from the oil.
  - Minimise any adverse effects from the cleanup efforts.
  - Facilitate the natural recovery of the shorelines.
  - Restore the shoreline as close as possible to its condition before oil impact.

- Rehabilitate oil affected biological communities if necessary.

7.4.3 Scope of The Oil Spill Contigency Plan

This Oil Spill Contigency Plan (OSCP) describes procedures to be used in the event of oil spills occurring during all Port operations taking place on marine surface or seashore, in order to reduce loss and damage to the environment. All personnel in Port Staff and Contractor workers are obliged to adhere to the Oil Spill Contigency Plan (OSCP) during operations. Personnel in charge of any given activity are always responsible for the practical implementation of the OSCP. All personnel are required to familiarise themselves with the operational response action procedures. For this purpose a summary of the procedures set out in the OSCP is given in the Guidelines for fuel handling, storage and transport.

7.4.4 Purpose of Plan

The purpose of the plan is to outline the procedures necessary to:

- Increase staff awareness on Spill Response
- Define the coordinating mechanisms necessary for staff to utilize their resources in Response Procedures.
- Establish and define clearly the roles and responsibility of Management in Spill Contingency and Response procedures.

7.4.4.1 Mechanism

This plan institutes the need for a timely and effective response to incidents of spill in the marine environment. In order to respond rapidly and successfully to a spill, personnel responsible for containing and cleaning up the spill must know the steps that need to be followed during and after the spill. Contingency plans describe information and processes for containing and cleaning up a spill that occurs in a defined area of the project.

7.4.4.2 Fuel Management

Fuel management is a very critical safety issue considering the type of development and its location. It is however, not a difficult task to do considering the small to medium volumes that will be handled by the project. Fuel will be managed to prevent spills and leaks via the following:

Storage: Fuel will be stored inside a reinforced concrete containment wall. To protect against any accidental fire the tank will be sited away from all electrical installations within the utility zone.

Documentation: It is important to keep in mind that the project must order the correct amount or volume of fuel required for operation. For this reason, all the fuel consumed and received must be recorded.

Maintenance: It is necessary to inspect the containment walls, fuel tanks and generators for spills and/or leaks.

7.4.4.3 Causes of Disaster

1. Human failure
2. Accident
3. Sabotage
4. Natural disaster

7.4.4.4 Type of Emergency:

- Fire in the port installations.
- Spillage of any chemical followed by fire/ toxic effect
- Spillage of any oil followed by fire or toxic effect
- Spillage of oil from pipeline snaps and leaks.
- Collision of ships in the vicinity of coastal and in the port area.
- Mishaps at the tanker terminal

7.4.4.5 Level of Oil Spill

Level 1: Minor oil spill which does not affect the surrounding area and is limited within the port premises and can be managed by the available resources. It calls for the Onsite Emergency Plan within the Jetty premises.

Level 2: Major oil spillage where surrounding area gets affected and extensive district/state and coast guard assistance is required. In this case Off-Site Emergency plan has to be activated.

7.4.4.6 Types of Leaks And Spillages

The OSCP has been designed to cover all spillages of oils carried by vessels arriving, transferring cargo and departing the ports etc.

It will be of prime importance to protect the marine and terrestrial ecosystem during the operations of crafts. The various possibilities of leakages and spillages of the fuel includes following probabilities

1) Spillages of fuel during re fueling
2) Leakages of fuel during navigation
3) Leakages of fuel from storage tanks

7.4.4.7 Natural causes -

Natural causes such as oil that seeps from the bottom of oceans which enters the marine environment. Crude oil is formed during long periods of time through natural processes involving organic matter from dead organisms. Thus, oil exists in many environments and may be naturally spilled due to various factors (including climatic conditions, disturbance, etc.). Such natural oil spills may occur in oceans, due to eroding of sedimentary rocks from the bottom of the ocean (the effect may be similar with that of an accidental oil spill from human drilling in oceans).

7.4.4.8 Anthropogenic causes –

Including accidental oil spills as well as leaks and spills due to a large variety of human activities related to oil refining, handling and transport, storage and use of crude oil and any of its distilled products.

Thus, it is evident that a variety of sources for oil spills and a variety of ways the oil could be spilled exist. While various anthropogenic and natural sources of oil spill pollution determine the type and amount of oil spilled, as well as the location of the oil spill, the type of the oil spill pollution is important for the fate and transport of the spilled oil and its impact on humans and the environment. This could have disastrous effects due to the high concentrations of released contaminants and the difficulty to remediate such big spills. At the same time, an oil spill involving small but continuous releases such as those from leaking pipelines or road runoffs may have little visible effect (they are naturally attenuated usually due to microbial degradation as well as due to many chemical-physical processes)

7.4.4.9 Spillages of fuel during Re- fuelling

The crafts will require fueling its operation depending upon its trips two end fro. There will be a possibility of spillage of fuel during re-fueling process. This may lead to disturbance in the shore ecosystem in a temporary manner. The spillage portion will be although small one, it may affect the natural marine life to save extent. To avoid such accidental spillage Following measures shall be adopted

- ➢ Proper routine checks shall be performed on the pipeline used for re-fueling, Various pumps, motor valves etc.
- ➢ Safety audit shall be performed yearly to account for the performance of the re- fueling system
- ➢ Chemical foam system shall be kept accessible to spray on the spillage,
- ➢ Oil-water separator shall be installed,
- ➢ Area of spillage should be contented using HDP or PE pipes.
- ➢ Oil spill contingency plan shall be followed.

In case of such a spillage oil-water separator shall be immensely used to recover the oil spread on the surface of seawater. In case, of major spillage, containment technique shall be employed immediately and oil shall be recovered without further spreading it on the sandy shore.
Therefore, the major methods to be adopted for the oil spill closed to the shore shall be

i) Containment technique
ii) Scavenging
iii) Mechanical removal
iv) Dispersion technique
v) Use of absorbing material

7.4.4.10 Leakages of fuel during Navigation

There is a possibility of fuel being leaked from engine room because of various reasons. It may even happen during a collision and fuel/oil may spread on larger area in the sea. To prevent such an accidental leakages, proper mechanical maintenance shall be carried out during the routine surveys as mentioned above. In case of such an event the craft shall be very well equipped with recovery system here are number of methods which shall be force in to action depending upon type of oil, quantity of spread, distance from the shore, etc. universal accepted methods adopted for such an event are described below:

i) Burning of the oil
ii) Scheming the surface with a suction device

iii) Absorbent technique
iv) Gelling method
v) Sillking method
vi) Emulsification / dispersion

Various ill effects of the leakages shall be summarized as fishing problems, spawning problem, distraction of marine eco-culture, smell nuisance, etc.

7.4.4.11 Leakages of fuel from storage tanks

There will be possibility of minor/major leak from the storage tank. It may be due to faulty materials of construction, faulty erection, etc. Periodical checks shall be carried out of the tanks to find minor leakages, which may not be detected, in the routine course. The leakages, if on the ground, can be prevented and tackle immediately but in case it is from the bottom the surface, the care should be taken to avoid its meeting into the sea. In case of such events following emergency measures shall be taken:

i) The marine terminal building shall be well equipped with 0il containment Facilities.
ii) There shall be a small drainage system near the fuel storage tanks, which can carry the leaked oil to the oil-water separator.
iii) Absorbent and dispersion techniques made available near the fuel storage tanks

7.4.5 Effects of Oil Spill on the Environment

The shiny, rainbow colored substance floating on the water is nothing less than a layer of death. As brutal as that might sound, both, the environmental and livelihood effects of this disaster are nothing less than fatal.

There are a number of ways that oil may be introduced into the marine environment, including the operational, accidental and illegal discharges from shipping (and to a lesser extent boating), tanker accidents resulting in major oil spills, dumping of industrial wastes, sewage and industrial discharges and atmospheric deposition. For ports and harbours located within urbanised areas, all of these sources are likely to occur. For many estuaries, inlets or bays chronic inputs (for example sewage and industrial effluents) are the most important source of oils. It follows from this that within the port environment, port or shipping related activities might not be the only cause, or the major cause, of any oil contamination that may exist.

Over 80% of reported oil spills occur within port and harbour areas, however the majority are small in size and result from normal operations such as loading and bunkering (MPCU 1997). Other inputs may occur from the transport of oil in tankers, including the accidental or illegal discharges of tank washings and oil-contaminated ballast water. However, oil pollution is not only a concern of ports with oil terminals or commercial traffic, but small ports, harbours and marinas can also contribute to the amounts of oils entering the marine environment. Inputs from recreational craft are generally recognised as being insignificant in comparison to the inputs from commercial shipping (BMIF 1997), but can contribute to the potential effects of oil pollution in marine SACs. For example, sources of oil contamination in marinas include, spills of fuel and lubricating oils, exhaust emissions, wood treatment solutions, and run-off from marina parking lots (Voudrais & Smith 1986). These are common sources that also arise from shipping and maintenance activities in ports and harbours.

It is difficult to assess the effect of oil in the marine environment because of the large variation in sources, quantities, and nature of the oil, also the physical, chemical and biological conditions of the environments involved. The majority of research relating to the effects of oil on the marine environment relate to major oil spill events, usually from shipping accidents and groundings, the environmental effects of which are well known by all, particularly the associations with oiled birds and mammals. However, very little literature describes the effects of chronic discharges from run-off or numerous small discharges of oil, which are common in port and harbour areas. A summary of some of the potential effects of oil on the environment is shown below. As well as causing environmental damage, oil pollution can be very costly to clean up.

Ecological imbalance

Oil spill casts a slick, sticky charcoal grey coloured layer of oil (with a strong suffocating stench of tar) that covers the water surface, obstructing sunlight. Due to this, the phytoplanktons or plants growing at the bottom of the sea cannot photosynthesize due to absence of sufficient sunlight, leading to their death, if left untreated.

The substance is so toxic that it can cause massive loss of species that live in the sea. Oil spill penetrates into the plumage and fur of birds, breaks down the insulating capabilities of feather which makes them heavier, disallow them to fly and kill them via poisoning or hypothermia.

Presence of dense crude oil restricts marine animals from absorbing oxygen through the water. And it doesn't stop there. This oil laden water enters their gill slits, suffocating them to death.

Oil spills disturb the ecological equilibrium to a great level causing destruction of species.

Summary of the potential effects of oil on the environment

- Marine animals and plants tend to be tolerant of low level concentrations of oil in sediments from chronic or small discharges, however this is not always the case.
- Exposure to major and minor oil spills can lead to the mass mortality of benthic communities, fish, marine mammals and birds, and the severe damage of saltmarsh.
- Conversely, the effects of major oil spills on marine habitats and species can often be temporary and non-fatal
- Saltmarsh vegetation often recovers well after a single spill, however chronic pollution may cause the long-term loss of saltmarsh vegetation. Different saltmarsh species show different tolerance to oil, with the result that repeated spillages may alter the community structure and allow tolerant species to become dominant.
- Contamination of sediments with oil may modify chemical, physical and biological processes. Contaminants can be trapped in the sediments and later released as a result of disturbance, such as erosion.
- In sediments, as it is organic, oil will be broken-down relatively quickly by micro-organisms which may result in the localised removal of oxygen from the sediments and surrounding water with possible effects on marine life.
- The persistent toxic constituents of oil, such as heavy metals, can become stored in the sediments and taken up into the food chain.

The containment, dispersal or clean-up of oil spills can greatly minimise the extent of the effects on the environment. The use of dispersants assists in the breakdown of oil, removing it from the water surface and preventing its spread, therefore timely use in the right locations may prevent oil spills reaching the intertidal and may avoid or reduce impacts on birds. However, they promote the penetration of oil into the sediments, potentially affecting shallow fishing grounds and other sensitive intertidal habitats. In cases where oil cannot be prevented from covering intertidal habitats it may sometimes be better left untreated and allowed to be removed by tidal action, as the clean up operations are often more damaging than the effects of the oil alone (Howard, Baker & Hiscock 1989). For example, considerable damage was caused by vehicles driving over eelgrass *Zostera* beds during clean-up operations following the Sea Empress spill (SEEEC 1996). All environmentally sensitive areas should be identified in the risk assessment.

7.4.6 Onsite Emergency Control Plan:

Responsibility: The responsibility of the Onsite emergency control plan execution and completion will be assigned to the specific responsible officials.

Site Main Controller decides whether emergency exists or is likely requiring the emergency plan

- Exercises direct operational control of the works outside the affected area
- Shutting down of the operation and evacuation if required in consultation with other key personal.
- Liaise with Environmental officer, fire officer, Police services and statutory authorities.

Site Incident Controller :

- On hearing emergency oil spill will rush to the site of incident, take control of the situation and inform the site main controller.
- Initiate pollution control operation to secure safety of personal and minimize damage.
- Direct rescue and Firefighting operation.
- Inform Emergency control centre, Fire/Safety Officer and Site Main controller regarding the incident and type of control required.
- Inform the Medical officer in case of emergency.

Fire Officer:

- To lead fire fighting team and rush to the incident location
- In consultation with the site incident controller, evacuate the workers to the assembly point.
- To maintain sufficient water pressure in the fire hydrant system

- To arrange for fire extinguishers as well as fire-brigade.
- To rescue causality based on severity and sent them to medical centre in coordination with Medical officer.
- To arrange required safety equipment.

Medical Officer:

- To arrange for medical assistance to the injured during emergencies.
- To coordinate with other hospitals and doctors in Raigad district in case of bigger disaster.
- To maintain sufficient stock of medicine for purpose of disaster management
- To provide first aid to the injured.
- To train the employees for first aid in case of emergency.

Site Engineer:

- To move to Emergency control centre.
- List out people in affected site by head count.
- To inform relatives of affected people
- To arrange to call all concerned engineers
- To arrange for materials and vehicles as required.

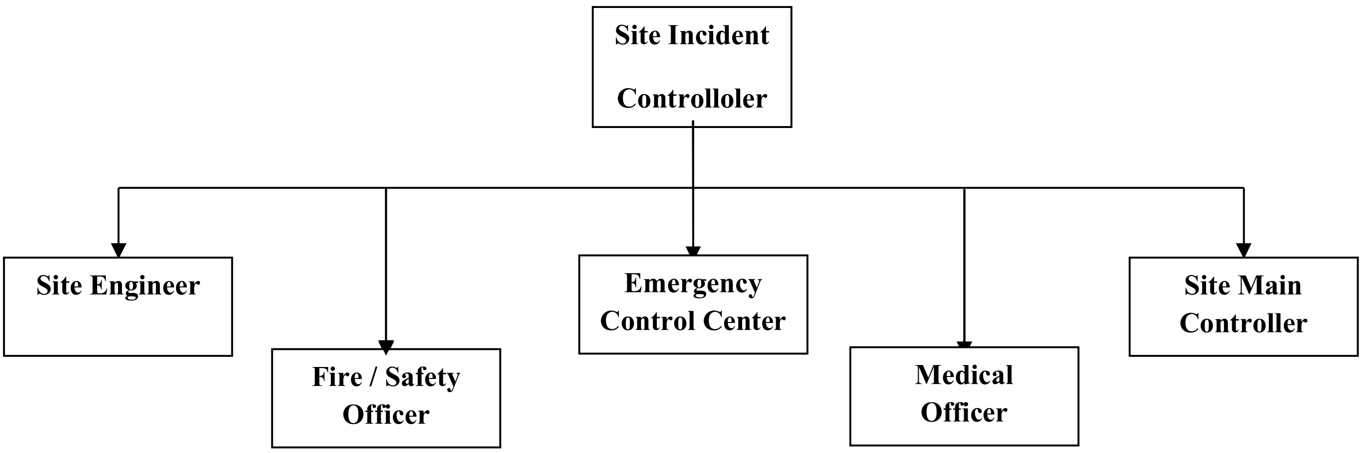
Emergency Control Centre:

The emergency control centre will be in the administrative building at the site. The control centre will be equipped with the following:

- Adequate number of telephones, internal telephones, telex, fax.
- VHF transceiver will be available for emergency purposes.
- A hotline linking the district authority.
- Internal external Telephone Directories
- Emergency Telephone numbers
- Emergency manuals.
- Emergency light.
- Wind direction and speed indicator.

- Complete plan of jetty showing : location of Berths, transmission lines, sources of safety equipments, Personal protective equipments, fire fighting system, stock of other fire-extinguishing material, Site entrance and roadways, emergency exits and emergency evacuation paths, Assembly points and routing, medical centre, life saving equipment, etc.
- Notepads, pens, pencil, computer, etc.
- A list of key individuals with addresses and telephone numbers, etc.

ONISITE EMERGENCY PLAN



7.4.7 Offsite Emergency Plan:

The offsite Emergency plant shall include the reporting and coordination to the district fire services, medical department, Police department in case of level -2 Emergencies.

- Pollution response facility – Oil pollution response vessel and response boats.
- Pollution Contianment Equipment- RIVER Boom
- Pollution Recovery Equipment – Skimmers, recovery bags, sorbents, dispersant spray system, Oil spill dispersant.
- Waste collection, storage and disposal facilities.
  Pollution response training

7.5 REHABILITATION AND RESETTLEMENT ACTION PLAN

Action Plan for Land Acquisition

Approximately 298.44 hectares of private land, 79.38 Hectare of adivashi land area spread across 21 villages of Dhahanu and Palghar Taluka of Palghar District of Maharashtra State. over a total length of ~33.4 km is required for the project. The land is required for construction of road and rail and maintenance, parking space, etc Acquisition of land required for the project will affect properties falling within the Right of Way (RoW) and thereby persons associated with the properties. The acquisition of land will mainly impact agricultural land. The impacts of the project will majority will be limited to agricultural land but will also affect and displace people residing and/ or operating a business or other activities from the structures that are falling on the RoW. Thus, the project will cause both physical and economic impacts. Therefore, improvements on land will be impacted leading to relocation, disruption of shelter and business, loss of livelihood, etc. The broad impacts likely to be caused due to the proposed project are:

1. Loss of agricultural land;
2. Severance of land plots;
3. Residual land area becoming unviable;
4. Loss of structure (full or partial) of Titleholder, Squatter, Encroacher, Occupant;
5. Loss of other properties and assets such as boundary walls, hand pumps, tube wells, dug wells,etc,
6. Displacement of owners and tenants of both residential and commercial entities, if any
7. Loss of livelihood of land owners and persons associated with land and business,
8. Loss of kiosk, work shed, etc
9. Loss of trees, standing crops, etc
10. Loss of common property resources such as religious places, samadhi, graveyard, cremationplaces, water resources, village gates, etc,
11. Impacts on the livelihood of persons losing business units including commercial encroachers and,squatters,
12. Disruption of social network during the construction period and access to resources, etc.

The purpose and objectives of legal and policy framework are to ensure that compensation and resettlement and rehabilitation aspects of the project are consistent with the national, state laws, notifications, policies and funding agency's guidelines. Resettlement and rehabilitation activities are implemented in accordance with the provisions laid down under this section.

Table 151 Land acquisitation details

Sr. No.	Taluka	Village	Total Land Acquisition (in Ha.)			Private Land Area			Adivashi Lan Area			Govt. Land Area			Forest Land		
			For Road	For Rail	Total	For Road	For Rail	Total	For Road	For Rail	Total	For Road	For Rail	Total	For Road	For Rail	Total
1	Dahanu	Varor	20.62	10.06	30.68	20.49	10.03	30.53	-	-	-	0.13	0.03	0.15	-	-	-
2	Dahanu	Chinchani	9.65	5.40	15.04	9.64	5.40	15.04	-	-	-	0.00	-	0.00	-	-	-
3	Dahanu	Tanashi	29.41	14.38	43.79	29.34	14.20	43.53	-	0.14	0.14	0.07	0.04	0.11	-	-	-
4	Dahanu	Bavade	44.09	21.12	65.21	40.36	20.37	60.73	0.28	-	0.28	3.44	0.75	4.20	-	-	-
5	Dahanu	Vangaon	9.35	5.19	14.53	9.35	5.19	14.53	-	-	-	-	-	-	-	-	-
6	Dahanu	Kolavali	22.54	10.89	33.43	22.33	10.80	33.13	-	-	-	0.20	0.10	0.30	-	-	-
7	Palghar	Newale	25.36	1.97	27.33	24.01	1.97	25.98	1.35	-	1.35	-	-	-	-	-	-
8	Palghar	Hanuman Nagar	10.96	-	10.96	-	-	-	-	-	-	-	-	-	10.96	-	10.96
9	Palghar	Shigaon	20.89	-	20.89	6.81	-	6.81	13.29	-	13.29	0.79	-	0.79	-	-	-
10	Palghar	Sumadi	19.79	-	19.79	6.50	-	6.50	5.95	-	5.95	0.07	-	0.07	7.28	-	7.28

Sr. No.	Taluka	Village	Total Land Acquisition (in Ha.)			Private Land Area			Adivashi Lan Area			Govt. Land Area			Forest Land		
			For Road	For Rail	Total	For Road	For Rail	Total	For Road	For Rail	Total	For Road	For Rail	Total	For Road	For Rail	Total
11	Palghar	Gargaon	21.33	-	21.33	7.96	-	7.96	2.20	-	2.20	-	-	-	11.16	-	11.16
12	Palghar	Ravate	6.14	-	6.14	1.47	-	1.47	4.67	-	4.67	-	-	-	-	-	-
13	Palghar	Chichare	16.83	-	16.83	2.89	-	2.89	1.41	-	1.41	-	-	-	12.53	-	12.53
14	Palghar	Akoli	5.52	-	5.52	3.67	-	3.67	1.85	-	1.85	-	-	-	-	-	-
15	Palghar	Akhegavaon	19.27	-	19.27	-	-	-	16.75	-	16.75	-	-	-	2.52	-	2.52
16	Palghar	Nanivali	41.18	-	41.18	36.54	-	36.54	4.64	-	4.64	-	-	-	-	-	-
17	Palghar	Ambhedhe	13.89	-	13.89	8.87	-	8.87	-	-	-	5.02	-	5.02	-	-	-
18	Palghar	Dhamatane	22.98	-	22.98	-	-	-	17.98	-	17.98	-	-	-	5.00	-	5.00
19	Palghar	Kolhan	17.10	-	17.10	0.27	-	0.27	2.73	-	2.73	-	-	-	14.10	-	14.10
20	Palghar	Ghol	20.61	-	20.61	-	-	-	4.17	-	4.17	-	-	-	16.44	-	16.44
21	Palghar	Tawa	7.97	-	7.97	-	-	-	1.96	-	1.96	-	-	-	6.01	-	6.01

Sr. No.	Taluka	Village	Total Land Acquisition (in Ha.)			Private Land Area			Adivashi Lan Area			Govt. Land Area			Forest Land		
			For Road	For Rail	Total	For Road	For Rail	Total	For Road	For Rail	Total	For Road	For Rail	Total	For Road	For Rail	Total
22	Total		405.46	69.01	474.47	230.49	67.95	298.44	79.24	0.14	79.38	9.73	0.92	10.64	86.01	-	86.01
	Grand Total		405.46	69.01	1,947.47	230.49	67.95	298.44	79.24	0.14	79.38	9.73	0.92	10.64	86.01	-	86.01

RESETTLEMENT POLICY AND LAND ACQUISITION FRAMEWORK

The guidelines are prepared for addressing the issues limited to this project for resettlement and rehabilitation of the PAPs. This policy has been developed based on the National Highways Act 1956 and The Right to Fair Compensation and Transparency in LA RR Act, 2013.

R&R Benefits for Project Affected Families

The resettlement and rehabilitation (R&R) benefits shall be extended to all the Project Affected Families (PAF) whether belonging to below poverty line (BPL) or non-BPL. The details are provided in the entitlement matrix. For tribal the following provisions will be adhered. Each Project Affected Family of ST category shall be given preference in allotment of land.

Tribal PAFs will be re-settled close to their natural habitat in a compact block so that they can retain their ethnic/linguistic and cultural identity

The Tribal Land Alienated in violation of the laws and regulations in force on the subject would be treated as null and void and the R&R benefits would be available only to the original tribal landowner.

PRINCIPLES AND POLICIES ADOPTED FOR THE PROJECT

The core involuntary resettlement principles for this project are:

a) land acquisition, and other involuntary resettlement impacts will be avoided or minimized exploring all viable alternative sub-project designs;
b) where unavoidable, time-bound resettlement plan (RP) will be prepared and PAPs will be assisted in improving or at least regaining their pre-project standard of living;
c) Consultation with PAPs on compensation, disclosure of resettlement information to PAPs, and participation of in planning and implementing sub- projects will be ensured;
d) vulnerable groups will be provided special assistance (v) payment of compensation to PAPs for acquired assets at replacement rates;
e) payment of compensation and resettlement assistance prior to the construction contractor taking physical acquisition of the land and prior to the commencement of any construction activities;
f) Provision of income restoration and rehabilitation; and

g) establishmentof appropriate grievance redress mechanisms.

ENTITLEMENT MATRIX

The broad entitlement matrix comprising the R & R compensation and assistance is presented below. The titleholder PAPs will receive compensation for land and assets, as decided by the competent authority. The titleholders are entitled to receive compensation for land/assets at replacement cost,R & R assistance and allowances for fees or other charges. They should be given advance notice to harvest non-perennial crops, or compensation for lost standing crops. They will have the right to salvage material from existing structures

The LARR-2013, represents a significant milestone in the development of a systematic approach to address resettlement issues in India and closes significantly the gap between Indian national policies and operational policy of the World Bank/ADB. The NationalHighways Act, 1956 gives directives for the acquisition of land in the public interest and provides benefits only to titleholders.

Based on these, the following core involuntary re-settlement principles are applicable:

- Avoid or minimize land acquisition and involuntary resettlement impacts by exploring all viable alternative designs;
- Where displacement is unavoidable, prepare time-bound RAP for PAPsso that they are not worse off than the present socio-economiccondition after the implementation of the project. In other words, assist affected persons in improving their former living standards and income earning capacity with additional assistance to vulnerable groups;
- Ensure wide range of meaningful consultations with stakeholdersincluding likely PAPs on compensation, disclosure of resettlement information, participation of PAPs in planning and implementation of the resettlement program in order to suitably accommodate their inputs and make rehabilitation and resettlement plan more participatory and broad based;
- Facilitate harmonious relationship between the Executing Authority and PAPs through mutual co-operation and interaction;
- Ensure payment of compensation and resettlement assistance prior totaking over the possession of land and commencement of any construction activities;

- Provision of rehabilitation assistance for loss of livelihood/income;

Land Acquisition Plan

Land acquisition plan has been prepared by VPPL based on the approved alignment. Revenue maps of all villages and urban areas falling in the Vadhavan Port Project alignment were collected and digitized. The final alignment was then transferred on revenue maps of villages. Latest available ownership documents such as Form 7, Form 12, etc. were collected for each land plot of every revenue village for the compilation of land acquisition plan. Village wise land acquisition plan comprised revenue map of village, alignment marked on village revenue map, summary table of affected land plots (survey no.), land area to be acquired from each land plot, and other relevant documents as per the requirement of Land Acquisition Collector for scrutiny and necessary processing under Section 11 of RFCTLARR Act, 2013. Thus, village wise land plots affected (under acquisition) by the project formed the basis for conducting surveys for titleholders. Names of owners of land plots under acquisition have been obtained from Form 7 (ownership document) for conducting a census and socio- economic survey.

Need for Identification of Structures and Other Assets Affected -

Structures and other properties likely to be affected within the Right of Way have been identified and noted based on physical survey. Any structure (residential, commercial, small business units, etc.) and Common Property Resources (CPRs) falling within the proposed RoW either partially or fully have been considered as likely affectedstructures. However the details about the dimension of structures, present use, construction materials used, etc.have to be assessed. Simultaneously, names of owners, possessors of structures, etc associated with the likely affected structures and properties are required to be noted once the perception of people is diverted to the project benefits.

The land acquisition proposal is to be finalized on the basis for conducting a census and socio-economic survey. Surveyors who conduct the survey shall be provided a list of land owners of Gata/ Survey No.of the village for conducting the survey. Census survey to be conducted with owners and others (encroacher, squatter, tenant) who are available during the survey. Efforts shall be made by revisiting the villages to conduct a survey with as many affected persons as possible. The survey will generate data to assess the extent of impacts and provide baseline data on socio-economic conditions ofthe PAPs. The survey formats covered data generation on demography, education, occupation,sources of income, land holding, ownership of dwelling and other properties, consumer durables and consumer assets owned by the households, livestock holding, availability of basic facilities (drinking water, toilet, bathroom, electricity, etc) and their views on the project and option for resettlement and rehabilitation.

The socio-economic survey questionnaire to be developed keeping in view the aims and objectives and baseline data needed for assessing the socio-economic conditions of project affected persons with specific concern to vulnerable sections of the society (Scheduled Caste, Scheduled Tribe, Women-Headed Household, Disabled, Elderly Persons, etc) for monitoring the status of project affected persons during and after the implementation of project, if any.

Land Acquisition Process

In the state of Maharashtra, acquisition of private land for irrigation and other projects by negotiation through direct purchase method (Govt. of Maharashtra, Revenue & Forest Department, Govt. decision No. SANKIRNA-03/2015/Para. Kra.34/A-2 dated 12 May 2015 &Govt. decision No. SANKIRNA-03/2015/Para. Kra.34/A-2 dated 30 Sept, 2015) will befollowed for acquisition of land for the project as it widely accepted and followed in DFCC, NHRDCL, MUTP-III and Samrudhi Marg etc.

Land Acquisition and Resettlement Impacts

Development projects generate not only positive impact/ benefits but also cause adverse social impacts as well. Various alternatives have been explored from the beginning of the study for finalization of the alignment. One of the prime criteria for selection of final alignment has beenleast resettlement impacts particularly, impact on residential structures i.e. bypassing habitations/settlements in the project corridor as far as possible. Even then the adverse impactsof the project cannot be avoided fully.

The Vadhavan Port project is likely to bring several positive impacts in the area in terms of connectivity between various urban centers along the alignment, development of ancillary industries, development of planned urban centers, generation of employment, etc, but not without its adverse impacts in terms of land acquisition and involuntary resettlement impacts, if any. The implementation of the project will result in loss of land, dismantling of structures sometimes leading to displacement, loss of livelihood, loss of community resources, etc which are falling within the Right of Way of Road and Rail connectivity (RoW). The implementation of the proposed project will affect owners, and persons associated withproperties and assets and as such appropriate mitigation measures to address such adverse socialimpacts is a logical necessity.

Scope of Land Acquisition

Majority of the project alignment traverses through greenfield area and as such major impacts are on fertile agricultural land. Land required for the project includes construction of road and rail will be at an elevation to avoid crisscrossing of local traffic and intrusion of animals on road. Private land required for the project will be acquired primarily through consent award and government land will be transferred through inter-governmental process.

LEGAL AND POLICY FRAMEWORK

A Legal and Policy Framework (LPF) has been prepared by VPPL Project proponent i.e JNPA. This LPF includes purpose and objectives, resettlement and rehabilitation principles, applicable acts, notifications, guidelines, policies, entitlement matrix and approach to be followed in minimizing and mitigating adverse impacts likely to be caused by the project implementation. The compensation and resettlement and rehabilitation assistance to project affected persons shall be provided in accordance with this LPF in letter and spirit.

Legal Frameworks for Land Acquisition and Resettlement & Rehabilitation

The following section outlines the laws, policy principles and procedures recommended to be followed for land acquisition, compensation and resettlement and rehabilitation assistance for project affected households/ persons (PAHs/PAPs).

i. The Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation andResettlement Act, 2013 (RFCTLARR, 2013).

ii. Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Acts, 2006;

iii. The Scheduled Castes and The Scheduled Tribes (Prevention of Atrocities) Act, 1989;

iv. Govt. Decision No. SANKIRNA-03/2015/Para. Kra.34/A-2 dt 12 May 2015, Revenue & ForestDepartment, Govt. of Maharashtra – Reg. Acquisition of Private

Land for Irrigation and other Projects by negotiation through direct purchase method

v. Govt. Decision No. SANKIRNA-03/2015/Para. Kra.34/A-2 dt 30 Sept 2015, Revenue & ForestDepartment, Govt. of Maharashtra – Reg. Acquisition of Private Land for Irrigation and other Projects by negotiation through direct purchase method

vi. The Gazette Notification (RNI No. MAHENG/2009/35528), Govt. of Maharashtra

vii. The Gazette of India, Extraordinary, S.O 425(E), Ministry of Rural Development Notification dated9th February 2016;

viii. The Provisions of the Panchayats (Extension to the Scheduled Areas) Act, 1996;

ix. The Gazette Notification (RNI No. MAHENG/2009/35528), Govt. of Maharashtra on PESAexemption of linear projects;

x. Right to Information Act, 2005

xi. CSR activities under Companies Act, 2013

Action Plan for Fishermen

The JNPA will prepare a Fisher-folks Compensation Policy (FCP) for VPPL project in consultation with all stake holders and fishermen community. and a Fisher-folks Compensation Committee (FCC) will be set up by JNPA/VPPL with Dy Chairman, JNPA as the Chairman, and members from Fishing Community, Department of Fisheries, Revenue, MMB, Police, Fisheries Scientist and JNPA/ VPPL officers as its members. The Committee conduct will meetings for formulating the policy. In addition, a Stakeholder's meeting will also be conducted by the Dept. of Fisheries and site visits with PAPs.

Participation Process

A Stakeholder Engagement Plan is proposed to be developed by CMFRI which includes a full identification and mapping of stakeholders, prioritization, and the design of communication. The plan clearly conveys expectations, responsibilities and the commitment to engagement.

Early stakeholder engagement significantly helps to understand stakeholder expectations and to channel them to feasible, sustainable projects. This substantially reduces conflicts in the short and medium-terms and lowers project implementation costs. It is a key to understanding project dynamics and sources of leverage.

Proceedings of all meetings and workshops need to be held with project stakeholders and recorded using audio, video and photographs.

A Legitimate Process

Potentially impacted stakeholders are being carefully consulted during the preparation of the Plan. Representatives of potentially impacted fisher-folks, mussel harvesters' associations, and others are participating in the compensation program selection, providing legitimacy to the process and its results.

Compensation is being closely supervised by JICA & MMRDA. Since compensation will be participatory, the institutions that supervise or observe the Project will beable to validate the transparency and the results of the resulting programs.

Magnitude of displacement (Economic) which can impact the coastal community);

1. Loss of common area.
2. Loss of fishing area.
3. Loss of historical fishing ground for the gillnetters, dol nets, hand pickers and other inshore fishing activities.
4. Loss and displacement of fishing structures, fishing stakes ('*sus*') and nets from the port area, navigational channel, berthing areas permanently.
5. May affect fish abundance and productivity of the area.
6. Loss of income and livelihood.
7. With the decreased fishing areas, there will be chances of increasing conflicts over fishing space.
8. Loss of fishing time and increased operating cost (fuel) to reach fishing grounds and return.
9. Additional income opportunity to coastal community

Fishing is a seasonal activity. Most fisher-folks fish during winter and beginning of summer, but there are some of them who also fish in the rest of the seasons, including rainy season.

Though, for many fisher-folks, fishing is the primary source of livelihood, some fisher families are not solely dependent on fishing activities and may have some other sources of income.

Fishing villages around the proposed fishing area

The proposed Vadhavan Port is planned almost at the northern side of coastal Maharashtra very near to the Dahanu creek, Palghar. Fishing and allied works are the major livelihood activities for the majority of the population in the selected 16 fishing villages within 10 km radius of the proposed Vadhavan port area. The fisher population, in general, and the fishing crafts and gears in particular, operating from villages near to the proposed site are likely to be affected by the port construction and activities. As per the guidelines of environmental impact studies, an area of 10 km radius and the villages falling in this area from the boundaries of the proposed port area have been identified. As explained earlier, a few villages beyond the radius of 10 km are also included in the survey as the fishing boats from these villages utilising the landing, operating facilities in the identified coastal villages within 10 km range.

The boundaries of the proposed port were collected from JNPA as 19º55'59.85"N 72°39'42.36"E. Based on this location, ICAR-CMFRI identified 16 villages, which come under 10 km radius from the proposed Vadhavan Port location as the possibly affected villages. The proposed port and the port facilities will be in the reclaimed area on the offshore zone near Vadhavan village taking advantage of the large tranquil location and the port will need a minimum land acquisition. The list of coastal villages identified by ICAR-CMFRI which are likely to be impacted by the development of the port development are given in below. The villages within the port limit can be considered as the most affected villages due their proximity (Tadiyale, Gunguwada, Dakti Dahanu,Vadhavan and Varore).

Table 152 Affected villages due their proximity

Name of the Village	Name of the Village
1 Ghivali	9. Gungwada
2. Kambode	10. Matgaon
3. Tarapur	11. Asangaona
4. Chinchanib	12. Agara

Name of the Village	Name of the Village
5. Tadiyale	13. Narpad
6. Varor	14. Dandepada
7. Dhakti-Dahanu	15. Dhumket
8. Dahanu	16. Abram

a Narpad, Agar &Asangaon are not exactly coming under 10 km radius of the project area, but the majority of fishers from these village are members in Dahanu Fishermen Co-operative Society and they operate boats from Dahanu landing centre, conduct fishing in the near-shore waters. Therefore, CMFRI has included these fishing villages for the study.

b Dandepada and a part of Chinchani revenue village is a hamlet in Govt.documents, but it is a separate fishing village as per Marine Fisheries Census 2010.

It is seen from the table that out of 5,333 fisher households, 91.2% are pucca houses while 470 households (8.8%) are kutcha houses. Of the total, 3,582 (67.2%) fisher households are above the poverty line (APL) and 1,751 households (32.8%) are below the poverty line (BPL). Most of the fisher population seems to be congregated in Dhakti-Dahanu village (21.0%) followed by Dahanu (9.3%), Chinchani (8.7%), Ghivali (8.7%), Gungwada (8.6%), Dhumket (7.5%). The remaining 7,525 fisher population (36.2%) resides in the remaining 10 villages.

7.6 HTL/LTL DEMARCATION AND CRZ MAPPING

In order to comply with CRZ Notification, 2019 detailed HTL/LTL demarcation studies were conducted with respect to the project site. The study has been conducted through Institute of Remote Sensing (IRS), Chennai.

The proposed details viz Approach Trestle, Breakwater, Navigational Area, Offshore Reclamation Area, Sheltered Area within Vadhavan Port Limits lies in CRZ-IVA and Reclamation Area near Shore lies in CRZ-IB, CRZ-III (200m to 500m from HTL), CRZ-III (No Development Zone), CRZ-IVA and outside CRZ areas as per approved CZMP (Map nos: MH 95, 97, 98 & 99).

The reclamation area near shore in within Vadhavan Port Limits lies in CRZ-IB, CRZ-III (200m to 500m from HTL), CRZ-III (No Development Zone), CRZ-IVA, and outside CRZ areas as per approved CZMP (Map nos: MH 95, 97, 98 & 99).

The remaining Area where there is no development proposed within Vadhavan Port Limits lies in CRZ-IA, CRZ-IA (50m Mangrove Buffer Zone), CRZ-IB, CRZ-III (No Development Zone), and CRZ-IVA areas as per approved CZMP (Map nos: MH 95, 97, 98 & 99).

The proposed Road and Rail Alignment for the port connectivity lies in CRZ-IB, CRZ-III (200m to 500m from HTL), CRZ-III (No Development Zone) and Outside CRZ areas as per approved CZMP (Map nos: MH 95, 97, 98 & 99).

The superimposing the project layouts have been prepared and is attached as Annexure 3

7.7 PUBLIC HEARING

The project proponent is required to conduct public consultation as per EIA Notification, 2006. Public consultation refers to the process by which the concerns of locally affected people and others who have probable stake in the environmental impacts of the mining activity. The Maharashtra State Pollution Control Board and Daman Administration shall conduct the public hearing. The minutes of public hearing will be sent to the regulatory authority for their consideration before a final decision is taken regarding grant of Environment Clearance.

CHAPTER 8 - PROJECT BENEFITS

8.1 General

The port will be constructed majorly 6.5 Kms away from the sea shore and for support activities small part of space between inter-tidal zone (land between low tide and high tide) in low lying land will be reclaimed from sea for the basic infra for foreshore development and connectivity to fore shore Port and operational area

8.2 Project Benefits

- The development is envisaged to play a significant role in strengthening connectivity along the Maharashtra coastline.
- Enhancement in economy of Maharashtra.
- Substantial positive impact on socio-economic profile of Vadhavan, in Particular, and Dahanu, in general, both in terms of overall employment and skill development of local workforce.
- Direct as well as indirect employment potential is envisaged.
- Probable augmentation in infrastructure resources such as transport, Communication, health facilities & other basic facilities.

8.3 Economic Benefits

The port is likely to generate large scale employment during construction phase of port. Direct and indirect employment would be generated for people working on the project for construction of civil infrastructure, installation of mechanical and other utilities infrastructure. The material handling equipment for container terminal are likely to be imported. However, all other equipment and machineries would be procured locally.

These would add to growth in the local economy. The project cost for project is estimated at INR 76,220 Crores.

Following are the prominent benefits to the Government by way of tax collection during construction phase of Vadhavan port

- The construction of port would directly add Government tax collection in the form of goods and services tax. The port construction would attract 12% GST.

- The two phase construction of project by noodle authority JNPA and the concessionaire would require bank finances during construction phase. The estimated interest earning during construction sees a banks translates into an interest earning of 1,406.17 crores by banking and other similar institution.

- The construction of port will involve several other associate infrastructure development by other ancillary and service providers. These investments will directly lead to tax earnings for the government during construction phase.

Following are the prominent benefits to the economy during construction phase of Vadhavan port

It is estimated that around 10% of the construction cost of civil and marine infrastructure is directly spent on the salaries of personals working on in the company. Additional around 10 to 12% is spent on the manpower by the companies subcontracted to undertake construction works by the primary EPC contractor

This translates into close to 20 to 25% of the civil construction cost Direct employment. The proposed Vadhavan port is estimated to have a civil construction cost of around INR 47,280 crores. This translates into close to 9500 crores of expenditure on manpower. That translates into an equivalent amount as earnings personals employed in the EPC work.

With an average pay package of 8 lakhs an annum, this will lead to an employment of 1.19 lakhs people for construction of port during the 3 phase construction. A person with 8 lakhs earnings (salary) pays around INR 50,000 per annum as income tax. The cumulative income tax collection by government would by to the tune of INR 595 Crores. There will be additional INR 8,900Crores added to the economy by balance salary left with construction employs. There would multiplier effect and employment generation in the economy due to the disposable income left with the employees involved in construction phase of the port.

The marine and civil construction works involves large scale requirement of building materials including steel, cement, etc. These raw materials have to be procured locally from companies based in India. Hence, the construction of such a large port along with connectivity infrastructure to the port would generate secondary economic benefit to all the companies and service providers operating in the construction industry. There would lead to large scale employment in those construction industries as well.

The operation of port will lead to large-scale direct and indirect employment. Vadhavan port would have similar market focus of JNPA. This would be handling containers and other clean cargo. Hence, the direct employment generation of Vadhavan port would be similar to JNPA. JNPA had an employee base of around 1,500 personals in the financial year 2020 for handling close to 10 million tonnes cargo directly by port and balance 56 million tonnes by PPP operators of JNPA. It is estimated that around 8% to 10% of the officers were involved in monitoring and facilitating PPP operators. Rest all of 90% to 92% of the workforce was involved in cargo handling operations to achieve a traffic throughput of 10 million tonnes. This excludes the subcontractors hired by JNPA for operating its terminal. Vadhavan port with around 400 million tonnes of Trade volume at its peak would handle around 40 times JNPA current terminal traffic. It is believed that Vadhavan port, due to its latest technology and automation, might require a lower manpower compared to the existing JNPA terminals. Providing a factor of 15% discount on the manpower employment at Vadhavan Port, Vadhavan would require around 1,000 personnel per 10 million tonnes of cargo operation. Hence at 400 million tons of traffic Vadhavan port would need at least 40,000 personals directly involved in port operations either directly on ports pay role or concessionaire payroll. There would be additional employment by subcontractors and other service providers operating in the Vadhavan Port.

Indirect Benefits;

Indirect impacts occur through the supply chain in the activities of businesses that supply goods and services to support operations, leading to more economic output and jobs. Indirect employment includes the portion of employment in supplier industries which are dependent on sales to the sector/ project. For example, in the marine transport industry, indirect impacts include oil refining activities for fuel, food wholesalers that supply food for catering on cruise ships, companies providing accounting and legal services to terminal operators, etc.

For the Greenfield Vadhavan Port some of these benefits include:

- Job creation in the overall transportation logistics sector. These are:
  - New jobs at the terminal for works such as terminal management, stevedoring operations, dockworkers, surveyors, agents, container freight station staff, custom agents, barge operators, marine bankers, legal, insurers etc.
  - New jobs in the back-end logistics such as trucking and railways - drivers, freight forwarders, warehousing, kitting, security personnel etc.
- Increase in Machinery & Parts Production
  - Cargo handling Equipment
  - Construction equipment
  - Trucks and trailers – repair and services
  - Dredging Machinery – tools and plants
  - Container repair related parts – steel slabs and coils, scrap, reefer parts etc.
  - Break-bulk and liquid bulk related tools and parts
- Increase in indirect consumable spend
  - Incremental spend on fuel and lubes on account of incremental traffic
- Benefits on account of incremental indirect tax to the exchequer – service tax, excise duty, customs duty etc.

i) Induced Benefits

These are the benefits accruing to due to incremental household spending on items such as food, clothes, rent, transport etc. These are the multiplier benefits due to rotation of money in the economy. It is worth mentioning that induced benefits usually suffer from double counting and the time lag for the benefit to accrue is generally vague. For this reason, this EIRR does not include induced benefits.

The economic impacts during construction and operational phases can be viewed in terms of a change in the following:

- Job creation
- Value-added (or GGP)

- Personal income
- Business output (or sales volume)
- Impact on the balance of payments.

Any of these measures can be an indicator of improvement in the economic well-being of residents, which is generally the goal of any investment project. The net economic impact is usually viewed as the expansion of contraction of an area's economy, resulting from the induced changes.

8.4 Socio-Economical Benefits

The socio-economic scenario in the region will certainly change with positive impact on the existing regional socio-economic pattern. There will be change in employment pattern with local residents will be given preference for jobs opportunities and/or self-employment. The economic growth will have positive impact; it will also help in increase in living standards of the local residents. Due to enhancement in infrastructure facilities and utilities in living condition will also improve. During the construction phase of the project, many persons are expected to be employed whereas during operation phase there will be lots of job openings. Most of these workers/ staff are likely to be from the study area. Hence there shall be temporary minor positive impact on the employment.

8.5 Aesthetics and Landscape

It is proposed to develop greenbelt around the plant, which will go a long way to achieve environmental protection as well as aesthetics of the area.

- A vegetative cover at both ends of the project and also along internal roads will certainly reduce the air pollution.
- This vegetation cover will also act as a barrier for any penetration of air quality and odor in the nearby area.

Approach roads will be covered with green belt on both the sides to avoid any air quality problems to the nearby residents

CHAPTER 9 - ENVIRONMENTAL COST BENEFITS

- The development of proposed Greenfield port at Vadhavan is envisaged to play a significant role in strengthening connectivity along the Maharashtra coastline.
- Enhancement in economy of Maharashtra.
- Substantial positive impact on socio-economic profile of Vadhavan, in Particular, and Dahanu, in general, both in terms of overall employment and skill development of local workforce.
- Direct as well as indirect employment potential is envisaged.
- Augmentation in infrastructure resources such as transport, Communication, health facilities & other basic facilities

Table 153 ***Estimation of cost for environmental cost benefits***

SN	Parameters	Remarks
1	Ecosystem services due to proposed forest diversion	There is no any forest land involved in the proposed port activity. Forest diversion is required for Rail-Road corridor.
2	Loss of animal husbandry productivity, including loss of fodder	JNPAwill acquire about 700 acres of private land for rail and road linkage only. This will not cause any significant loss to animal husbandry or fodder or productivity. Port does not cause any pollution as it does not manufacture any product.
3	Cost of human resettlement	There is no displacement of any house and therefore there is no cost of human settlement.
4	Loss of public facilities and administrative infrastructure (Roads, buildings, school, dispensaries, electric lines, railways, etc.)land if these facilities were diverted due to the project	None of these facilities are affected by the port project nor is any road or rail closed or diverted. Hence there is no loss.

SN	Parameters	Remarks
5	Possession value of land to be diverted	Is it all land or only private land? We have calculated the area Pl clarify
6	Cost of suffering to oustees	There is no oustees in the project as no house is affected or acquired. Hence no cost
7	Habitate Fragmentation Cost	In view of above question does not arise

Table 154 Guidelines for estimating benefits

Sr. No	Parameters	Remarks
1	Increase in productivity attribute to the specific project	•The development is envisaged to play a significant role in strengthening connectivity along the Maharashtra coastline. •Enhancement in economy of Maharashtra. •Direct as well as indirect employment potential is envisaged. •Probable augmentation in infrastructure resources such as transport, Communication, health facilities & other basic facilities. • Overall enhancement of socio- economic condition of the area along the project. • Though overall mission to increase the GDP of the said region and make it comparable/abobe the nation GDP
2	Benefits to economy due to the specific project	Increase in employment opportunities both direct and indirect. Boost to entrepreneurship and local business. Facility of import and export benefits the economy at large
3	No. of population benefited due to specific project	Population of 55,000 within 10 kms radius But Palghar district and Maharashtra state as well
4	Economic benefits due to specific project	Employment opportunities, better health and educational facilities, improvement in living standards in local population.

Benefits to Port Users

These are mainly cost saving benefits arising from reduced operating expenses, and overall inland transport costs. However, the reduced costs could result in improvement of the port's competitive position and in the attraction of additional cargo to the port, thereby producing revenues and benefits. The transportation savings can also improve competitiveness of the port area, which can result in the expansion of the markets of the industries in the area. Another factor which should be considered as the cost saving, is the savings in ships' operating cost arising from economy of scale of operating larger ships. The reduced transportation costs will allow the EXIM cargo to compete in the world market. There are intangible benefits and can't be measured in monetary terms. Most of these benefits can't be evaluated in the benefit/cost method. A port may be constructed or developed because a country wants to be self-sufficient and not dependent on neighboring foreign ports, or a port may be constructed/ developed because of national interest and defense purpose.

In the appraisal of port projects, the analysis of direct cost benefits are considered with respective to the following aspects;

1. Avoided diversion and generated cargo is a theoretical assumption to value the economic benefits, as in practice these volumes would likely be facilitated by a different not yet planned new ports in case Vadhavan would not be realized.
2. Capital and operational costs in the CBA excluding of taxes and in real amounts.
3. Freight Travel Time cost savings which are relevant for sea transportation and inland transportation by road and rail.
4. Volumes handled through the new Vadhavan port will result in less sea travel distances and travel time. The benefits of less travel distance and travel time are accounted for using estimations for vessel operating costs and value of freight time.
5. Volumes handled through the new Vadhavan port will result in less inland travel distances and travel time will lead to a decrease in inland travel times and distances, due to the relative distances from alternative ports in the region to Vadhavan hinterland locations. The benefits of less travel distance and travel time are accounted for using estimations for vehicle operating costs for road and rail and value of freight time.

6. More direct calls at Vadhavan port decreases transshipment and result in additional income due to generated traffic.
7. Less travel kilometres for inland transportation leads to less accidents and environmental costs;
8. Less Environmental costs due to reduced travel kilometres for inland transportation by both rail and road will lead to less strain on the environment.

Starting point for the economic analysis is the financial analysis in which the analysis assumes a landlord port model, in which JNP acts as Port Authority and concessions out port operations to private sector operators. JNPA provides the private operators the basic port infrastructure and the (reclaimed) land to develop terminals for port activities. For the economic analysis, the port is considered as one integrated project. Financial costs are converted to economic costs. Economic benefits were determined by looking at logistic cost reductions and volumes driving changes in consumer surplus and producer surplus. The following assumptions are made for the CBA analysis;

a) A phased development approach is assumed, with two distinctive phases (Phase 1 and 2).
b) The CBA planning horizon is set to 2055. In practice the project will continue to operate after the said period. No residual value is included in the CBA.
c) This is a conservative assumption, as economic value at the end of the set horizon is positive.

Assumption	**Value**	**Unit**
CBA price level	2021	year
Index for price level correction	4.00 %	% p.a.
Exchange Rate USD	75.17	INR / USD

1. **Avoided diversion and generated Cargo;**

(i) Volumes going through Vadhavan in the ‘with-project’ case are assumed to be split in two categories; avoided diversion and generated volumes.

(ii) Avoided diversion volumes account for the traffic that in the ‘without-project’ case would be facilitated by other ports in the region. Based on estimates of available capacity this is assumed to be 47% of total traffic to be handled by Vadhavan in the 'with-project' case.

(iii) Generated volumes account for the traffic that is assumed not to be facilitated in the 'without-project' case. This is a theoretical assumption to value the economic benefits, as in practice these volumes would likely be facilitated by a different not yet planned new ports in case Vadhavan would not be realised. Generated volumes are assumed to be 53% (100% - 47%) of total traffic to be handled by Vadhavan in the 'with-project' case.

Rule-of-half

(iv) In monetising the benefits in the CBA the 'rule-of-half' is applied to all benefits related to generated volumes. This rule is commonly applied in CBA; it states that the average change in consumer surplus of generated traffic can be estimated as half of the difference in the generalised costs of transport with and without the project.

Import & Export

(v) The CBA assumes that the benefits based on an increase in consumer surplus are only accounted for imported volumes. It assumes that benefits from cost reductions in the transportation of exported volumes will fall with consumers outside of India.

(vi) The import and export volume share are 53:47

2. Capital and operational costs in the CBA are excluding of taxes and in real amounts;

(i) **General**

a. Cost cash flows in the financial analysis are in nominal amounts. These were adjusted to exclude any projections of inflation or indexation.

(ii) **Conversion**

a. To convert financial costs to economic costs, the CBA applied conversion factors, based on national standard conversion factors of 0.88 (with the exception of fuel costs).

b. This value has been derived during previous research for the Vadhavan port project and was found to be in line with a study by the Asian Development Bank[1]. A high-level calculation based on more recent macroeconomic indicates the current conversion factor may be higher (up to 0.98). A sensitivity scenario is included to assess the impact of a higher conversion factor.

(iii) **Taxes**

a. The cash flows in the CBA are excluding any taxes

b. The financial analysis was already performed based on cash flows excluding GST. No correction was needed.

3. Capital and operational expenditures from the financial analysis are corrected for inclusion in the CBA;

- **Capex**

a. Land reclamation - The capex from the financial analysis was corrected for costs for land reclamation under the assumption that the economic costs of reclaiming the land will be offset by the net economic value created by the newly available land.

The economic value of new port area created, netted from the economic costs of losing seabed area, based on construction costs is considered a conservative assumption as actual economic value is deemed to be higher (but hard to value).

b. Contingencies - Physical Contingencies are included in both the financial and economic analysis.

Price Contingencies are excluded from the economic analyses and only considered in the financial analysis.

- **Opex**

a. Fixed and variable operational costs - The CBA only accounts for the additional operational expenditures of the 'with-project' case; the extra costs that come with the implementation of Vadhavan project.

   The OPEX from the financial analysis was corrected for costs that are assumed to be variable operational costs linked to diverted traffic.

b. Fuel costs - The part of the operational expenditures that relates to fuel costs was converted using a specific conversion factor to express financial costs into economic costs. A conversion factor of 0.43 is applied over fuel cost to convert financial costs to economic costs in the CBA

4. Freight Travel Time cost savings are relevant for sea transportation and inland transportation by road and rail

(i) **Value of Freight Travel Time**

a. The CBA accounts for benefits relating to the total time needed for freight arriving at its destination. This related to travel time at sea, travel time for inland transportation and travel time due to transhipment.

b. The benefits of freight travel time cost savings are assumed based on the average value of containerized cargo and financing costs.

c. For non-containerized volume the value of freight travel time is assumed to be zero. A conservative assumption, but the actual value is deemed to be low.

Component	**Unit**	**Value**
Value of consignment	INR	4,000,000
Interest rate	% p.a.	12.00%
Days per year	Days	365
Hours per day	Hours	24
Value of Freight Time (containerized traffic)	INR / TEU hour	55.00

5. Volumes handled through the new Vadhavan port will result in less sea travel distances and travel time

(i) **Sea travel distance and time**

a) The realisation of Vadhavan port facilities will lead to a decrease in sea travel times and distances, due to the relative distances to alternative ports in the region.

b) The benefits of less travel distance and travel time are accounted for using estimations for vessel operating costs and value of freight time.

c) For sea transport the origin or destination of volumes for Vadhavan is assumed to be split in three major areas': (1) East bound Traffic, (2) West Bound Traffic and (3) Asian Traffic

(ii) **Vessel Operating Costs**

a) The differences in vessel operating costs are estimated based on discounts offered by shipping line vessels comparing lowest quotes for FCL 20 Ft. between Indian and Foreign Ports (US$)

	% of volume	**Vessel operating costs savings in USD/TEU**
East Bound	40%	83.00
West Bound	40%	55.00
Asian Trade	20%	50.00

b) Savings from less travel distance and less travel time of non-containerised volumes are excluded from the analysis resulting in a conservative approach to the benefits included in the CBA.

6. Volumes handled through the new Vadhavan port will result in less inland travel distances and travel time;

(i) **Inland travel distance and time**

a) The realisation of Vadhavan port facilities will lead to a decrease in inland travel times and distances, due to the relative distances from alternative ports in the region to Vadhavan hinterland locations.

b) The benefits of less travel distance and travel time are accounted for using estimations for vessel operating costs for road and rail and value of freight time.

(ii) **Vehicle Operating Costs (VOC)**

a) Vehicle operating cost savings for road transport are based on a breakdown of costs of transportation and assumed at 4.1 INR per ton kilometre.

b) Vehicle operating cost savings for rail transport are based on a benchmark by Ministry of Shipping, Road Transport and Highways and assumed at 2.1 INR per ton kilometre.

7. More direct calls at Vadhavan port decreases transshipment and generated traffic generates additional income

(i) **Transhipment**

a) Development of state-of-the-art port facilities at Vadhavan port with a deep draft will increase direct ship calls. A percentage of containers that are presently using intermediary transhipment terminals will shift to direct calls.

b) Only transhipment benefits for containers are included in the CBA. Transhipment reduction benefits related to non-containerised volumes are assumed to be zero.

c) The CBA assumes 30% of container volumes, using vessels over 14,000 TEU, are transhipped in the 'without project' case. In the 'with project' case the transhipment is decreased with 50% to 15%.

d) An increase in direct calls and decline in transhipment will also result in both freight travel time savings as well as vessel operating cost saving. The latter is hard to quantify based on available information and excluded from the CBA.

(ii) **Additional income**

a) The CBA assumes that a large percentage of total volumes that will be facilitated by Vadhavan in the 'with-project' case are generated volumes.

b) These additional (generated) volumes result in additional income that can be included as benefits from an increase in producer surplus.

8. **Less travel kilometres for inland transportation leads to less accidents and environmental costs;**

(i) **Accidents**

a) Less travel kilometres for inland transportation by road will lead to less accidents.

b) Benefits are based on benchmark figures by Ministry of Shipping, Road Transport and Highways for number of accidents per distance travelled and the economic costs of accidents.

Accidents Road per 100 million vkm	**Number of accidents**
Fatal accident	3
Serious accident	30
Major Accident	0 (no data)
Minor accident	0 (no data)

Economic costs	**unit**	**2009**	**2021**
Fatal accident	INR	864,350	1,823,779
Serious accident	INR	391,800	826,698
Major Accident	INR	172,650	364,292
Minor accident	INR	30,450	64,250

9. **Environmental costs;**

a. Less travel kilometres for inland transportation by both rail and road will lead to less strain on the environment.

b. Benefits are based on benchmark figures by Ministry of Shipping, Road Transport and Highways expressed in INR per ton kilometre

Environmental costs	**unit**	**2008**	**2021**
Rail	INR / ton km	0.015	0.035
Road	INR / ton km	0.202	0.467

CHAPTER 10 ENVIRONMENTAL MANAGEMENT PLAN

10.1 Introduction

Impact assessment helps in identifying potentially damaging aspects of a proposed project. Based on the findings of the impact assessment, Environment Management Plan is devised to minimize adverse impacts and enumerated various steps to be taken for improvement of the environment.

However due to no major adverse impact on the Air, Water, Land, Biological Environment due to the project, the Environment Management Plan shall not be very complicated and only regular Monitoring of ambient air quality, water quality, noise level monitoring and soil quality monitoring shall be carried out as per the requirements.

All persons working near the noise generation equipments shall use Personal Protective Equipment such as earplugs muffs and closely monitored for implementation. All workers should be made aware of adverse effect high noise levels through training program; this will ensure proper implementation of mitigation majors.

Environmental Management Plan (EMP) is the key to ensure a safe and clean environment. A project may have identified proper mitigation measures but without a management plan to execute it, the desired results may not be obtained. The present chapter on Environment Management Plan envisages proper implementation of mitigation measures to reduce the adverse impacts arising out of the project activities.

10.2 Summary of Critical Impacts/ Issues

The major impacts due to different project activities and their mitigation measures have been identified in Chapter 5. These measures together constitute part of Environmental Management Plan (EMP). Environmental study carried out by the consultants has highlighted the following critical features of the project.

Table 155 - Critical Impacts / Issues

Sr. No	Issues	Description
1.	Ambient Air Quality	During construction air and noise pollution may increase and would require mitigation.
2.	Ambient Noise Level	In construction & operation phase noise levels are generally expected to increase. However, measures would be taken to control pollution due to increased vehicular traffic near the project area.
3.	Land Use Pattern	Land use patter will change for rail road.
4.	Soil Quality	Soil quality can be deteriorate due to disposal of solid as well as liquid ware both during construction and operation phase
5.	Water Quality	During construction waste surface water runoffs, sewage, construction wastewater can cause contamination of sea water. Also percolation of oil, chemicals, wastewater etc. can cause contamination of ground water resources.
6.	Ecology	Due to reclamation activities, sea bottom strata will be affected at reclaimed area of the port.
7.	Socio-Economic	There will no impact due to proposed development since proposed road & rail corridor in (four) villages passes through Government owned land only, none of the private land holders are affected from these villages. No R & R involved in this project.

In the Environmental Management Plan (EMP), impact mitigation and monitoring requirements are specified and the institutional arrangements for implementation of the project identified. The EMP also includes the cost of implementing mitigation and monitoring requirements.

10.3 Environmental Management Plan

Day to day management of environmental aspects and impacts of operation activities are to be managed through Environmental Management Plan (EMP). Additional EMP may be developed from time to time where an audit, environmental assessment, incident investigation or other corrective action identifies the need for additional controls to be in place.

The following issues have been addressed in this EMP:

- Mitigation measures for abatement of the undesirable impacts caused during construction and operation stages
- Details of management plans
- Institutional set up for implementation of the EMP
- Post project environmental monitoring programme to be undertaken after commissioning of the project
- Expenditures for environmental protection measures.

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 port project is classified into the following categories:

- EMP DURING CONSTRUCTION PHASE
- EMP DURING OPERATION PHASE

The EMP's that will be put into place consist of those during construction and operating stages of the project and includes the following elements:

Sr. no	Management Parameters	Applicable Legislations
1.	Construction & Debris Management	Construction & Demolition Waste Management Rules, 2016 and subsequent amendments
2.	Solid Waste Management	Solid Waste Management Rules, 2016 and subsequent amendments International Convention for the Prevention of Pollution from Ships (MARPOL)

Sr. no	Management Parameters	Applicable Legislations
3.	Hazardous Waste Management	Hazardous and Other Wastes (Management and Trans boundary Movement) Rules, 2016 and subsequent amendments
4.	Biomedical Waste Management	Bio-Medical Waste Management Rules, 2016 and subsequent amendments
5.	E-waste Management Plan	e-waste (Management) Rules, 2016 and subsequent amendments
6.	Air Pollution Control and Management	• The Air (Prevention and Control of Pollution) Act 1981, amended 1987 and subsequent amendments • National Ambient Air Quality Standards, Notification 2009, and subsequent amendments • International Convention for the Prevention of Pollution from Ships (MARPOL)
7.	Noise Control and Management	The Noise Pollution (Regulation and Control Rules 2000), and subsequent amendments
8.	Dredged Management	• Guidelines on undertaking Dredging at Major Ports, Government of India Ministry of Shipping (November 2015) • The Water (Prevention and Control of Pollution) Act, 1974, amended 1988 and subsequent amendments • International Convention for the Prevention of Pollution from Ships (MARPOL)
9.	Water Management	• The Water (Prevention and Control of Pollution) Act, 1974, amended 1988 and subsequent amendments • International Convention for the Prevention of Pollution from Ships (MARPOL)

Sr. no	Management Parameters	Applicable Legislations
		• Indian Standard for Drinking Water as per BIS specifications (IS 10500-1991) and subsequent amendments
10.	Oil Spill Management	• The Water (Prevention and Control of Pollution) Act, 1974, amended 1988 and subsequent amendments • International Convention for the Prevention of Pollution from Ships (MARPOL)
11.	Water Contamination Management	• The Water (Prevention and Control of Pollution) Act, 1974, amended 1988 and subsequent amendments • International Convention for the Prevention of Pollution from Ships (MARPOL) • Indian Standard for Drinking Water as per BIS specifications (IS 10500-1991) and subsequent amendments
12.	Energy Management	--
13.	Environmental Management of Contractors	All the regulations shall be followed
14.	Occupational, Safety and Health Issues	• IS 18001:2000 Occupational Health and Safety Management Systems. • The factories Act • Explosives Act, 1884 • Petroleum Act, 1934
15.	Environmental Monitoring	• National Ambient Air Quality Standards, Notification 2009 • Guidelines for the Measurement of Ambient Air Pollutants, Central Pollution Control Board - 2012-13 and subsequent amendments

Sr. no	Management Parameters	Applicable Legislations
		• The Noise Pollution (Regulation and Control Rules 2000) and subsequent amendments • Protocol for Ambient Level Noise Monitoring, Central Pollution Control Board - 2015 • IS 18001:2000 Occupational Health and Safety Management Systems. • Indian Standard for Drinking Water as per BIS specifications (IS 10500-1991) and subsequent amendments
16.	Emergency Response Plans for Emergency Scenarios	• IS 18001:2000 Occupational Health and Safety Management Systems. • Indian Standard for Drinking Water as per BIS specifications (IS 10500-1991) and subsequent amendments
17.	Plantation, Landscaping and Land Management	--
18.	Materials Management	--

10.4 Environment Management Plan for Vadhavan Port area

10.4.1 Solid Waste Management

During construction phase domestic solid waste will be generated from labour camp, which will include leftover food, vegetables peels, tea leaves, eggshell etc. Other waste will be packaging materials such as paper, cartoon, boxes, plastic, thermacol etc. will be generated.

During Operation phase

10.4.1.1 Performance Criteria/Outcome

- No disposal of solid waste in improper manner
- No disposal of solid waste in water bodies / marine area

- Conversion of biodegradable waste to manure & its reuse
- Recycling of recyclable waste

10.4.1.2 Mitigation Action

- Waste shall be segregated in three types i.e. bio-degradable, non biodegradable and domestic hazardous wastes in suitable bins
- Suitable bins with colour coding shall be provided for various categories of waste
- Daily collection of waste will take place from all the bins.
- Daily sweeping and collection of waste from roads and other common facility area would also be done daily.
- The biodegradable waste will be processed in the Eco-composter for manure gardening.
- The non biodegradable wastes shall be handed over to authorized waste collectors as per the direction or notification by the local authorities from time to time
- Recyclable waste such as paper, plastic, glass etc. shall be reuse to maximum, extent & remaining if any shall be handed over to authorized recycler only.
- No waste generator shall throw, burn or burry the solid waste generated by him, on streets, open public spaces outside his premises or in the drain or water bodies.

10.4.2 Hazardous Waste Management

During construction phase hazardous waste such as lubricating oil from vehicles, empty paint, Oil & grease filter form surface runoff, sludge containing oil, empty paint cans etc. will be generated.

During operation phase Empty barrels/containers/liners contaminated with hazardous chemicals /wastes, contaminated cotton rags or other cleaning materials, Oil contained material form oil spill cleaning etc. will be generated.

10.4.2.1 Performance Criteria/Outcome

- Proper system for storage & disposal of Hazardous waste
- No disposal of Hazardous waste on land or marine area
- Regular submission of Hazardous Waste Returns

10.4.2.2 Mitigation Action

- Safe and environmentally sound management of hazardous and other wastes shall be provided
- Hazardous wastes generated shall be sent or sold to an authorised actual user or shall be disposed of in an authorised disposal facility
- Hazardous and other wastes shall be transported from port to an authorised actual user or to an authorized disposal facility in accordance with the provisions of Hazardous and Other Wastes (Management and Trans boundary Movement) Rules, 2016 & amendments .

10.4.3 Biomedical Waste Management

- In construction phase there will be generation of the biomedical waste such as syringes contaminated Cotton, bandages etc. during medical checkups / health camps & first aid area / medical area.
- During operation phase there will be generation of the biomedical waste such as syringes contaminated Cotton, bandages etc. from the first aid area / medical area within port.

10.4.3.1 Performance Criteria/Outcome

- Proper system for storage & disposal of Biomedical Waste
- No disposal of Biomedical waste on land or marine area

10.4.3.2 Mitigation Action

- All necessary steps to ensure that bio-medical waste is handled without any adverse effect to human health and the environment
- colored bags or containers shall be used for storage of biomedical waste as specified in Schedule I Bio-Medical Waste Management Rules, 2016
- Ensure that there shall be no secondary handling, pilferage of recyclables or inadvertent scattering or spillage by animals and the bio-medical waste from such place or premises shall be directly transported in the manner as prescribed in these rules to the common bio-medical waste treatment facility or for the appropriate treatment and disposal, as the case may be, in the manner as prescribed in Schedule I of Bio-Medical Waste Management Rules, 2016

- Dispose of solid waste other than bio-medical waste in accordance with the provisions of respective waste management rules made under the relevant laws and amended from time to time;
- Not to give treated bio-medical waste with municipal solid waste;
- Provide training to all its health care workers and others, involved in handling of bio medical waste at the time of induction and thereafter at least once every year
- Immunize all its health care workers and others, involved in handling of bio-medical waste for protection against diseases including Hepatitis B and Tetanus that are likely to be transmitted by handling of bio-medical waste, in the manner as prescribed in the National Immunization Policy or the guidelines of the Ministry of Health and Family Welfare issued from time to time;
- Ensure occupational safety of all its health care workers and others involved in handling of biomedical waste by providing appropriate and adequate personal protective equipments;

10.4.4 E-waste Management

During operation phase there will be generation of waste from Information technology and telecommunication equipments. Other waste such as electrical and electronics waste will be generated such as Fluorescent and other Mercury containing lamps, Air-conditioners, Television sets (including sets based on (Liquid Crystal Display and Light Emitting Diode technology), Refrigerator etc.

10.4.4.1 Performance Criteria/Outcome

- Proper maintenance of records electrical and electronic equipment
- Disposal of the end of life electrical and electronic to authorised recycler

10.4.4.2 Mitigation Action

- The electrical and electronic equipment listed in Schedule I of E-Waste (Management) Rules, 2016 shall be channelized through collection centre or dealer of authorised producer or dismantler or recycler or through the designated take back service provider of the producer to authorised dismantler or recycler
- The record of the e-waste generated shall maintain in Form-2 of the -Waste (Management) Rules, 2016 and make such records available for scrutiny by the concerned State Pollution Control Board;

- End-of-life electrical and electronic equipment are not admixed with e-waste containing radioactive material as covered under the provisions of the Atomic Energy Act, 1962 (33 of 1962) and rules made there under.

10.4.5 Air Quality Management

Fertilizer is the potential major dry bulk commodities for proposed Vadhavan port. The total dry bulk cargo traffic potential by FY 2050 is estimated to be around 14.77 MTPA.

It is estimated that Vadhavan has a potential to handle around 2.02 MTPA of fertilizer traffic by FY 2050.

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 mechanized handling system and the other associated equipments such as hoppers, belt conveyors, stacker cum declaimers along with integrated dust suppression systems.

Dust may be generated in the following circumstances:

- From material handling of fertilizer and other cargo / container
- From undeveloped areas of Port if dry soil is exposed to wind (wind erosion)
- Due to vehicle movements across exposed dirt
- Due to earthworks.

Dust clouds can be visually intrusive and can create traffic hazards on and off-site if clouds drift across roadways. If dust settles on adjacent properties, this also causes nuisance to landholders and tenants. While dust deposition on vegetation and in surface waters can also cause environmental impacts, it is unlikely that either the quantity or duration of dust that might be generated from activities at Port would cause these sorts of impacts.

10.4.5.1 Performance Criteria/Outcome

- No visible deposition of dust outside immediate work areas
- No visible dust plumes leaving Port boundary
- All valid dust-related complaints resolved.

10.4.5.2 Management Actions

- Storage of Fertilizer in covered sheds
- Provision of water sprinklers
- Provision of windshields
- Cover undeveloped areas through grass, mulching or other means to protect these areas from wind erosion. Prevent vehicle access to these areas to maintain cover.
- Do not allow vehicle access to undeveloped areas.
- Ensure that dust control requirements are inserted into any contracts involving Environmental Management of Contractors
- In the event of a complaint in relation to dust, the complaints procedure is followed
- Utilise seawater or other available water to spray over the area
- Avoid using water from reticulated water supply unless urgent response is required and there is no other water available
- In the event that contractors create dust plumes, contractors are to correct the issue to meet contract requirements.
- Contractors may use seawater for dust suppression. Dust suppression should not cause surface runoff.
- 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.
- An area near entry/exit for vehicle type washing shall be provided. Tyres of the trucks shall be washed before going out of construction area to reduce dust generation on roads.
- Regular Ambient Air Quality Monitoring shall be carried out

10.4.6 Emissions Management Plant

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 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.
- The standards for DG sets prescribed by CPCB needs to followed by the contractor operating the DG sets.
- 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:

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

  H = Total height of stack in meter

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

  KVA = Total generator capacity of the set in KVA
- Regular monitoring of stack attached to DG set shall be carried out

10.4.7 Noise Management Plan

Construction activities such as dredging, material handling may create a problem of noise and vibration generated by construction equipment, truck traffic, work vessels and other similar sources. During construction phase, there could be high noise levels due to operation of various construction equipment and increased number of vehicles supplying man and material to the site. It is known that continuous exposure to high noise levels above 90 dBA affects the hearing acuity of the workers/operators or residents and hence, require mitigation planning. Another impact for the proposed port is anticipated due to the rock blasting due to which communities residing near the port may experience the vibrations.

Transmission of noise and vibration are limited by the distance from their sources. Noise could be considerably reduced by adoption of low noise equipment or installation of sound insulation fences. Green belt can be a good noise barrier. Limitation of working hours may be a possible means to mitigate the nuisances of construction activities.

Key issues in relation to noise management that is relevant to operational activities at Port

- When carrying out dredging and related works, noise limits
- When carrying out other building and construction work, the requirements of Noise Standards , in relation to the times when noise from building and construction work must not be audible at a sensitive receiver

10.4.7.1 Performance Criteria/Outcome:

- No non-compliances with requirements of environmental authority or the EP Act in relation to building and construction works, including dredging and related activities
- All valid noise complaints resolved in accordance with requirements of EP Act.

10.4.7.2 Mitigation Action

- Ensure that construction contractors are aware of noise requirements in under Noise Rules 2000 and amendments thereof.
- Ensure that dredging contractors and pile driving works comply with noise limits
- Noise from any site activities including pile driving must not exceed the noise standards
- Controlled blasting techniques to be adopted to reduce vibrations.
- The established time for blasting will be notified and displayed in the project area at strategic places such as main gate, project office, project roads, near blasting site etc.
- The construction works will be carried out during the day time. The work hours should be limited depending on convenience of the local people.
- Noise levels of machineries used shall conform to relevant standards prescribed in Environment (Protection) Rules, 1986. Workers shall not be exposed to noise level more than permitted for industrial premises, i.e. 90 dBA (Leq) for 8 hours;
- Exposure of workers near the high noise levels areas can be minimized. This can be achieved by job rotation/automation, use of ear plugs, etc.

- Labour camps shall be established away from high noise generating area. Workers exposed to high noise level shall use ear plugs or ear muffs;
- Regular maintenance of all vehicles and machinery shall be made mandatory to keep noise under check;
- Nearby communities will be notified of the construction schedule and construction works shall be structured to daylight working hours;
- Any 'High Noise Area' shall be posted with warning signs and will have restricted access.
- Noise from air compressors could be reduced by fitting exhaust mufflers and intake mufflers.
- Chassis and engine structural vibration noise can be dealt with by isolating the engine from the chassis and by covering various sections of the engines.
- Crushers, if any, will be fitted with rock lining to act as natural sound insulator during the crushing process;
- Noise levels from the construction equipment can be reduced by fitting of exhaust mufflers and the provision of damping on the steel tool.
- It is proposed to develop a greenbelt within the port premises including along the road stretches.
- Noise from the DG set should be controlled by providing an acoustic enclosure or by treating the enclosure acoustically.
- Regular monitoring and maintenance of all the equipment and DG sets shall be taken up to keep a note on noise levels and to take corrective actions.
- Notify any upcoming noisy activities that might give rise to annoyance. Provide information on the duration of the activity.
- Noise monitoring should be undertaken by a accredited laboraroy
- Monitoring should be undertaken in accordance

10.4.8 Dredged Management Plan (for Navigation Channel and Berth Area)

The geotechnical investigation borehole data at the site reveals that the subsurface generally consists of marine deposited silty sand followed by rock for the full depth of exploration in the approach channel area while layers of silty sand and rock were encountered in the terminal area.

The borehole data within the proposed channel area was analysed to understand the properties of dredged material. Profile across the boreholes MBH-37, MBH-35 and MBH-40 at the outer approach channel reveal presence of silty sand of 3 m thick. The weathered rock is encountered below -20 CD, therefore certain amount of rock dredging is also anticipated in the outer channel.

Along the inner channel, two boreholes MBH-19 and MBH-47 available at the southern edge of the breakwater and profile across three boreholes mbh-46, mbh-45 and mbh-43 at the northern edge of the breakwater reveals the 4 m of silty sand overlying the weathered basalt. these boreholes show sand content in excess of 70% for the silty sand layer. The weathered rock is encountered at -17 to -22 m CD, therefore certain amount of rock dredging is also anticipated

However, geophysical survey shows that rock layer is encountered beyond depth of -17 m CD in the outer approach channel. It is also observed that rock can be expected along the container berth face at around – 16 m CD to -20 m CD. In other areas, weathered to hard rocks are expected to be found at depths at or below -15 m CD. The dredge depths proposed for the port are deeper than rock levels and hence it is expected to encounter hard material.

The borehole profiles show that the dredge spoils (except the initial surface material up to the depth of approximately 0.5 – 1 m below the existing seabed) comprise of good quality silty sand and is suitable for reclamation for the development of the onshore facilities. The unsuitable material, such as silty clay, will be dredged and discharged to the designated offshore disposal area.

Based on these boreholes it was deduced that the volume of sand is estimated to be in the order of 3.97 million m^3. The volume of the weathered rock is estimated to be in the order of 3.06 million m^3

10.4.8.1 Performance Criteria/Outcome

- Dredging activities shall not cause degradation of water quality and the associated environmental values in the sea. Compliance with the water quality limits is considered to protect water quality and associated environmental values.
- Dredging activities shall not cause harm to marine ecology
- Minimal disturbance and disruption to surrounding area dredging activities.

10.4.8.2 Management Action

1. A dredge material disposal option shall be in place
2. Adequate capacity shall be available at the disposal location for the quantity of the material to be removed, taking into account bulking factors and water content
3. All necessary environmental and planning approvals shall be in place in relation to dredge material disposal
4. Testing of dredged material shall be undertaken on regular basis
5. Harbour Master shall be notify of dredging program, including timing, locations to be dredged, equipment to be used and any access restrictions or hazards to vessels using the navigation access channel.
6. Harbour Master shall be notify of completion of the dredging program
7. Fishermen shall be notify of proposed works
8. Proper signage shall be in place to notify Fishermen
9. It shall be ensure that the dredging equipment and associated vessels comply with all the necessary requirements
10. It shall be ensure that access to the port limit is maintained throughout the dredging program.
11. It shall be ensure that pipelines and other floating, partially submerged or fully submerged components are marked so as to be clearly visible to all boat operators. If left in place at night, ensure that warning lights are used.
12. It shall be ensure that there are no discharges from the dredging vessels
13. It shall be ensure that there are no sewage discharges within the marine area / port area
14. It shall be ensure that litter and other wastes are fully contained on all barges and vessels associated with dredging.
15. Waste materials shall be removed from barges and vessels each day, and the minimum required amount of hydrocarbons shall be kept on board
16. Any chemicals shall not be carried on barges or vessels associated with dredging. Only fuel and oils contained within equipment shall be carried.
17. Do not wash down decks of barges or vessels unless all wash down water is fully contained on the barge.
18. Spill kit suitable for small to medium spills shall be carried.

19. Confirm that all dredging will take place within the originally approved port limit and navigation access channel. If dredging outside this area is required, seek additional approvals.
20. Clearly delineate area to be dredged and review with dredging contractor. Provided written advice to dredging contractor on dredging area.
21. Dredge only in delineated areas
22. Ensure that silt curtains are available for deployment if required.

    Check water quality monitoring results for any non-compliance with the water quality triggers or guidelines. Initiate corrective action as required to address any non-compliance or trends towards triggers

Dredging and Reclamation Management Plan (for sourcing of sand from offshore)

The proposed construction of the Vadhavan port envisages use of dredged material from marine burrow pit for reclamation apart from using the dredged material in the port area. The capital dredging capacity in Phase I of the proposed Project is 6.98 Mcum. Apart from this, additional dredged material is sourced from marine borrorw pit to meet the reclamation requirement which is to the tune of 177 Mcum. This outline of a Dredge and reclamation Management Plan is based on the Revised OSPAR Guidelines for the Management of Dredged Material (Reference number: 2004-08). As the dredged material will be mainly used for the reclamation purpose in the berthing area, the adverse impact on the disposal of dredged material elsewhere is reduced. The following measures will be adopted to mitigate the potential impacts from dredging and when reusing the dredge material:

Dredging will be carried out using suitable dredgers only, depending upon the terrain of the area to be dredged.

Use techniques (e.g. silt curtains), to minimise adverse impacts on aquatic life from the resuspension of sediments.

Potential pollutants in the dredged material should be analysed for their physical, chemical, biological, and engineering properties prior to material dredging and reuse. (as per Technical Annex II of the Revised OSPAR Guidelines for Management of Dredged Material) shall be applied before using that material for reclamation.

Reclamation with the dredged material should be conducted in a way that no negative impacts may occur, meaning no discharge of polluted excess water, no discharge of fines, etc.

The dredging Contractor is to develop a proper Dredging and Dredge Disposal EHS Management Plan as a part of Contractors EMP following the appropriate standards (IFC, OSPAR and Indian) and PS 2, 3 and 4.

This Dredging and Dredge Disposal EHS Management Plan should be developed by the Contractor and approved by the Developer prior to commencement of dredging works.

10.4.9 Water Quality Management Plan

10.4.9.1 Sewage Management Plan

Construction Phase

- Sewage generation: 85 KL/day
- During construction phase mobile toilets will be provided. Sewage generated during construction phase will be treated in mobile STP.

Operation Phase

For the buildings complex having administration building and port user buildings, according to Sewage treatment plant capacity of 5000KLD is to be considered.

Performance Criteria/Outcome

- No disposal of treated / untreated sewage in marine areas
- Reuse of treated sewage to the maximum extent

Management Action

- If the basic pollution level is critically high, a sewage treatment system should be planned as part of the environment management of the area.
- Regulations on discharges of sewage into water and provision of sanitary treatment facilities are indispensable for reducing pollutants from hinterlands.
- Reuse of treated sewage for flushing gardening etc.

10.4.9.2 Water Contamination Management Plan

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 aspects identified that may lead to water pollution in the port area basin are as under

- Bilge water discharges from vessels using the port and boat ramp may contain hydrocarbons (oils and fuel).
- Illegal to discharge oily bilge water
- Sewage discharges from vessels.
- Other discharges from vessels using the port and boat ramp.
- Overland storm water flow across land within the port may mobilise contaminants including sediments, litter and oil and grease into storm water systems and into the port basin. Note that it is illegal to release contaminants to waters, or to place potential contaminants in a location where the contaminant may reasonably be expected to wash into storm water drains or water bodies.
- Building and infrastructure construction works will require some materials to be stored and used on the site that may be hazardous to the environment. Quantities will be small in most cases. These may include:
    - Fuels for refuelling mobile and stationary plant.
    - Lubricating oils, hydraulic oils, solvents, degreasers, detergents for use in maintaining stationary plant and large mobile equipment.

Performance Criteria/Outcome:

- Reducing the likelihood of releases of contaminants by ensuring that preventative measures are in place

- Reducing the consequence in the event of a contaminant release by minimising the quantity and toxicity of potential contaminants that might be released.

Management Action

- Ensure that contracts contain conditions in relation to erosion and sediment control, management of hazardous substances and other aspects of water quality protection.
- Store minimum quantities of hazardous substances necessary on site, for example only store enough fuel for 1-2 days refuelling.
- Hazardous materials to be stored securely so as to avoid tampering or accidental damage or release. Secure storage may consist of location inside a lockable building or compound.
- Ensure that undeveloped areas are stabilised to prevent erosion from overland flow (and wind erosion)
- Make every effort to inform vessels using the port of requirements in relation to release of pollutants from vessels.
- If hazardous materials are present in sufficient quantities, Material Safety Data Sheet (MSDS) to be kept on site for these materials. Check with supplier whether threshold for requiring MSDS has been exceeded. Sign showing location of MSDSs to be posted at storage areas.
- If refuelling is required, refuelling equipment to include:
    - Automatic cut off when recipient tank is full.
    - Manual operation only (ie operator must depress handle to pour fuel).
- Spill response kits to be available at:
    - Marina arms
    - Locations where liquid hazardous materials are stored.
    - Locations where refuelling and equipment maintenance taking place.
- Spill response kits to be suitable for oil/fuel spills to land and water.
- Refueling procedure (land areas)
- Ensure that well clear of any water bodies and drainage lines.
- Ensure that spill kit is on hand and contains all necessary items.
- Place nozzle in tank and commence filling (do not commence filling until nozzle is placed in tank).
- Monitor filling and stop before tank overflows.

- In the event of a spill, Oil Spill Managed procedure shall be followed
- Cover hazardous material management topics in toolbox talks as appropriate.
- Dispose of waste packaging, spilt material, waste oil and any other wastes potentially contaminated with hazardous materials in accordance with (Waste Management).

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 generated 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.

10.4.9.3 Rain Water Harvesting System

Maharashtra is known for its torrential rains during SW monsoon. The water scarcity scenario in and around the project site can be solved by rainwater harvesting (RWH). Therefore, rainwater harvesting units are suggested to construct at strategic locations along with storm water drainage system. Rainwater harvesting has been planned in all EMP units (landward side).

A typical RWH unit (injection type) consists of pipes, filtration system and injection well. In this method rainwater is allowed to percolate through a percolation pit or filter bed, which comprises of sand and gravel. Rain water drained from roads and car parking/ servicing area/ area near fuel and lubricant storage need to have oil and grease separator before leading to a RWH unit. This Water Management Plan should be approved by the Developer prior to construction.

10.4.9.4 Waste, Energy, Materials Management Plan

Construction Phase

Dredging estimates include quantities for approach channel and harbour basin.

There will be generation of solid waste from labour camp. Other waste such as packaging material, glass, waste etc. will also be generated during operation phase.

A range of resources are utilized in operating Port as follows:

- Electrical energy is used for a range of uses including lighting, air conditioning, computers and other office equipment, refrigeration and hot water
- Electricity is also supplied to berths
- Diesel, petrol and outboard fuel are used to power vehicles and vessels
- Water is used for kitchens and bathrooms as well as for cleaning and watering of plants and landscaped areas.
- Water is also supplied to berths.
- Office activities utilise paper, office furniture and other resources
- A wide range of materials are also used in construction and maintenance of buildings and facilities.

Consumption of energy, water and other materials creates an environmental impact as the extraction of these resources from the environment causes environmental impacts, and there are emissions associated with electricity generation, water treatment and manufacturing of materials. As energy, water and materials must also be paid for, there is both a financial and environmental incentive to minimise consumption.

A range of wastes are also generated, including wastes from consumption of water and materials. Sewage is generated and Port is connected to the sewage treatment plants.

Generally accepted waste management hierarchy as follows:

- **Avoid** waste generation altogether or **reduce** the amount of waste being generated
- **Reuse** wastes (with no or minimal reprocessing)
- **Recycle** wastes by **reprocessing** them into a new product
- **Treat** wastes so as to reduce their impact on the environment
- **Dispose** of wastes to a safe disposal site such as a landfill.

Performance Criteria/Outcome

Performance criteria and outcomes will be set following the first energy and materials audit. In the interim, the following general criteria are relevant:

- Waste generation is minimised and managed in accordance with the Waste Management Hierarchy
- Energy consumption is minimised
- Consideration is given to minimising wastage when ordering materials.

Management Action

Waste

Current waste management arrangements shall be as follows:

- General waste disposal bins and recycled waste bins shall be provided for vessels. These shall be emptied regularly by a waste contractor.
- Office waste shall be removed by cleaning contractors.
- Refuse rooms shall be provided within the port area
- Waste shall be segregated into recyclable and non-recyclable components and placed in bins provided by the waste contractor. These shall be emptied regularly by a waste contractor
- A residential refuse room shall be provided for residential area. Waste is placed in secure bins which shall be emptied regularly by a waste contractor
- If any unusual wastes shall be generated, there shall be adequate storage space within the refuse rooms for these wastes to be temporarily stored prior to removal.
- Where waste is generated by contractors undertaking any form of construction or maintenance works, contract conditions require these wastes to be securely stored at the works area and promptly removed by the contractor.

- Bins shall be provided in public areas.
- Grease trap wastes (commercial kitchen wastes) shall be managed by the waste generators.
- Wastewater generated from various building / areas of port shall be treated in STP and treated sewage shall be totally reused to achieve zero discharge

When planning new activities or developments, identify likely types and quantities of wastes to be generated and ensure that:

- An appropriate storage area shall be provided for
- A suitable waste management contract shall be place
- Waste minimisation, reuse and recycling opportunities shall be maximised

In the event that regulated wastes are generated, contact a waste contractor to arrange removal. Regulated wastes may include:

- Waste oil, oily wastes, for example as generated from maintenance activities
- Hydrocarbon wastes and materials contaminated with hydrocarbons, for example as generated from cleaning up a spill or leak
- Sewage, sewage sludge, grease trap wastes and other wastewater contaminated with human or food waste
- Saline wastes, salt contaminated wastes

If any unusual, non-routine wastes shall be generated:

- Shall check if the waste is regulated/trackable
- Shall be Place in a secure, sealed container
- Container shall be clearly label the with the type of waste contained inside and the date
- Provided the waste does not pose a health and safety risk (eg human wastes, bacteria containing wastes, toxic chemicals), the container shall be placed the commercial/retail refuse room
- If the waste poses a health and safety risk, the waste shall be place in a secure location and prevent access
- Waste contractor shall be contacted and prompt arrangement for removal of waste shall be carried out.

Invoices shall be retain from waste contractors on EMP file (Waste management) as a record of waste generation quantities

When selecting new office equipment or other equipment and appliances:

- Shall be replaces only when the equipment and appliances cannot be repaired
- smallest equipment/appliance shall be selected for the for the job (allowing for future growth if necessary)
- Low energy consumption model shall be selected
- For items using water, low water consumption model shall be selected
- Purchase shall be made from local manufacturers if possible to minimize transport emissions

The following day to day energy, water and material saving measures are to be adopted:

- Turn off computer screens when away from desks
- Turn off computers overnight, and if away from desk for more than four hours
- Turn off lights when leaving rooms empty or where there is sufficient natural light
- Keep doors and windows closed when air conditioning is on
- Discourage printing and maximise use of electronic filing and circulation of documents by email rather than paperfiles and printed copies
- Print double sided
- Do not run dishwashers or washing machines unless full
- Do not leave taps running while cleaning and dishwashing
- Turn off TV screens and other display screens when not in use
- Do not activate irrigation systems if rain has fallen in the past 48 hours and/or soil remains moist
- Retain electricity and water bills on EMP file (monitoring) as a record of consumption and for auditing purposes
- Develop and implement an energy, water and material reduction plan once an energy/ waste/ materials audit has been undertaken

10.4.10 Green Belt Development Plan

The green belt area will be developed within port area. The details of tree species along with the number of trees to be planted are given in Table below.

Table 156 Details of Tree Plantation

Sr. no.	Area/ Building	Tree Species	No. of Tree (no.)
1	Main Road	Arjun (*Terminalia arjuna*)	15
2	Road Side	Peepal (*Ficus religeosa*)	15
		Amaltas (*Cassia fistula*)	20
3	Parking Area	Gulmohar (*Delonix regia*)	25
		Rain Tree (*Albizia saman*)	15
		Chafa (*Plumeria alba*)	20
		Chafa (*Plumeria Rubra*)	20
4	Near Compound Wall	Karanj (*Pongamia Pinnata*)	25
		Badam (*Terminalia Cattappa*)	15
Total			**170**
Grass species Lemon Grass (*Citronella sp*) and Umbrella Grass (*Cyperus Alternifolius*) will be used in landscaping			

- Green belt of 2 meter width will be developed along the entire alignment of the Rail & Road.

10.5 Environment Management Plan for Road

The road alignment starts from Varor (Vadhavan port) and ends at NH-48 (Tawa junction). The length of the new road is about 33.4km. The proposed Rail alignment runs parallel to road alignment for initial 12 Km.

10.5.1 Top soil Management

There will be loss of top soil due to indiscriminate excavation of the area. Loss of fertile top soil may be anticipated if not managed properly

10.5.1.1 Mitigation Action

- Prior to excavation or filling top soil shall be removed.
- The topsoil removed shall be stored in earmarked areas. The topsoil stock / heap are prone to erosion, hence proper erosion control measures shall be provided.
- Mixing of topsoil with excavated material shall be avoided.
- All the top soil will be preserved separately at earmarked site away from other construction materials at site so as to avoid mixing with other materials or contamination.

- The topsoil removed shall be reused in green area development.
- To avoid loss of topsoil the ROW shall be marked in order to restrict movement of machineries and vehicles within the ROW only.
- To avoid contamination due to leakage or spillage the chemicals such as bitumen, oil, diesel, paint etc shall be stored in earmarked place with proper platform with catch pits etc.

10.5.2 Construction & Debris Management

The corridor is planned to be 120 m wide for a length of 12 km where road and rail will pass through and the remaining part of the corridor is planned as 100 m wide for only road connectivity which will be of approximately 22 Km long. Construction of rail & road will generate excavated earth.

10.5.2.1 Mitigation Action

- Excavated earth, muck, debris shall be segregated, collected & stored at designated place
- Proper measures to be adopted to ensure that, other waste (such as solid waste) not get mixed with this waste and is stored and disposed separately
- Waste into four streams such as concrete, soil, steel, wood and plastics, bricks and mortar etc.
- The waste shall be stored within the premises of site and shall be reused to maximum extent. The remaining waste shall be handed over to authorised facility only
- During transportation of the construction waste measures shall be adopted to avoid littering or deposition of construction on road or other areas

10.5.3 Air Quality Management

The air quality will be altered due to following

- Due to vehicle movements across exposed dirt
- Due to earthworks.
- Dust clouds can be visually intrusive and can create traffic hazards on and off-site if clouds drift across roadways. If dust settles on adjacent properties, this also causes nuisance to landholders and tenants. While dust deposition on vegetation and in surface waters can also cause environmental impacts, it is unlikely that either the quantity or duration of dust that might be generated from activities at Port would cause these sorts of

impacts

10.5.3.1 Mitigation Action

To control the air pollution during construction phase following measures will be adopted –

- During excavation, pilling, drilling process the site will be barricaded.
- Proper management of construction vehicle traffic.
- Construction material will be stored in designated place.
- For dust suppression water sprinkling will be carried out on roads used for movement of construction vehicles.
- Proper and regular maintenance of construction equipments.
- Wind barricades for storage area will be provided.
- Vehicle in good condition and with PUC certificate will be used during construction phase.
- Construction material will be transported through covered vehicles.
- DG set will be provided with a stack of adequate height.
- Workers will be provided with face mask to avoid inhalation of air pollutants

10.5.4 Noise Management Plan

During construction phase Construction equipments and vehicle will increase noise level

10.5.4.1 Mitigation Action

- Barricading the construction site will helps in limit the noise within construction site
- Proper maintenance of machineries and vehicles
- Use of construction vehicles which are properly maintained and with PUC
- Provision of mufflers, padding to reduce vibration, which will in turn reduce the noise
- Provision of ear muffs /plugs to the workers working near high noise generating machineries
- Proper maintenance of path used for construction vehicle to reduce smooth flow and reduce noise
- Carrying noise generating activities in day time only
- Transportation of construction material during non-peak hours

10.5.5 Green Belt Development Plan

Green belt will be developed at both side of the road. About 16467 no of indigenous plant will be planted.

Table 157 ***Details of no. of trees to be planted***

SN	Rows	No. of trees to be planted/km as per IRC:SP:21-2009	No. of trees to be planted for Rail and Road corridor
1	1st Row	333	10989
2	2nd Row	166	5478
Total		**499**	**16467**

(IRC: Indian Roads Congress, Guidelines on landscaping and Tree plantation)

Table 158 List of the plant to be planted is as flows

SN	Scientific Name	Common Name
1	*Azadirachta indica*	Neem tree
2	*Tamarindus indica*	tamarind
3	*Cocos nucifera Linn*	Coconut tree
4	*Ficus benghalensis*	Banyan Tree
5	*Zizyphus mauritiana*	Ber
6	*Caesalpinia pulcherrima*	White gold mahur
7	*Trema oreintalis*	Charcoal tree
8	*Alstonia scholaris*	Devil tree
9	*Duranta repens*	Duranta
10	*Anona squamosa Linn*	Custard Apple
11	*Dendrocalamus strictus*	lathi bans
12	*Thespesia populnea*	Umbrella tree
13	*Anthocephalus chinensis*	kadam
14	*Prosopis cineraria*	khejri
15	*Acacia nilotica*	babul
16	*Ficus semicordata*	Drooping fig
17	*Madhuca longifolia*	Mahua
18	*Barringtonia racemosa Roxb*	powder-puff tree

SN	Scientific Name	Common Name
19	*Ficus benjamina Linn*	Weeping fig
20	*Derris indica*	-
21	*Pongamia pinnata*	-
22	*Terminalia Arjuna*	Arjun
23	*Tabernaemantana divaricata*	crape jasmine
24	*Acacia farnesiana*	Cassia flower
25	*Heterophragma roxburghii DC*	
26	*Acacia tortilis Hayne*	Umbrella thorn tree
27	*Anona reticulata Linn*	Bullock's heart
28	*Hibiscus rosa-sinensis*	Jasud
29	*Barringtonia acutangula*	India oak
30	*Ficus elastica*	Rubber tree
31	*Cassia pumila Lamk*	Yellow cassia
32	*Prosopis pallida*	kiawe
33	*Dalbergia sisso Roxb*	Sheesham
34	*Kigelia africana Lamk*	Sausage tree
35	*Ficus gibbosa Blume*	Datir
36	*Hamelia patens*	Scarlet bush
37	*Aphanamixis polystachya*	Rohituka tree

10.6 Environment Management Plan for Rail

The Port is about 12 km from Vangaon Railway Station of Mumbai- Delhi Western Railway route and about same distance from the proposed New Palghar crossing station of Western Dedicated Freight corridor which runs parallel to Mumbai -Delhi Western Railway Main line.

The nearest railway stations to Vadhavan port on WDFC will be the proposed New Palghar crossing station of Western Dedicated Freight Corridor which runs parallel to Mumbai -Delhi Western Railway line

10.6.1 Air Quality Management

During Construction phase impacts relate largely to dust emissions from:

- Vehicle movements over unsealed surfaces; and
- Exposure of soils to wind erosion.

  Dust emissions may affect receptors within 500 m of the alignment, however with mitigation measures, impacts are likely to be restricted to within 100m or less.

  Emissions from construction vehicles and equipment are not likely to contribute significantly to degradation of environmental values in relation to air quality.

  Potential sources of air emissions from the operation phase of the Project include: exhaust emissions from diesel powered locomotive engines.

10.6.1.1 Mitigation Action

During construction, the following control strategies and measures will be implemented:

- Soil stock piles will be placed in areas protected from the wind and away from public places where possible. Stockpiles will be aligned with prevailing winds to minimise cross sectional area presented to the prevailing wind direction. Spoil stock piles will be lightly compacted after placement;
- Existing vegetation will be retained where possible or cleared areas and stockpiles re-vegetated with fast growing species for rapid coverage to temporarily or permanently stabilise soil;
- Vehicle speeds on unsealed surfaces will be limited to 50 km/hr, or less if significant dust plumes arise;
- All trucks hauling dirt, sand, soil or other loose materials to and from the construction site will be covered when traveling on public roads;
- Wheel wash units or rumble pads will be installed where vehicles enter and exit unpaved roads on to paved roads. Wash-off equipment for trucks and any equipment will be available for any vehicles leaving the site to remove excessive dirt, mud or debris from tyres and other under-surfaces. Material spillage on sealed roads will be cleaned up as soon as possible;
- All construction vehicles, mobile plant and machinery will be maintained and operated in accordance with the manufacturers' pacifications to minimize exhaust emissions; and any complaints received in relation to dust emissions will be recorded and acted upon in accordance the complaints handling procedure.

10.6.2 Waste Management

Waste generation for the construction and operation of the Project may include:

- Vegetation,
- Typical construction wastes including packaging, surplus construction materials such as timber, concrete, gravel, metals and plastics,
- Surplus spoil from earth works and drainage construction,
- Electrical and telecommunications cabling off-cuts, and typical domestic waste-to be generated from occupation of accommodation villages

10.6.2.1 Mitigation Action

If wastes are not managed and disposed of properly, environmental values such as health and well being of people, ecosystem health and land use capability may be affected.

- Wastes also represent a loss of resources
- All waste materials are handled and stored in a safe and appropriate manner;
- There is no environmental impact on, and disturbance to, the surrounding environment from waste;
- The construction equipment is maintained in a clean and tidy manner; and no waste is to be disposed of in the marine or terrestrial environment or incinerated
- Minimise vegetation clearing where possible;
- Ensure vegetation materials are mulched and used on site for rehabilitation and re vegetation works;
- ensure detailed design and specifications are undertaken so as to minimise the generation of waste during construction and the durability of materials is considered;
- Set up designated waste transfer areas;
- Store recyclable waste separately from residual/non-recyclable waste;
- Appropriately manage stockpile areas and storage areas;
- Reuse or recycle timber and plywood;
- Use pre-painted products to minimise use of paints and solvents;

Store used oils, oily rags, solvents, lubricants and fuel in covered and bunded areas

10.6.3 Hazardous Waste Management

Hazardous waste would mainly arise from the maintenance of equipment which may include used engine oils, hydraulic fluids, waste fuel, spent mineral oil/cleaning fluids from mechanical machinery, scrap batteries or spent acid/alkali, spent solvents etc

10.6.3.1 Mitigation Action

- It shall be the responsibility of the contractor to ensure that hazardous wastes are labeled, recorded, stored in impermeable containment and for periods not exceeding mandated periods and in a manner suitable for handling storage and transport.
- The contractor shall maintain a record of sale, transfer, storage of such waste and make these records available for inspection.
- The contractor shall approach only Authorized Recyclers for disposal of Hazardous Waste, under intimation to the Project Authority

10.6.4 Management plan for other attributes

- 20 No. of Toilet blocks will be provided at the Railway yard and the waste generated will be collected at STP having 10 m^3 capacities.
- Canteen waste

  Waste Generated from canteen will be collected separately in dry waste bins and wet waste bins
- Safety plaques:

  50 no. of Safety plaques will be provided at various locations at station yards
- Greenery at yard

  150 no. of Indoor plans and 200 outdoor plants with earthen pots and in open areas Lawn grass will be provide.

  50 no of Earthen Bird Water feeder will be placed at different location at Yard
- Potable water arrangements:

  Potable Water will made available for all the staff and others

- Housekeeping at station/yard

  24 no. of Cleaners in 3 shifts (8 persons in a shift) 2 supervisors, 1 Manger will be provided at Station yard

- Medical/First aid room

  Medical/First aid room will be provided at Yard. The room will be equipped with First aid Kit, Beds, 1 on-call doctor, 2 male nurses and 2 helpers

  4 Biomedical waste collector bins will be made available at room

- Parking at Railway Yard/Station

Parking for 10 no. of trucks, 15 no. of 4 wheeler and 25 no. of 2 wheeler will be provided.

10.7 Roles and Responsibilities

This section describes the overall accountability and responsibility of the port management team and associated contractors for environmental compliance and performance. Additional detailed responsibilities for various management actions are identified throughout the EMP. Roles and responsibilities are set out in the following Table and the corresponding organizational structure is shown in following Figure

Distinction is made between contracts for routine maintenance activities, including waste management, and project-specific contracts which may be issued for non-routine maintenance and major repairs, as well as further development of the port assets.

Table 159 – Roles & Responsibility

Position	**Accountabilities**
Manager & Asst. Manager	Ensure compliance with all aspects of: • Legislation and subordinate legislation • Permits and approvals • Ensure adequate resources are provided for implementation of the EMP Ensure that the EMP is regularly reviewed and kept up to date
Asset Manager	Act under direction of receivers and managers to:

Position	**Accountabilities**
	• Ensure that all aspects of the EMP are implemented • Ensure that new or altered activities do not commence until the environmental assessment procedure has been implemented and relevant approvals obtained. • Communicate with staff & workers on environmental requirements including legislative and compliance requirements and good practice standards • Manage complaints and enquiries in relation to environmental issues • Proactively manage community and other stakeholder communications and relationships • Manage the corrective action procedure • Manage the incident investigation procedure • Ensure that all contracts contain relevant environmental requirements • Report against objectives and targets
Port Operations Manager Property Operations Manager	Act under direction of receivers and managers to: • Ensure that routine maintenance contracts, including waste management contracts meet the requirements of this EMP • Manage all aspects of environmental performance of contractors undertaking routine maintenance or waste management contracts • Ensure that contractors are competent to undertake any environmental management or monitoring aspects of the activity • Maintain a filing system for all records required to be kept under this EMP
Routine maintenance and waste management contractors	Comply with all aspects of legislative requirements and approval conditions, including holding authorisation for

Position	**Accountabilities**
	environmentally relevant activities Ensure familiarity with relevant legislative requirements and approval conditions and the relevant requirements of this EMP ensure high standards of environmental performance are achieved Take measures to prevent adverse impacts and incidents from occurring
Port Operations Team Property Operations Team All port staff	Act under direction of receivers and managers to: • Ensure that the site and environs are kept in a neat and tidy manner such that risk of environmental impact or incident is minimised • Provide "first at scene" response to environmental incidents as required • Report any incidents, near misses, actual or potential environmental issues to the Asset Manager
Environmental Advisor	Provide advice and assistance to the Asset Manager and other team members as requested including: • Keeping the EMP up to date • Advising on incident response • Reviewing monitoring data • Advise on scopes and contracts in relation to environmental monitoring and auditing and other aspects.

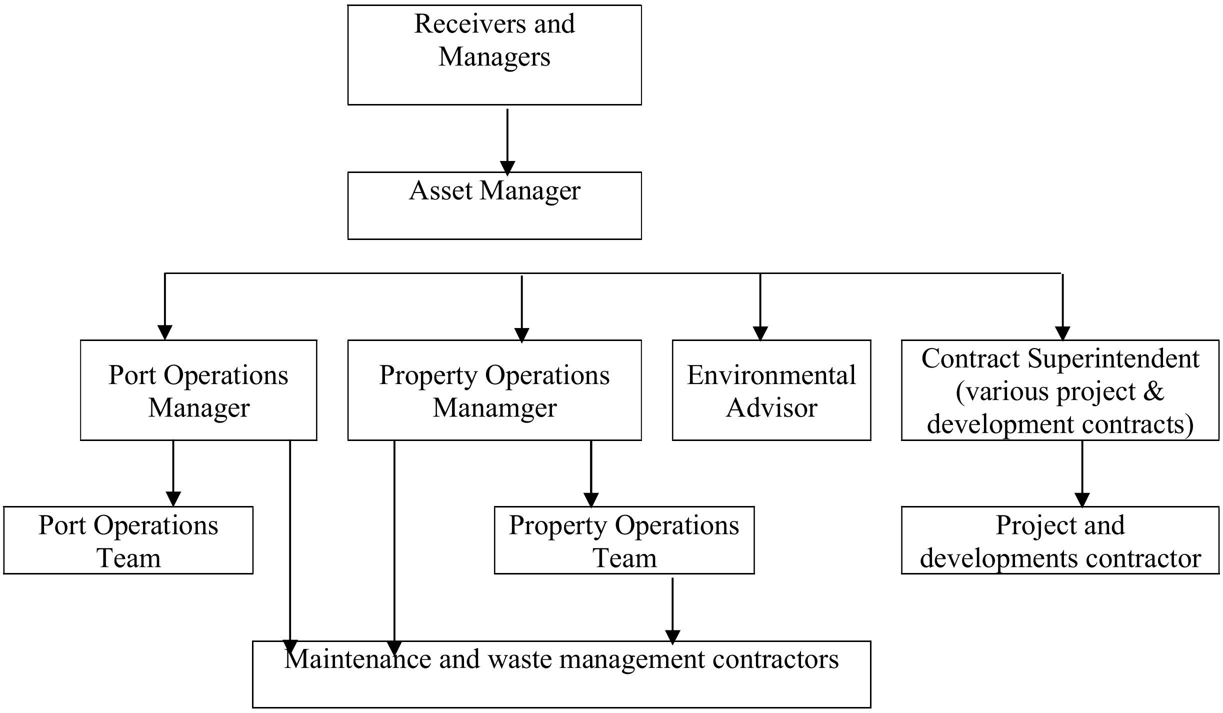


Figure 109 – Roles & Responsibilities

10.7.1 Delegation of Responsibilities

Responsibilities in Table 84 and elsewhere in the EMP can be delegated to others provided that:

- Delegation is in writing and clearly sets out:
  - the items, matters or actions that are delegated
  - the required performance requirements
  - the period over which the delegation is valid.
- The delegator is satisfied that the delegate is suitably competent and has sufficient capacity to undertake the delegated responsibilities
- The delegation is acknowledged by the recipient
- Written evidence of the delegation having been made and acknowledged is maintained on the EMP files

10.7.2 Objectives, Targets and Performance Criteria

Objectives, targets and performance criteria have been identified for Port and are set out in Table 159 below. Note that workplace safety, community safety and traffic are not covered by this EMP and hence, targets for these aspects have not been developed.

Table 160 - Objectives and Targets

Objective	Targets	Performance Criteria/Outcome
Achieve compliance with legal requirements	Legal compliance is achieved at all times	No activities undertaken without appropriate approvals
		All new or amended activities undergo environmental assessment
	Compliance with conditions of approval is achieved at all times	All activities are undertaken in accordance with relevant conditions of approval
Maintain strong positive relationship with the community	Positive and proactive communication is maintained with key business stakeholders at Port	• Grampanchayat Vadhavan and other nearby Grampanchayat • Fishermen
	Complaints and requests for information are responded to promptly and courteously	Initial response time <5 business days
		All complaints (valid or vexatious) closed out within 1 month
		No valid repeat complaints
	Public access areas and facilities, including boat ramp and navigation access channel are available and contribute to local amenity	All public access areas and facilities are available and fully functional for 50 weeks of each year
		Public access facilities are in a neat, clean and safe condition at all times when the facilities are available for use
Manage impacts of maintenance	Disturbance from noise is minimised	No non-compliances with requirements of environmental standards in relation to

Objective	**Targets**	**Performance Criteria/Outcome**
and development activities on neighbours		building and construction works, including dredging and related activities
		All valid noise-related complaints resolved
	Disturbance from dust is minimised	No visible deposition of dust outside immediate work areas
		No visible dust plumes leaving Port boundary
		All valid dust-related complaints resolved
Minimise resource consumption and waste	Energy consumption is minimised	To be determined following first energy and materials audit
	Water consumption is minimised	To be determined following first energy and materials audit
	Waste generation is minimised	To be determined following first energy and materials audit
Implement EMP effectively	Staff are trained and aware of EMP requirements	All new staff undergo induction and awareness training within 1 month of commencement
		All staff undergo refresher training annually
	Audit results indicate effective implementation	No major non-compliances identified in audit results
		No more than three minor non-compliances identified in audit results
Continually improve environmental management performance	Corrective actions are closed out in a timely manner	Corrective actions which pose a high level of environmental risk, indicate non-compliance with legal and other obligations or non-compliance with the EMP are closed out within one week

Objective	**Targets**	**Performance Criteria/Outcome**
		Other corrective actions are closed out or transferred to the Environmental Management Program within one month.
		Environment Management Program items are completed on schedule.
Effectively prevent incidents and minimise severity of incidents	Incident prevention measures are in place	No incidents causing serious or material environmental harm
		No more than two minor incidents per year (minor incidents are those that do not cause serious or material environmental harm)
	Incident response processes and equipment are in place	Environmental harm arising from incidents does not increase as a result of delayed or inappropriate response.

10.7.3 Reporting Requirements

- Other corrective actions are closed out or transferred to the Environmental Management Program within one month.
- Environment Management Program items are completed on schedule.
- No incidents causing serious or material environmental harm
- No more than two minor incidents per year (minor incidents are those that do not cause serious or material environmental harm)
- Environmental harm arising from incidents does not increase as a result of delayed or inappropriate response.

Performance against objectives and targets is required to be reported by the Asset Manager as follows:

- Monthly reports should report performance by exception, that is, where any of the performance criteria have not been met in the past month; this should be specified in the monthly internal report
- Rolling monthly report
- An annual report of performance against objectives and targets should be prepared
- Evidence to support stated performance is to be retained on EMP files or other Port files as appropriate, with cross referencing provided in the annual reporting to where evidence can be viewed.

10.7.4 Training and Awareness

General Site Inductions

Employees and certain long term contractors must undergo an environmental awareness induction within one month of commencement of employment, with refresher training as follows:

• Every two years

• More frequently if there is a significant change to the EMP.

The environmental awareness induction will take approximately half to one hour and be delivered by the Owner's Environmental Advisor or suitably trained delegate.

Matters to be covered in the general environmental awareness induction include:

- Introduction to the site
- Project environmental objectives and targets.
- Environmental and community values and sensitivities, including:
    - Protected flora and fauna likely to occur
    - Surrounding land uses.
    - Legal requirements including:
        - The general environmental duty
        - Legal requirements in relation to water pollution, noise emissions, notification of environmental harm
        - Conditions of approvals and permits

• Roles and responsibilities
• Preventing contamination of water
• Waste management
• Incident response and reporting
• Complaint reporting and resolution
• Record keeping and document control.

Management Training

The Asset Manager, contract superintendents and other nominated senior management will undergo more detailed training covering:

- Requirements of environmental approvals and development permits
- Other legal obligations
- The requirements of the EMP.

Continuous Improvement

The Continuous Improvement Cycle
Continual improvement requires a cycle of:

Commitment and Policy: JNPA has developed an environmental policy and is committed to achieving the policy

Planning: This EMP represents the planning stage of the continuous improvement cycle. This EMP identifies the environmental impacts and risks arising from the activities undertaken at Port, and in relation to those activities managed by JNPA, sets environmental objectives and targets and contains procedures to achieve these.

Implementation: This stage is achieved by implementation of this EMP

Evaluation: The various monitoring, checking and auditing requirements EMP provide an opportunity to evaluate the performance of the EMP. Outcomes from investigations of incidents and near misses will also serve as evaluation of the effectiveness of the EMP in minimizing risk of environmental incidents.

Review: This section of the EMP contains procedures for regular review of the EMP and additional review where evaluation indicates that performance is not adequate.

10.7.5 Corrective Action Procedure

Corrective action is the core outcome of the EMP and allows continuous improvement of environmental management performance.

Corrective actions may be required in the event that:

- Any aspect of the EMP is not being complied with
- Non-compliance with approvals has been identified
- An incident or complaint has occurred
- Completion of a checklist indicates that additional actions are required
- An audit indicates non-compliance or identifies improvement opportunities.
- In some cases, corrective actions will require amendment to the EMP.

10.7.6 Performance Criteria/Outcome

- Continuous improvement is demonstrated through the identification and timely completion of corrective actions

Management Action

Review outcomes of internal and external audits.

- Identify corrective actions and Environmental Management
- Programs arising from audit recommendations.
- Review EMP dredging and identify any corrective actions required.
- Review weekly site inspection checklist and identify corrective actions required.
- Where non-compliance with approval requirements procedures or performance criteria is identified, prepare Corrective Action Request (CAR)
- Where possible, consult with those identified as responsible for undertaking corrective actions prior to finalising the form.
- Inform persons with responsibility to undertake corrective actions.

- Provide copy of form and discuss required action.
- Follow up to ensure that corrective actions have been implemented within time frames specified and obtain record for corrective action file (e. g. action signed off by responsible person).
- When all actions on the CAR have been satisfactorily complete close out CAR by signing
- Include review of corrective actions raised and closed in site environmental audits

10.8 Corporate Social Responsibility

JNPA has already started implementation of CSR activities in project area as follows:

10.8.1 Health checkup camps

People's health is of vital importance to the development of communities all around the world. In rural areas, there are often no facilities available for basic health care needs. The few that are there are under-staffed and mismanaged. Due to such circumstances, the poor living in these remote locations go on suffering from easily preventable diseases. Even after decades of freedom, India is struggling to provide basic health services to its people.

JNPA has conducted various health checkup camps at Dahanu Tehsil. For this purpose JNPA appointed an NGO, Abhinav Janseva Association. Abhinav Janseva Association carried out two Camps on Cancer Awareness, Check-up, Early Detection and Cure in Association with Indian Cancer Society.

Many more cancer awareness camp and other healthcare check-up camps are propped by JNPA for Dahanu taluka and Project affected people.

10.8.2 Livelihood:

Vadhavan village and other nearby villages are known as Fishery villages. Major occupation of the villagers is fishing. Construction of Vadhavan port will likely to impact on fisheries on that region. After examination fisheries in the Vadhavan area, it is understood that Vadhavan shoreline have good fish catch and lobster culture practices. JNPA appointed Central Marine Fisheries Research Institute (CMFRI) to study possible impact on Costal fisheries and to alternatives for fishing activates. CMFRI conducted training program for identified and interested fishermen in the Vadhavan village and other nearby villages about practices in Open Sea Cage Culture.

JNPA also has conducted public awareness program for Vadhavan port (report Attached as Annexure 14a)

10.9 Budget for Environmental Management Plan

The mitigative measures suggested in the preceding chapters forms costs related to measures incorporated into engineering design; project scheduling, site planning and preparation of tender documents. The cost on this account will be covered with the construction budget and should not be seen as items of cost for implementing Environmental Management Plan. The estimated environmental cost considered here includes:

a) During Construction phase
- Compensatory tree plantation for tree cutting, if any
- Provision of Sanitation at workers camp
- Provision of air, noise, and dust vegetative barrier/ special screens- both side of project area
- Dust suppression
- Erosion Control Measures, if any
- Solid barrier to check noise pollution for sensitive receptors like school etc
- Solid waste management due to construction activity

b) During Operation phase
- Air pollution monitoring
- Noise monitoring
- Water quality monitoring
- Soil quality monitoring
- Solid waste management

The environmental cost is consists of monetary value of the mitigative measures adopted to minimize the negative impact of project on environment. Environmental cost is divided into two categories, i.e. capital cost and operation and maintenance cost. Capital cost is the cost of all the structural measures proposed for environmental protection during construction phase while the operation and maintenance cost include the cost of monitoring air, noise, soil and water and maintaining the structural measures over project life.

Table 161 - Budget Environmental Management Plan - Construction Phase for Port Area

Heads	EMP	Measures	Capital Cost (in Lakhs)	O & M Cost per Annum (in Lakhs)
Land Environment	Soil Quality Monitoring	--	--	0.60
	Geotechnical Investigation	--	5.00	--
	Soil Erosion Control Measures	Soil Covering, Soil Stack area Barricading, Mulching	35.00	20.00
	Soil contamination prevention measures		18.00	10.00
	Solid Waste Management	Provision of Dust bins and collection & proper storage & disposal of Solid Waste, Debris etc	20.00	15.00
	Hazardous Waste Management	Provision of separate area for storage of hazardous waste, proper management & Disposal of Hazardous Waste	50.00	12.00
	Biomedical Waste Management (BMW)	Provision of separate area colour coded bins for BMW, proper management & Disposal of BMW	15.00	5.50
Water Environment	Surface Water Pollution Control Measures	Oil/Water Separators, Spill Containment Facilities, Curb And Containment Facilities	20.00	7.50
	Surface runoff Water Management	Sedimentation ponds, curb and gutter, concrete drainage gutter, concrete drainage systems, etc.	32.00	8.50
	Water Quality Monitoring	--	26.00	20.00
	Marine Water Quality Monitoring	--	--	5.50

Heads	EMP	Measures	Capital Cost (in Lakhs)	O & M Cost per Annum (in Lakhs)
	Ground Water Quality Monitoring	--	--	3.00
	Mobile Sewage Treatment Plant for Labour Camps	--	35.00	10.00
Air Environment	Air Pollution Control Measure	Site Barricading, Tree Plantation, Water Spanking, Vehicle tyre washing facility	28.00	20.00
	Ambient Air Quality Monitoring	--	--	20.00
Noise Environment	Noise Pollution Control Measure	Site Barricading, Provision of PPE's, provision of muffles noise control measure for machineries etc.	18.00	7.50
	Ambient Noise Level Monitoring	--	--	7.25
Training and institutional streingthining	-	-	-	25.00
TOTAL			**302.00**	**197.35**

Table 162 - Budget Environmental Management Plan - Operation Phase for Port Area

Heads	EMP	Measures	Capital Cost (in Lakhs)	O & M Cost per Annum (in Lakhs)
Land Environment	Green Belt Development	Tree Plantation near admin building, internal road etc.	50.0	10.00
	Soil contamination prevention measures		10.0	2.00
	Solid Waste Management	Provision of Dust bins and collection & proper storage & disposal of Solid Waste, Debris etc	50.00	30.00
	Hazardous Waste Management	Provision of separate area for storage of hazardous waste, proper management & Disposal of Hazardous Waste	26.00	8.00
	Biomedical Waste Management (BMW)	Provision of separate area colour coded bins for BMW, proper management & Disposal of BMW	12.00	6.00
	E-waste Management	Provision of spate storage area for E-waste & proper management & Disposal of E-Waste	18.00	5.50
5.	Sewage Treatment Plants	--	100.00	100.00
	Effluent Treatment Plan	--	35.00	10.00
	Storm Water Drainage	--	30.00	80.00
	Rain Water Harvesting	--	30.00	80.00
	Surface Water Quality Monitoring	--	--	2.00
	Marine Water Quality Monitoring	--	--	5.50

Heads	EMP	Measures	Capital Cost (in Lakhs)	O & M Cost per Annum (in Lakhs)
	Ground Water Quality Monitoring	--	--	3.50
	Sewage Quality Monitoring (Inlet / Outlet)	--	--	2.50
	Effluent Quality Monitoring (Inlet / Outlet)	--	--	2.50
Air Environment	Dust Suppression Measures	Tree Plantation, Water Spanking for conveyer, Vehicle tyre washing facility	32.00	10.50
	Fugitive Emission Control Measures	Site barricading, sheds, Tree Plantation, Water Spanking,	18.00	8.50
	Ambient Air Quality Monitoring	--	--	3.50
	Stack Emission Monitoring	--	--	3.50
Noise Environment	Noise Control Measures	Site Barricading, Provision of PPE's, provision of muffles noise control measure for machineries etc.	32.00	3.50
	Noise Level Monitoring	--	--	2.50
Training and institutional streingthining	-	-	--	25.00
			443.00	**404.5**

Table 163 - Budget Environmental Management Plan Operation Phase – Rail & Road

Heads	EMP	Measures	Capital Cost (in Lakhs)	O & M Cost per Annum (in Lakhs)
Land Environment	Green Belt Development	Tree plantation along rail & road corridor, median etc.	13.50	18.50
	Measures for Prevention of Soil contamination	--	10.0	2.50
	Soil Quality Monitoring	--	--	2.50
	Solid Waste Management	Provision of Dust bins and collection & proper storage & disposal of Solid Waste, Debris etc	18.00	5.50
Water Environment	Storm Water Drainage	--	30.00	3.50
	Rain Water Harvesting	--	30.00	3.50
	Surface Water Quality Monitoring	--	--	2.50
	Ground Water Quality Monitoring	--	--	3.50
Air Environment	Dust Suppression	Water sprinkler along rail & road corridor, median etc.	20	6.50
	Ambient Air Quality Monitoring	--	--	4.50
Noise Environment	Noise Control Measures	Site Barricading, Provision of PPE's, provision of muffles noise control measure for machineries etc.	22.00	3.50
	Noise Level Monitoring	--	--	0.25
Energy Saving Measures	Solar Panels	Providing Solar Panels at Railway Yard	30.00	--

Heads	EMP	Measures	Capital Cost (in Lakhs)	O & M Cost per Annum (in Lakhs)
Others	Greenery at Railway Yard/station	250 no. of Indoor plans and 250 outdoor plants with earthen pots and in open areas Lawn grass will be provide	10.00	4.00
	Earthen Bird Water feeder at Railway yard/station	50 no of Earthen Bird Water feeder	0.5	0.5
	Toilet blocks at Railway Yard	20 no of toilet blocks for officers and other staff	5.0	1.0
	STP at Railway Yard	10 m^3 STP at Railway Yard	12	1.2
	Safety plaques	50 no. of Safety plaques will be provided at various locations at station yards	1.0	--
	Housekeeping at station/yard	24 no. of Cleaners in 3 shifts (8 persons in a shift) 2 supervisors, 1 Manger will be provided at Station yard	5.22	5.22
	Medical/First aid room	The room will be equipped with First aid Kit, Beds, 1 on-call doctor, 2 male nurses and 2 helper	4.9	1.9
	Rainwater Harvesting	--	10.0	2.6
TOTAL			**222.12**	**73.17**

Table 164 - Budget Environmental Management Plan, Operation Phase – Residential Area

Heads	EMP		Capital Cost (in Lakhs)	O & M Cost per Annum (in Lakhs)
Land Environment	Green Belt development	Tree Plantation in internal road, residential area periphery, Landscaping,	36.00	8.00
	Solid Waste Management	Provision of Dust bins and collection & proper storage & disposal of Solid Waste, Debris etc	22.00	6.50
	Soil Quality Monitoring	--	--	3.50
	Solid Waste Management	OWC	2.00	5.50
Water Environment	Sewage Treatment Plant	--	50.00	5.00
	Rain Water Harvesting System	--	30.00	3.50
	Storm Water Management	--	30.00	3.50
	Sewage Quality Monitoring	(Inlet / Outlet)	--	4.50
	Surface Water Quality Monitoring	--	--	3.50
	Ground Water Quality Monitoring	--	--	3.50
Air Environment	Ambient Air Quality Monitoring	--	--	4.50
Noise Environment	Noise level Monitoring			3.50
Energy Saving Measures (Solar)	--	Solar Panels etc.	42.00	---
TOTAL			**212**	**55**

10.10 Corporate Environment Responsibility Budget

The Environment Impact Assessment (EIA) Notification, 2006, and amended from time to time, issued under the Environment (Protection) Act, 1986, as amended from time to time, prescribes the process for granting prior environment clearance (EC) in respect of certain development projects/activities listed out in the Schedule to the Notification.

Sustainable development has many important facets/components like social, economic, environmental, etc. All these components are closely inter related and mutually re-enforcing. Therefore, the general structure of EIA document, under Appendix-III to the notification, prescribes inter-alia public consultation, environment social impact assessment and R&R action plan besides management plan (EMP).

As per the MOEFCC Memorandum dated 1st May, 2018 JNPA has proposed an amount of Rs. 190 Crores under Corporate Environment Responsibility (CER). As per direction of MOEF&CC the Proposed Corporate Environmental Responsibility (CER) activities as follows-

Table 165 Proposed Corporate Environmental Responsibility (CER) activities

Sr. No.	Proposed activities	Fund allocation in Crs.
1	Education and skill development	58
2	Health	35
3	Drinking Water Supply, Sanitation	27
4	Roads	25
5	Cross Drains	5
6	Electrification including Solar Power	10
7	Solid Waste Management Facility	10
8	Rain Water Harvesting	5
9	Avenue Plantation	5
10	Plantation in Community Area	10
	Total	**190**

However, the final CER fundings will be subject to final outcome of the public consultation and as decided by EAC of the central or State level comittees and the same will be incorporated as prescribed in final EIA report

CHAPTER – 11 EXECUTIVE SUMMARY

11.1 Introduction

Jawaharlal Nehru Port is administered by the Jawaharlal Nehru Port Authority, Major port under Ministry of Ports, Shipping and waterways Government of India. The port was developed to relieve pressure on Mumbai Port, then the pre-eminent port of India.

The Jawaharlal Nehru Port Authority (JNPA) at Navi Mumbai is a premier container handling Port in India accounting for around 50% of the total containerized cargo volume, across the major ports of India. Commissioned on 26th May 1989, in less than three decades of its operations, JNPA has transformed from a bulk cargo terminal to the premier container port in the country. Ranked 26th among the top 100 Container Ports in the world, JNPA is connected to over 200 ports in the world.

Major exports from Jawaharlal Nehru Port are textiles, sporting goods, carpets, textile machinery, boneless meat, chemicals and pharmaceuticals. The main imports are chemicals, machinery, plastics, electrical machinery, vegetable oils and aluminium and other non-ferrous metals. The port handles cargo traffic mostly originating from or destined for Maharashtra, Madhya Pradesh, Gujarat, Karnataka, as well as most of North India.

As part of Sagarmala Programme, more than 574 projects (Cost: Rs. 6.01 Lacs Cr.) have been identified for implementation, during 2015-2035, across the areas of port modernization & new port development, port connectivity enhancement, port-linked industrialization and coastal community development. To fill the demand gap, 2 new major ports are planned which will bring in significant capacity expansion. The locations of these new ports are deliberated after detailed origin-destination study of cargo commodities and there are mainly three levers that propel the need for building new ports: New port locations have been identified based on the cargo flow for key commodities and the projected traffic: Greenfield ports are proposed to be developed at

- Vadhavan (Maharashtra)
- Paradip Outer Harbour (Odhisha)

Vadhavan Port is planned to be developed by JNPA (Jawaharlal Nehru Port Authority) and MMB (Maharashtra Maritime Board) to handle the additional traffic. Vadhavan is a Greenfield site located along the west cost of India, at the North tip of Maharashtra which is about 150 km north of JN Port.

Approval of the Govt. of India Cabinet Ministry proposal for setting up a major Port at Vadhavan, with due concurrence of the Ministry of Environment, Forest & Climate Control (MOEF&CC), was obtained on 19th February 2020. The MoPSW issued a Notification under Section 3(8) read with Section 5(2) of the Indian Ports Act, 1908 and Section 2(q) of the Major Ports Act, 1963, inter alia, declaring the port proposed to be set up at Vadhavan as a 'Major' port ("said Project"), with immediate effect. Pursuant to the exchange of communication between the MoEF&CC, the Central Pollution Control Board ("CPCB") and the MoPSW, on 08.06.2020, the MoPSW, inter alia, called upon JNPA to "…take further necessary action for development of Major Port at Vadhavan accordingly." On 20th July 2020, JNPA submitted an online proposal to the MoEF&CC, inter alia, seeking Terms of Reference ("TOR") to obtain an Environment Clearance Certificate ("EC") for the "Development of Greenfield Port at Vadhavan, District Palghar, Maharashtra", as mandated by the Notification 14th September 2006 published by the MoEF&CC ("EIA Notification"), and the subsequent amendments thereto.

After duly considering the aforesaid proposal and the detailed presentation made by JNPA, the Expert Appraisal Committee for Infrastructure, CRZ and other miscellaneous projects ("EAC") in it's 241st Meeting, inter alia, recommended the grant of TOR in respect of the said Project on 25th - 26th August 2020, respectively. Accordingly, on 7th October 2020, the MoEF&CC approved the TOR for the said Project for preparation of an EIA/ EMP report including condition to obtain NOC from Dahanu Taluka Environment Protection Authority (DTEPA), a monitoring body constituted by MoEF on 20th June, 1991. As per ToR all the studies were completed and submitted to DTEPA.

JNPA through the amendment proposal applied to the MoEF&CC, inter alia, seeking amendment in TOR for the change in reclamation quantity from 86.88Mcum to 200Mcum. Also, as per revised CWPRS layout, the location of the port was changed from onshore to offshore port. Considering the substantial amount of reclamation requirement, it was decided to extract the fill material through marine borrow pit as against the earth filling borrowed from land location and in view of ecological sensitivity of the region, the change of location is proposed to borrow material from Offshore. The marine borrow pit is identified in the offshore of the Daman coast about 50 km from the port site at a depth varying from 20 m to 25 m.

Accordingly, EAC after deliberation in its 324th meeting held on 19-21st April 2023, inter alia, recommended the proposal for amendment in ToR vide No. 10-52/2020-IA.III (Proposal no. IA/MH/NCP/295375/2022) dated 2nd June, 2023.

The Dahanu Taluka Environment Protection Authority (DTEPA) has granted JNPA permission to establish and develop the Vadhavan port in the Dahanu Taluka on 31st July 2023, based on draft EIA report submitted to them.

11.1.1 Brief Description of Nature, Size, Location of the Project

The proposed port is located at near Dahanu, abutting northern boundary of Palghar district of Maharashtra at co-ordinates Latitude 19^{0}55.8'N and Longitude 72°39.6'E.

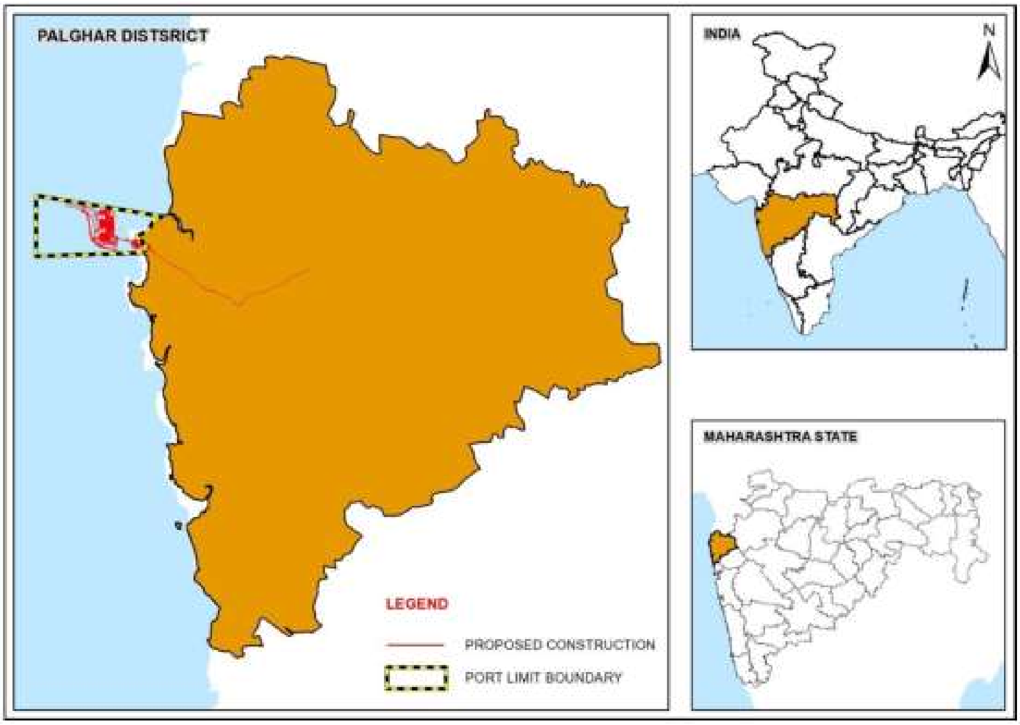


Figure 110 Location of project site

The port limits is as shown in below figure.

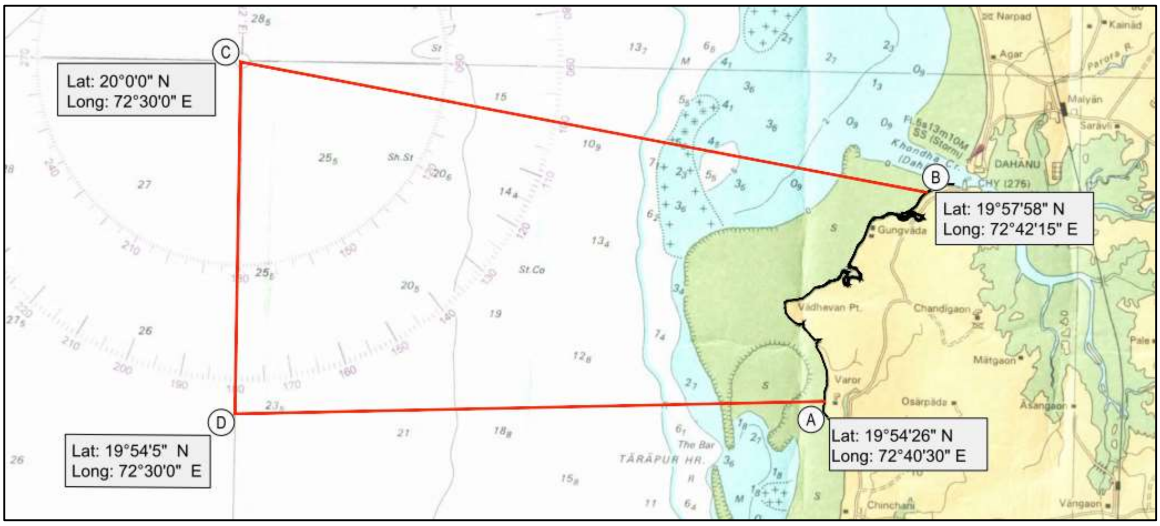


Figure 111 Port Limit of project site

A natural water depth of around 20.0 m below CD is available at 10 km from Vadhavan point and 15 m contour is available at a distance of 6 km which will allow safe voyage and mooring for the new generation vessels. As deep-water depth is available from 6 to 10 km, new generation vessels calling for deep draft can be planned with minimal cost on dredging.

Vadhavan can also be positioned as a hub port in the Arabian Sea catering to the container traffic of east coast of Africa, India's west coast, and countries in the Persian Gulf reversing the present picture. Deep draft, access to large hinterland of west and north west India, good evacuation possibility by rail and road network, one km. long container terminals with large container yards and landlord port development model are likely to attract major private operators to open their container terminals in Vadhavan port and call their container vessels of 16,000-24,000 TEUs capacity and then aggregate/distribute their containers from Vadhavan port, given advantages of economies of scale and thrust by the container shipping lines to reduce operating costs to remain competitive.

JNPA has been assigned the responsibility to develop Vadhavan port as a major port on landlord port development model. Port site has natural and strategic advantages to become a mega port and has prospect of achieving throughput of 300 million Tonnes.

The purpose of this Environmental Impact Assessment Study is to obtain Environment Clearance (including CRZ Clearance) for development of Greenfield Port at Vadhavan. The port is planned to be located on reclaimed land on inter tidal zone at Vadhavan. This project is a "Greenfield" project and it is proposed to be constructed in such a way that, it will have minimal impact to the environment, fishery activities, mangroves and locals.

The proposed development plays a significant role in strengthening connectivity along the Maharashtra coastline and enhancement in economy of Maharashtra.

11.2 Need and advantages of Vadhavan Port

Existing ports in the area have strong customer base, infrastructure, connectivity and logistics services along with long years of experience. However, over the period of time, existing ports will reach their operational capacity and due to expansion constraints. The congestion at these ports has already caused serious concerns especially in ports like JNPA and MbPA. Ports in the region are facing following 4 major restrictions for capacity expansion;

- Unavailability of waterfront to create new Jetties/Terminals (JNPA, AHPPL-partially)
- Located further away from the route considered unproductive for shipping lines to divert (Kandla, Dahej)
- Heavy siltation/tidal issues rendering cost of expansion of infrastructure extremely high (Hazira, Dahej)
- Legal & Regulatory issues embedded in the 30 years' concession agreement restricting expansion (Mundra and Pipavav).

There is no other container port planned in near future in the hinterland by respective state government. Vadhavan having the highest potential with modern facilities, deep draft and no capacity constraints in the initial years is expected to gain a large share in the traffic. It has been envisaged that Vadhavan will be the largest container port in Maharashtra catering to Northern, Western and Central India.

Some of the salient features of Vadhavan are as follows;

d. Futuristic Container Terminals with deep draft to cater largest container vessels available even on the design board;
e. Proximity to hinterland clusters including upcoming Dedicated Freight Corridor (DFC) and DMIC corridor resulting in lower inland evacuation cost to the hinterland;
f. Port is developed at a location of deep draft that would provide channel availability without recurring dredging. This would reduce maintenance cost of port, impacting favourable tariffs for container handling.
g. This will have state of art cargo handling system with minimal environmental impact.

The landlord-based development model of Vadhavan from beginning is likely to attract global container terminal operators. A combination of transparency due to government initiation and deep draft would increase attractiveness of Vadhavan port for developers compared to other ports in the region.

11.3 Project Vision:

The vision of JNPA is to develop a state-of-art Port which shall be in line with the International Standards. The port will be developed in two phases. In this model, basic infrastructure of the port necessitating upfront investment such as, breakwater, rail and road linkages, power, water lines and common infrastructure and services will be developed by the port/ SPV whereas all cargo handling infrastructure will be developed and operated by the agencies which are awarded the concessions.

11.4 Applicable Legal And Policy Framework

Prior to the implementation of the project Port as a whole it needs to get environmental clearances from various regulatory bodies like State level and National level agencies. The most important government departments and institutions responsible for environment protection and management in India are:

i) Ministry of Environment & Forests and Climate Change (MoEF& CC)
ii) Central Pollution Control Board (CPCB)
iii) State Pollution Control Board (SPCB)
iv) Local bodies – Corporations, Municipalities, Gram Panchayats

The EIA for the Vadhavan Port has been carried out conforming to the requirements of September 14, 2006 Notification issued by MoEF & CC, Government of India (GoI).

Table 166 Important Acts & Rules for Environmental Protection in India

Legal Requirement	Compliance/Application
The Environment (Protection) Act, 1986	An Act to provide for the protection and improvement of environment and the prevention of hazards to human beings, other living creatures, plants and property
Dahanu EZA Notification	Notification for Ecological Fragile Area (EZA) 1991. Approval from DTEPA authority.
Forest (Conservation) Act, 1980, and The Indian Forest Act, 1927	Act to provide for the conservation of forests and all related aspects of Development

Legal Requirement	Compliance/Application
And Forest (Conservation) Act, 2022.	
Wildlife (Protection Act), 1972	Act to provide the protection of wildlife
The Air (Prevention & Control of Pollution) Act, 1981	An Act to provide for the prevention, control and abatement of air pollution, include the preservation of the quality of air and control of air pollution; relates to the issue of the Air Consent (CFO) for the Stack and DG set emissions that are likely to be installed in the project site
The Water (Prevention & Control of Pollution) Act, 1974	An Act to provide for the prevention and control of water pollution and the maintaining or restoring of wholesomeness of water, for the establishment, relates to the issue of the Water Consent (CFO) for the water requirement for the day to day project operations and daily unit wise waste generation
The Public Liability Insurance Act, 1991	An Act to provide for public liability – insurance for the purpose of providing immediate relief to the persons affected – in terms of responsibility and finances
Biological Diversity Act, 2002	Aimed at conservation of biological resources and associated knowledge as well as facilitating access to them in a sustainable manner and through a just process
Environmental Impact Assessment Notification-2006 and subsequent amendment	Imposing certain restrictions and prohibitions on new projects or activities, or on the expansion or modernization of existing projects or activities based on their potential environmental impacts, being undertaken in any part of India, unless prior environmental clearance has been accorded in accordance with the objectives of National Environment Policy
Coastal Regulation Zone Notification, 2019	An act to empower the State and the central government authorities to take measures for protecting and improving the quality of the coastal environment and preventing, abating and controlling environmental pollution in the coastal areas of India
The Noise Pollution (Control & Regulation) Rules, 2000	Deciding the levels of noise at various areas or zones defined as industrial, residential, commercial and silence zone during day and night times
Solid Waste Management rule, 2000 as amended	This is applicable to port project related traffic movement. Details will be provided in the combined document.
The Hazardous Wastes (Management and Handling) Rules as amended	Although no such cargo is included as of now, this is applicable to port project related traffic movement. Details will be provided in the combined document.
Ancient Monuments and Archaeological site & Remains Act, 1958	Act to provide conservation of cultural and historical remains found in India
Land Acquisition Act, 1894 & 1989	Set out rule for acquisition of land by Government. This being a core Social impacts GoI is now formulating a new Land acquisition replacing an Act that is older than 1947, the independent India

Legal Requirement	Compliance/Application
National Resettlement and Rehabilitation Policy, 2003	All social issues related to land acquisition, resettlement and rehabilitation

11.5 PROPOSED VADHAVAN PORT INFRASTRUCTURE

Vadhavan Port is planned to be developed by JNPA (Jawaharlal Nehru Port Authority) and MMB (Maharashtra Maritime Board) as Joint Venture Project with equity share of 74% & 26% respectively. The port will be developed in two phases. The proposed port is to be developed on landlord model with the port terminals to be developed on PPP basis. In this model, basic infrastructure of the port necessitating upfront investment such as, breakwater, rail and road linkages, power, water lines and common infrastructure and services will be developed by the port/ SPV whereas all cargo handling infrastructure will be developed and operated by the agencies which are awarded concessions through global tender in an open and transparent manner by the port.

The development of port is envisioned to have the following components:

JNPA (Landlord)

Inside Port

- Breakwater of total length 10.14 km
- Dredging 6.98 M cum in Phase-1 and 21.5 Mcum in Phase-2
- Port craft/ Tug berth of 200 m.
- Total Reclamation area inside the port 1448 ha. with 1162 ha. in Phase-1.
- Road inside the port 32 km
- DFC rail yard 227.5 ha.
- Buildings with area of 23,500 m^2
- Pavement inside port.

Outside Port

- Land acquisition 571 ha. (For road and rail connectivity)
- External road connectivity of 33.4 km, 120m wide corridor
- Rail linkage area length 12 km 60 m wide corridor
- Water pipeline from Surya river which is about 22 km from port site
- Power line from PGCIL line/Tarapur Boisar power station 20 km from port

Concessionaire (Operator)

- Container terminals including storage yard, equipment, terminal pavements, drainage, utilities networks etc., with total berth length of 9000 m (4 terminals in Phase-1 and 5 terminals in Phase 2 each of 1000 m length) capable of handling vessels of 24,000 TEU and above with 24,000 TEU design container vessels.
- Multipurpose berths of 1000 m (4 berths each of 250 m) including equipment, storage yard/ shed
- 1 Ro Ro berth of 250 m including storage and onshore facilities
- 4 Liquid cargo terminals including pipelines and tank farm

11.6 CONNECTIVITY ASPECT – RAIL AND ROAD CONNECTIVITY

Vadhavan is 12 km away from Vangaon Railway Station along Mumbai-Surat Western Rail Link and will be linked to DFCC line at New Palghar Station. The port location is 33.4 km away from NH 48 and 22 km away from Vadodara Expressway from Port. All roads will be merging with the road connecting port to the NH-48 and Mumbai Vadodara expressway.

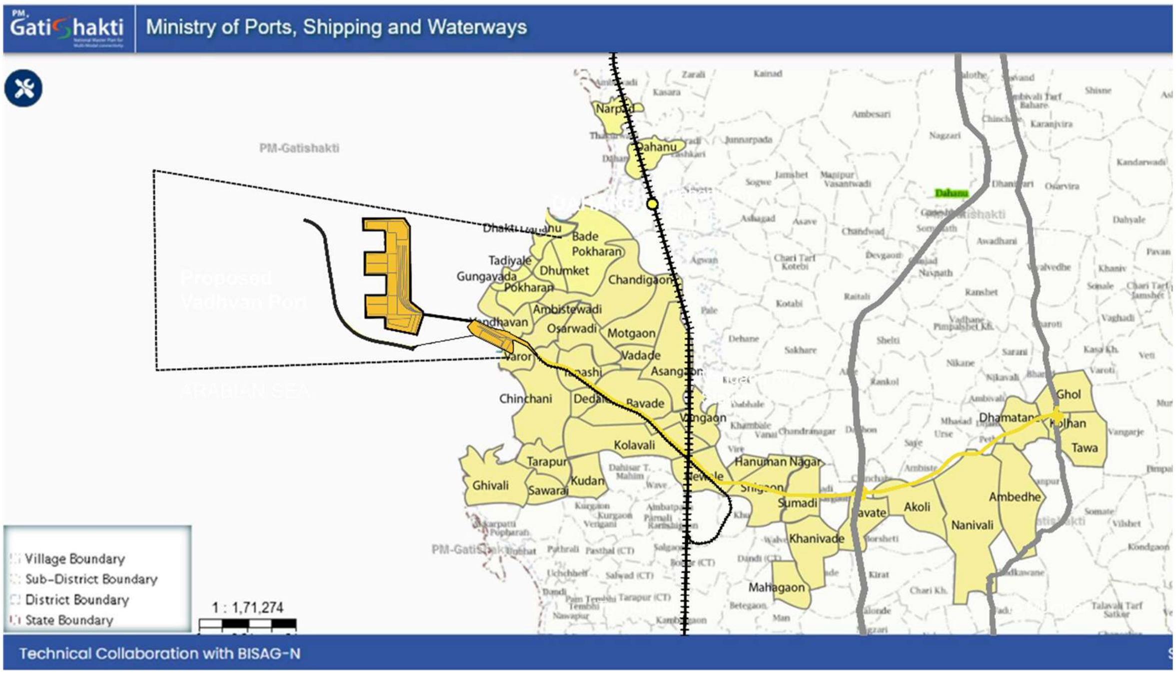


Figure 112 Port Connectivity

11.7 PROJECT DETAILS

11.7.1 Oceanographic investigations

The wind speeds measured during this period varies from 0.2 knots to 4.0 knots with most of the wind blows from 0-45° N.

Wave climate in the area is dominated during SW monsoon period (June to September). The maximum significant wave height observed in the entire period is 1.19 m and the minimum of 0.14 m. Currents are significant in the project area.

The current speeds in general are observed within the range of 0.00 knots to 2.60 knots with the dominant speeds observed in the range of 0.20 knots to 1.60 knots.

Site specific tide measurements were carried out for the proposed development. The observed tidal range was about 3.5 m during spring tide and 1.7 m during neap tide.

11.7.2 Bathymetry Survey

Bathy 500 dual frequency single beam echo sounder was deployed for the collection of bathymetry data. The bathymetric survey covered the proposed port limit with an area of 169 sq.km extending 18.4 km from the shore into the sea and about 7 km along the shore. Water depths within survey area range between a minimum of 0.0 m recorded in the Eastern end and maximum of 25.3 m at North West corner of the survey area. Rock outcrops appear in some places as high as 3 to 4 m above the adjoining seabed levels in the area. The '0' m contour is about 2.1 km from the shoreline at the NE corner, curving outwards for up to 4.9 km and then inwards. 5 m contour lies at about 3.5 km west of Vadhavan point.10 m contour starts on the north side from about 4.5 km west of Vadhavan point and runs towards south. At its nearest point, the 15 m contour lies 1.5 km west of 10 m contour on the northern side, running in the S-SE direction. 20 m contour lies at about 10 km from Vadhavan point

11.7.3 Geophysical Survey

Shallow seismic survey was carried out and the water depths are overlaid on the isopach contours to understand the minimum navigable depth that can be achieved by dredging in the study region. The shallow geological successions within the window examined by the digital data within the surveyed area are described as Silty clay/sand and Weathered bedrock. Silty clay/sand is recorded as the surficial layer in survey corridor in depths of more than 15 m and is interpreted as comprising silty clay/sand. The survey reveals predominant rocky seabed with buried channel comprising of soft clay over sand/gravel or highly weathered rock.

Side Scan Sonar Survey classifies the seabed into following categories such as Soft silty clay, Highly weathered rock /sand /gravel and Basalt rock. The seafloor appeared to be clear of any debris other objects which are likely to be hazardous or otherwise obstruct anchoring and operations in the port.

11.7.4 Geotechnical Survey

The geotechnical investigation was carried out to assess and confirm the sub soil data. Geotechnical investigation for marine areas was carried out through 61 boreholes. Additionally, 70 boreholes were carried out for proposed rail and road connectivity areas. Specific borehole data has been utilized to prepare soil profiles to study the distribution of the sub strata and assess the geotechnical conditions of the component. Since the port facilities are proposed to be located on the reclaimed land, the topographic investigations were carried out for the external rail and road connectivity to the port along the proposed corridor.

11.7.5 Breakwater

Tarapur Atomic Power Station (TAPS) is located some 11 km to the south of the proposed port site and numerical modelling studies had been carried out by CWPRS to assess the impact of port development on the power station intake/outfall. Based on the outcome of the studies, no impact was found with the proposed alignment.

The final layout of the breakwater and revetment/ reclamation bund has been arrived at through the wave tranquillity and hydrodynamic modelling studies completed by CWPRS:

a. Model Studies for Tidal Hydrodynamics and Siltation for the revised layout of Phase-1 and Master Plan development of port at Vadhavan, Technical Report No 5968 (Nov. 2021)
b. Model studies to assess the impact of proposed Capital Dredging on Tidal Hydrodynamics and siltation for development of port at Vadhavan, Technical 5970 (Nov. 2021)
c. Model studies for assessment of wave tranquillity for Modified final layout of Vadhavan port, Technical Report No 5971 (Nov. 2021)
d. Report on Impact of Breakwaters and Transport Carrier on the Erosion/ Accretion for the Vadhavan Port, Maharashtra by National Centre for Coastal Research (NCCR) & Indian National Centre for Ocean Information Services (INCOIS) (September 2023)

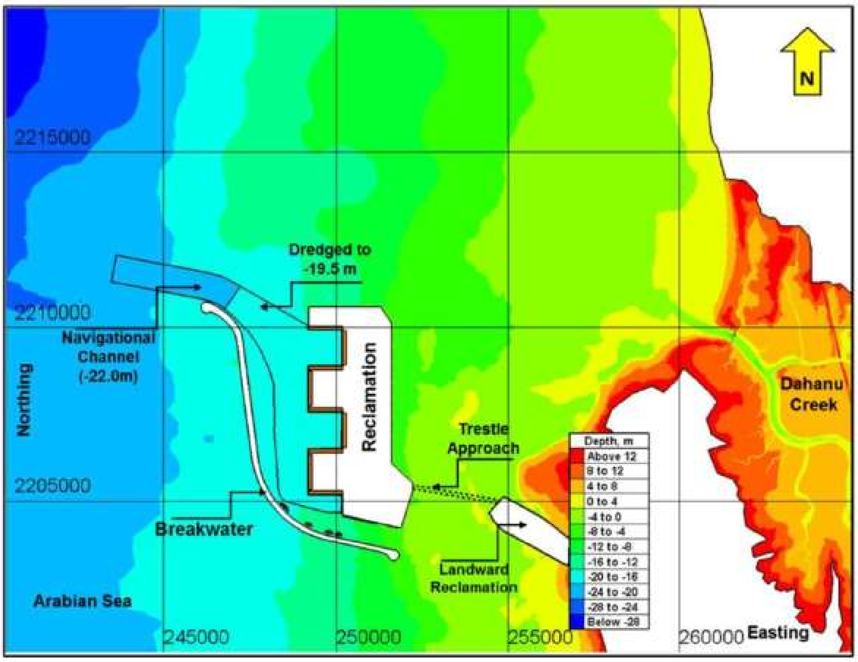


Figure 113 Breakwater alignment for Vadhavan Port

11.7.6 Traffic Study

The summary of the traffic projection for the proposed Vadhavan port is as below;

Table 167 Vadhavan Port's Container Traffic Projections (mn TEUs)

Commodities	FY21	FY25	FY30	FY35	FY40	FY45	FY50
Container Cargo (mnTEUs)	**0.0**	**0.9**	**6.5**	**14.1**	**23.2**	**31.3**	**39.4**
(MTPA)	**0.0**	**11.16**	**78**	**169.2**	**278.4**	**375.6**	**472.8**
Edible Oil	0.0	0.4	1.0	1.1	1.2	1.3	1.4
Chemical	0.0	0.6	0.9	1.0	1.1	1.2	1.3
Bulk Liquid	0.0	2.7	3.1	3.8	4.2	4.7	5.2
Fertilizer	0.0	0.9	1.0	1.2	1.2	1.3	1.4
General cargo	0.0	1.5	2.4	3.5	4.6	5.9	7.2
Coastal Cargo	0.0	1.0	1.7	2.4	3.2	4.1	5.0
Other Liquid	0.0	0.0	2.3	4.5	4.5	4.5	4.5
Total		**18.26**	**90.52**	**186.7**	**298.6**	**414.2**	**498.5**
Ro-Ro ('000 Vehicles)	0.0	20.9	49.5	76.8	169.0	195.9	227.1

11.7.7 Port Operation & Functional Requirement

One of the main factors that influence the layout and sizing of the port facilities and therefore the costs is the size of ships for different commodities, dimensions and the design of berth, the basin, the approach channel. This, in turn will influence the layout and alignment of the breakwaters, required at a particular port. Based on the outcome of ship size analysis for container traffic, the design ship sizes considered, and berth required for development of Vadhavan port have been carried out.

11.7.8 Container Storage and Gate Capacity

Container yard capacity is defined as the potential maximum throughput of containers handled inside the container yard. The container storage yard capacity requirement for Master Plan (Phase 1 and Phase 2) is 2,20,08,735 TEU/year. Gate capacity analysis is essential feature to get essence of seamless inward and outward traffic movement including major share of trucks having containers. The number of exit lanes required for Phase 1 is 6 lanes and in Master plan 17 lanes.

11.7.9 Other Cargo Capacity

The berth capacity for other cargoes have been assessed taking into consideration the proposed facility and handling arrangement. The basic data pertaining to traffic, design ship sizes, handling rates and berth occupancy, for the Phase 1 development of the Vadhavan port has also been carried out.

11.7.10 Approach Trestle Capacity & Port Crafts Berth

The road truck movements to/from the marine and rail terminals on the offshore reclamation has been evaluated to establish the requirements for the road connection to the offshore reclamation. Based on calculations the approach trestle capacity in Master plan 1,12,825 PCU/day is expected.

11.7.11 Buildings

The terminal administration building will be required to house the terminal operator's management, security, admin, and customer service personnel. Typical users/uses of the administration building shall include;

- Terminal Administration, Customer Service, Quay Crane and Marine Operations Building, Gate Equipment Control, IT/Server, Gate Control Clerks, Offices, Shipping Lines Offices, and Terminal Security and Communications Hub, Port Fire Station, Rail Master Building, Residential Colony for Staff and Social Infrastructure.

11.7.12 Cargo Receipt and Evacuation

At Vadhavan Port, the cargo receipt and evacuation will be primarily through road and rail. The estimated proportions for different commodities to be brought in/ taken out through rail and road.

Based on the study, almost 13,441 trucks (71,661 PCUs) are expected in the year 2030, increasing to about 34,284 truck (186,348 PCUs) movements in 2040. It is proposed to provide an 8-lane road with a capacity of 173,000 PCU.

The evacuation of cargo through rail is expected to be 33.8 % (31.5% through DFCC and 2.3% through IR) of the total cargo resulting in 184 rake movements per day.

11.7.13 Port Master Plan

The final master plan layout incorporates the following:

- 9 container terminals each with a straight 1,000m long marginal quay. 7 terminals have the container storage yard located directly behind the quay apron whilst for two of the terminals the container yard is located about 1km behind the quay.
- A total of four multi-purpose berths each 250 m long at the southern end of the reclamation
- Four liquid bulk berths located on the leeside of the breakwater
- A Ro-Ro berth at the south-west end of the offshore reclamation with adjacent vehicle parking
- Small craft (pilot boats and tugs) and coastguard berths at the southern end of the reclamation.
- Additional berths for small craft may also be provided at the northern end of the reclamation if required.
- Rail terminal located along the eastern side of the offshore reclamation
- Onshore reclamation for liquid bulks storage and administrative facilities

The recommended master plan layout is mentioned below;

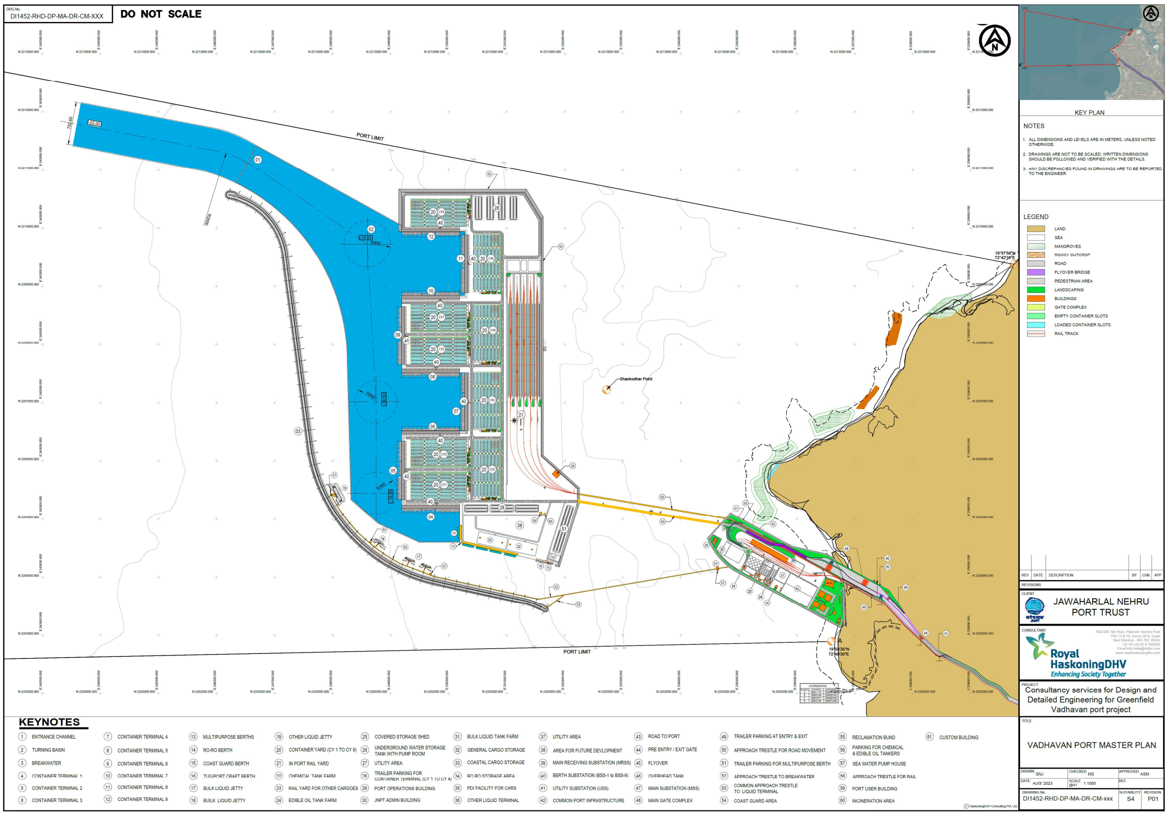


Figure 114 Recommended Master layout of port

CWPRS carried out hydrodynamic modelling of this layout. The results indicate the following:

- Maximum cross current at the harbour entrance of 2.55m/s reducing to 1.3m/s at the expected
- ship stopping point
- Maximum currents at the turning areas less than 0.4m/s in a S-N direction
- Currents in the dredged basins bet ween reclamation fingers less than 0.05m/s
- Currents longitudinal to the berths at the ends of the reclamation fingers less than 0.2-0.4m/s
- The total quantum of siltation in the dredged areas will be about 8.45 M cum.

Water depth in the channel is around 17 to 18 m depth below CD. +2.0 m tidal advantage has been considered as the MSL is about +2.8 m CD. The maximum velocities at harbour entrance, stopping distance and turning circle are 2.6 m/s, 1.2 m/s and 0.3 m/s respectively. The maximum current strength at berths is about 0.05 m/s. The annual siltation in the dredged areas will be about 6.45 M cum.

The diameter of the sheltered turning circle with tug assistance is 700 m. The main emphasis while developing the port layout is given to balance the cost of dredging and reclamation land area developed. It is estimated that approximately 200 million cum of reclamation material would be required for the proposed port development.

The existing reports on wave tranquillity, hydrodynamics, shoreline change assessment, and shoreline morphology study were analyzed and shoreline change analysis was carried out by NCCR. The following were the outcomes of the study:

1. The maximum significant wave height in the port basin is 1.0m in the Final Master Plan Layout as compared to 2.5 m height offshore.

2. The Tidal Hydrodynamic and Siltation study finalized the Master Plan Layout for favorable operation and maneuvering conditions with minimum effect on the morphology. The maximum current strengths at container terminals are within 0.15 m/s and flow approaches at an angle varying between 4° and 7° along oil berths and Other Liquid terminals. These hydrodynamic conditions allow the bypassing of sediments towards the North of the port area.

3. The shoreline morphology study reveals that a net transport of about 0.07 Mm^3 is transported just North of the proposed port area. Although Northerly transport is not fully hindered, maintenance dredging of the port can be utilized for nourishment in the North of the port. A minimum of 0.15 Mm^3 of sand shall be used for nourishment of the North which will be dredged from the port basin as a part of maintenance dredging.

4. The littoral drift and shoreline evolution comparing the original shoreline and proposed port indicates an insignificant effect on the adjacent shoreline.

5. The shoreline change analysis by NCCR suggests that a stretch of 2.4 km of the study area is in a moderate to high erosion state for long-term analysis. The construction of the port breakwater is likely to reduce erosion in the south.

11.7.14 Capital and Maintenance Dredging

Dredging and reclamation is one of the major costing parameters for any port project. The dredged volume of 7.01 M cum comprising of soil and rock is required to be dredged. The rocks that might encounter while dredging is envisaged that the rock strength shall vary from 6 to 51 MPa with an average of 19 MPa.

Based on the mathematical model studies on siltation, the estimate the likely rate of annual siltation for Phase 1 reveal that, the average rate of siltation in the dredged areas will be about 6.45 million cum. The siltation rates are not uniform over the area under consideration and seems to vary based on the prevailing hydrodynamic conditions. The dredged material in channel and harbour basin would be disposed at the designated dumping site offshore.

The location of the disposal site which is in deep water (beyond 25 m contour). The disposal site is spread over an area of about 20 sq. km and the depth of dumping will be restricted to only 0.5 m.

11.7.15 Borrow Material for Reclamation

The reclamation quantity expected from the project is 200 Mcum. The quantity of reclamation is much greater than the dredging quantity which in turn is dependent on the suitability of dredged material for reclamation, it is considered that additional reclamation will be carried out by the material sourced from marine borrow pit. JNPA has identified a borrow pit off shore Daman coast at around 50 km into sea from the proposed Vadhavan port for obtaining sand for creating reclaimed land at the proposed Vadhavan port. The marine sand will be dredged using Trailing Suction Hopper Dredger (TSHD) and the sand will be transported and dumped at the reclamation location.

11.7.16 Green Port Initiatives

The proposed port at Vadhavan aims to provide long-term commitment, strong policy push, innovation, and alignment of interests and business philosophies along with serious investment in technologies, systems, and manpower in order to achieve this objective set out in developing the vision of the port by JNPA. These sustainable solutions will range from analysis of climate change risk and resiliency at the planning stage for; (i) Renewable energy, (ii) Alternative energy sources, (iii) Cold Ironing / Shore power supply, (iv) Efficient port operations, (v) Other green initiatives and thereby achieving reduction in carbon footprints and energy costs during the operations phase.

11.8 ENVIRONMENTAL INFRASTRUCTURAL ATTRIBUTES

11.8.1 Power Supply

The required electrical system for the project will consist of:

a. The incoming electrical supply at 80 MVA level.
b. 220/33 kV substations containing transformers, switchboards, control equipment, etc. to supply the electrical power to various parts of the site at the required voltage levels of 11kV or 6.6 kV & 0.415 kV.
c. Control and Monitoring systems.

Two locations of the nearest 220 kV source from PGCIL line/ Tarapur Power Boisar and Dahanu are identified to be provided by MSETCL. The PGCIL line/Tarapur Boisar power station located at 20 km away from Vadhavan site by overhead 220 KVA HT Line to Vadhavan port site.

11.8.2 Water demand

Daily water demand for the Phase 1 development is estimated to be around 6.8 MLD (million litres per day) and for the master plan phase, the anticipated demand is at 13.3 MLD. Out of this the potable water demand for port usage is 1.8 MLD in Phase 1 and 2.8 MLD in master plan phase, with the balance being the demand for raw water and supply to port township. A static storage of raw water of 1-day storage is provided for the port while half a day storage is provided for the township.

The water source identified for the port operations is Surya River about 22 km (approx.) away from the proposed Vadhavan Port. Maharashtra Jeevan Pradhikaran (Government of Maharashtra) will be facilitating the required water supply to Vadhavan Port.

11.8.3 Waste Water Management Plan

The sewerage system is limited to the areas wherever office buildings, canteens, and other operational buildings are constructed. For the isolated buildings where the quantity is negligible, it is proposed to setup STPs for disposal. STP of adequate capacity with Sequential Batch Reactor (SBR) Technology is proposed to be installed. During monsoon months, the sludge will be stored separately in a storage structure with adequate capacity. The treated water will be recirculated for gardening and non-drinking purposes. The sludge from the treatment plant will be processed and converted into Biomass used as manure.

The ships will not be allowed to discharge their sewage in the port complex. As per MARPOL convention, the ships are now required to have STP on board.

11.8.4 Solid Waste Management

The solid waste generation will be basically from 2 sources – cargo handling and the garbage/ human waste. It is estimated to be 2000kg/day of Municipal waste generation from port operations, which shall be disposed off as per the Municipal Solid Waste Management Rules 2016 and the amendments thereof.

The cargo envisaged at the port is primarily container cargo. The garbage and human waste generation will be minimal and is proposed to be disposed off using the normal measures. The garbage will be carried through covered trucks and disposed at the designated dumping grounds in the locality. The port will have solid waste processing and disposal mechanism for management of wastes generated within the port.

11.8.5 CRZ DETAILS

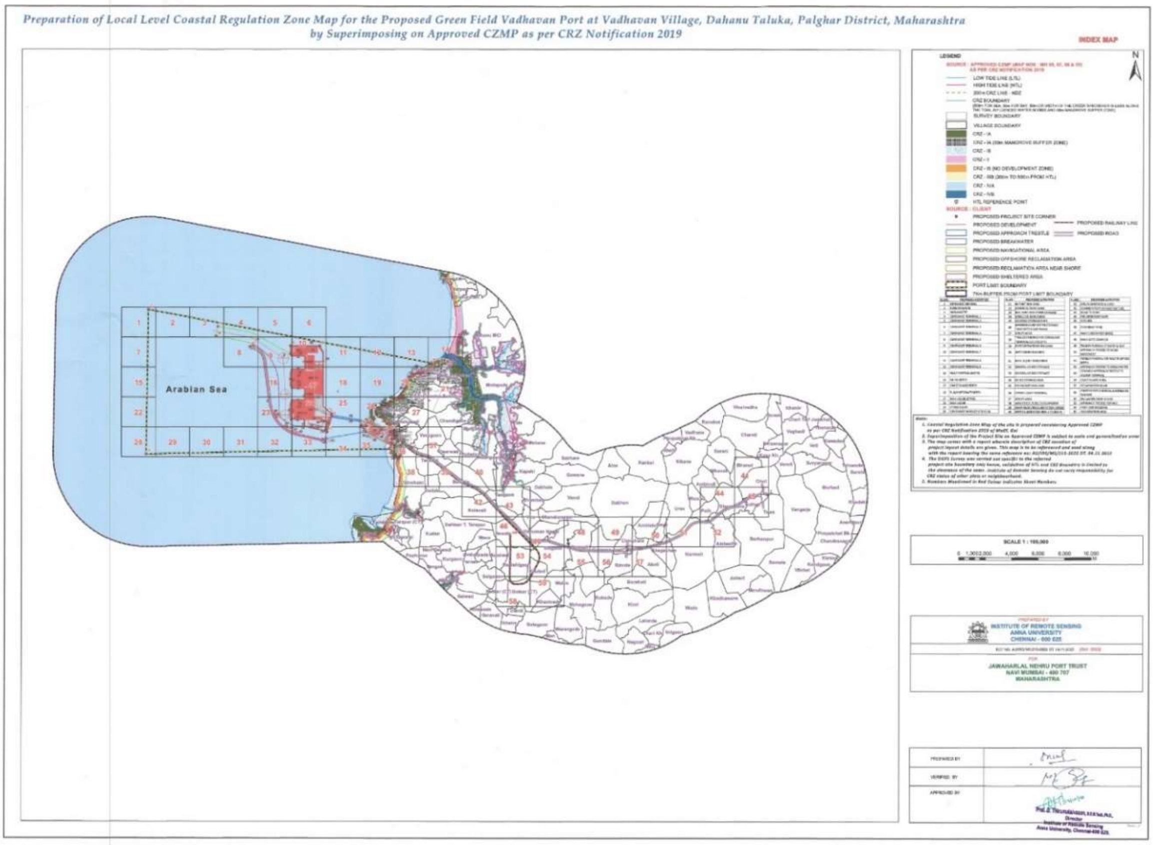
Preparation of Local Level Coastal Regulation Zone Map for the Proposed Green Field Vadhavan Port at Vadhavan Village, Dahanu Taluka, Palghar District, Maharashtra State by Superimposing on Approved CZMP as per CRZ Notification 2019 is prepared by Institute of Remote Sensing (IRS), Chennai (October 2023).

The proposed details viz Approach Trestle, Breakwater, Navigational Area, Offshore Reclamation Area, Sheltered Area within Vadhavan Port Limits lies in CRZ-IVA and Reclamation Area near Shore lies in CRZ-IB, CRZ-III (200m to 500m from HTL), CRZ-III (No Development Zone), CRZ-IVA and outside CRZ areas as per approved CZMP (Map nos: MH 95, 97, 98 & 99).

The reclamation area near shore in within Vadhavan Port Limits lies in CRZ-IB, CRZ-III (200m to 500m from HTL), CRZ-III (No Development Zone), CRZ-IVA, and outside CRZ areas as per approved CZMP (Map nos: MH 95, 97, 98 & 99).

The remaining Area where there is no development proposed within Vadhavan Port Limits lies in CRZ-IA, CRZ-IA (50m Mangrove Buffer Zone), CRZ-IB, CRZ-III (No Development Zone), and CRZ-IVA areas as per approved CZMP (Map nos: MH 95, 97, 98 & 99).

The proposed Road and Rail Alignment for the port connectivity lies in CRZ-IB, CRZ-III (200m to 500m from HTL), CRZ-III (No Development Zone) and Outside CRZ areas as per approved CZMP (Map nos: MH 95, 97, 98 & 99).



11.9 SOCIO ECONOMIC IMPACT ASSESSMENT

There is no land acquisition involved for the port estate onshore facilities, as the land requirement is mostly accommodated on reclaimed land of approximately 1448 Hectares in the inter-tidal area adjacent to the coast.

Vadhavan port is located at 12 km distance from the main rail link and upcoming dedicated freight corridor for rail connectivity and is 33.4 km from the Mumbai - Delhi NH-48. Accordingly, land acquisition is required for the rail and road right of way (ROW), with a corridor width of 160 m over a length of 12 km where both the road and the rail tracks are required, and a corridor width of 120 m over the remaining length of approximately 22 km where only road connectivity is required. The major acquisition of land that is to be done is agricultural land.

Proper Resettlement & Rehabilitation will be undertaken as per the guidelines prepared for addressing the issues limited to this project for resettlement and rehabilitation of the PAPs. The policy has been developed based on the National Highways Act 1956 and The Right to Fair Compensation and Transparency in LA RR Act, 2013. The resettlement and rehabilitation

(R&R) benefits shall be extended to all the Project Affected Families (PAF) whether belonging to below poverty line (BPL) or non-BPL.

Action Plan for Fishermen

The JNPA/VPPL will prepare a Fisher-folks Compensation Policy (FCP) for VPPL project in consultation with all stake holders and fishermen community and a Fisher-folks Compensation Committee (FCC) will be set up by JNPA/VPPL with Dy Chairman, JNPA as the Chairman, and members from Fishing Community, Department of Fisheries, Revenue, MMB, Police, Fisheries Scientist and JNPA/ VPPL officers as its members (or extended to Maharashtra Fisherman Compensation Policy, 2023).

11.10 BASELINE ENVIRONMENTAL STATUS

Field investigations were undertaken for collecting the existing baseline environment for air, water, noise, soil, ecological and socio-economic conditions. A study area of 10 Km radius from the project site is identified to establish the present environmental conditions. The main aim of the EIA study is to identify the critical environmental attributes which will be affected and have adverse impacts on the surrounding environment due to the proposed project. The field data generation is undertaken during the pre monsoon season of March 2021 to May 2021.

11.10.1 Ambient Air Quality

The status of the ambient air quality in the study area was established by carrying out monitoring for air quality parameters like $PM_{2.5}$, PM_{10}, SO_2 NO_X, O_3, Pb, etc. at 8 locations in the study area. All the parameters are within the NAAQs standard limit.

Ambient PM_{10} levels

The Average PM_{10} levels at various stations covered under the ambient air quality monitoring survey ranged from 52.3 to 61.7 µg/m^3 which is well below the permissible limits (100 µg/m^3) specified for industrial areas by CPCB/ MoEF.

The suspended particulate matter (PM_{10}) is average minimum as 52.3 µg/m^3 near Bada Pokharan Grampanchayat and average maximum of 61.7 µg/m^3 at Dahanu Khadi Bridge, Near Ganesh Mandir

Ambient $PM_{2.5}$ levels

The Average $PM_{2.5}$ levels at various stations covered under the ambient air quality monitoring survey ranged from 20.5 to 29.6 µg/m^3 which is well below the permissible limits (60 µg/m^3) specified for industrial areas by CPCB/ MoEF.

Ambient SO_2 levels

The Average SO_2 levels at various stations covered under the ambient air quality monitoring survey ranged from 22.3 to 25.3 µg/m^3 which is well below the permissible limits (80 µg/m^3) specified for industrial areas by CPCB/ MoEF&CC.

Ambient NOx levels

The Average NOx levels at various stations covered under the ambient air quality monitoring survey ranged from 27.3 to 30.2 µg/m^3 which is well within the permissible industrial area (80 µg/m^3) as specified by CPCB.

Other Parameter

It is observed that Lead, Benzene, Benzo-Pyrene, Ammonia and Ozone were found to be below the detectable limits during the field survey

11.10.2 Noise Environment

The monitoring for noise level was carried out for 72 hours using a portable sound level meter. Noise levels were recorded at a 1 hour interval. The L equivalent (Leq) was Calculated for the day and night time readings. The noise monitoring was carried out for eight different locations and the results obtained were compared to the standards prescribed by the Noise Pollution (Regulation and Control) Rules, (Year 2000).

The noise level around project area is a minimum of 59.5 dB(A) at Near Z.P. School, Matgaon and maximum 63.9 dB(A) near Near Bada-Pokharan Grampanchayat during day time & a minimum of 44.1 dB(A) at Near Z.P. School, Matgaon and maximum 51.8 dB(A) near Near PHC, Tarapur during Night time.

All the noise monitoring results were found to be within the acceptable limits for all the locations

11.10.3 Water Environment

Surface water and ground water monitoring was carried out within 10 km radius of project area. Total 3 Water samples each collected from the nearest locations of project area and the samples were analyzed for various parameters to check the Quality of water

Surface Water

The total dissolved solids (TDS) ranges from 900mg/l to 965 mg/l. Conductivity ranges from 1640 to 1754 µs/cm. The value of EC and TDS are correlated to the ratio of 0.55, which depicts the water is freshwater in nature and suitable for agricultural activities.

Chlorides values are less than 400mg/l and higher towards the sea side. The proposed project is not anticipated to have any impact on the surface water quality except increase in turbidity temporarily during construction.

Ground water

It is observed that all the values are in range and without any organic contamination. BOD ranges between 4.5 – 5.5 mg/l, DO ranged from 1.7-1.9 mg/l. Also, values of Ammonical Nitrogen are less than 4mg/l, hence there is no possibility of sewage contamination. All other parameters are within the limit.

The quality of ground water is generally alkaline and is good for domestic except high nitrate concentration in wells. For irrigation point of view the ground water falls in medium to high salinity and it should be irrigation with proper soil and crop management practices. The quality of ground water in basaltic lava flows is comparatively better than in alluvial sediments. Localized nitrate contamination is observed in rural areas.

11.10.4 Ecological Environment

The proposed Vadhavan port is planned to construct on reclaimed area off Vadhvan and the core site may have intertidal/benthic fauna. The region in the 1km radius range contains intertidal area and the Vadhavan village. It comprises of shrub lands, small agricultural Farms, households and other construction and rest is of open areas and barren land. Coastal area of in 1 km radius comprises a vast patch of Suru trees and sparse patches of mangroves

The list of species of plants and animals generated during the survey were processed and compared with the IUCN red data list and Maharashtra state protected species listings and it was observed that no species encountered during the survey in areas between 0-5 km of the project site represented rare, endangered, critically endangered or legally protected status.

Marine flora and fauna

The marine studies were conducted at Maharashtra as well as Daman region by CSIR – National Institute of Oceanography and Biodiversity Study for The Proposed Burrow Pit Region In Arabian Sea by Zoological Survey of India (ZSI).

The shore vegetation includes shrubs and ground covered with grasses. Sea grasses are absent on the site. Cnidarian community comprised of sand anemones, Aiptasia sp., Zoanthus sp., Zoanthus sansibaricus, Zoanthus vietnamensis, Palythoa sp. Palythoa mutuki and presence of hydrozoan colonies were recorded from the study area. Small annelids were present on the lateral margins of the rocky patches. Asterina lorioli and Antedon sp., were also recorded from the rocky crevices, which represent the echinoderm community. Stone crabs and Porcelain crabs were recorded from the rock regions. Molluscan community comprised of gastropods, such as Indothais sp., Thais sp., Gyrineum natator, Cantharus spiralis, Indothais sacellum, Nerita sp. Octopus vulgaris were observed from the tidal pool regions. Majority of the aforementioned organisms were observed from the rock region of Shankodar area.

There were only 12 species of fauna and one species of flora was recorded by NIO (June 2023) at Shankodhar point over a period of two days during the low tide. The number of organisms within the given area were abundant supporting the fact that Shankodhar point is biologically rich. The rocky outcrops at Shankodhar point serves as a habitat for variety of organisms including the barnacles, molluscs, hydroids, and corals. In addition to this, a school of three dolphins were sighted in the subtidal area of the Shankodhar point indicating the presence of cetaceans in the vicinity of Shankodhar point. Among other organisms recorded at Shankodhar point, the solitary cup coral *Paracyathus profundus* is listed under Schedule I list of protected animals under the Wildlife Protection Act (1972).

Zoological Survey of India in its technical report mentioned that there is no significant nesting/ breeding grounds for any endemic or threatened marine species observed in the proposed sand mining area.

Impact Assessment of Proposed Sand Mining on the Marine Fisheries and Fisher Community of Daman Union Territory was conducted by ICAR-Central Marine Fisheries Research Institute, Mumbai Regional Station, ICAR-CMFRI

Conclusion and recommendations of CMFRI report

a. The offshore sand borrow method is the most environmentally acceptable method of obtaining the required fill material. The site is selected with a view to achieving the smallest and least persistent environmental impact as possible.
b. Impact of removal of 1 m of bed is not expected to create a significant physical impact, the maximum possible impact will be from the temporary raising of the turbidity levels during dredging operations. The distance and depth at which dredging takes place will ensure that this activity will in no way have an impact on coastal stability.
c. As the marine borrow pit location far away from the coastal region approximately 50 - 60km with high tidal range and associated strong currents, the concentration of the sediment plume gets weakened immediately during the dredging activity.
d. Sea bed at site is completely flat and does not contain any reefs or habitats such as seagrass bed, coral reef etc. as evinced by the detailed bathymetric survey.

11.11 ANTICIPATED ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

The potential impacts on the environment from the proposed project are identified based on the nature of the various activities associated with the project implementation and projects operation (impacts during construction phase and operation phase)

Anticipated marine environmental Impacts

The anticipated environmental impacts due to the activities related to the construction, operation and post operational phases of the proposed port project were identified and described as below

Port construction and intertidal area reclamation

- Impact of dredging and disposal
- Environmental impact of breakwater system
- Impact of shipping operations on marine environment
- Air pollution from port operations
- Noise and light pollution
- Impact on marine cetaceans
- Impact of cargo handling
- Hazardous materials and oil

- Ship and boat generated wastes
- Introduction of non-native species into marine environment
- Oil spill

Mitigation measures

Table 168 - Environmental Impacts and Mitigation Measures - Construction Phase

Sr. No.	Environmental Parameters	Impact Attributes	Degree of Impacts	Mitigation Measures	Implementing Organization
1	Physiography	Disturbance in relief feature	Mild	– Will be achieved by systematic planning and designing of the project activities.	Promoter, Client, etc.
2	Land resources	Change in land-use for rail & road	Mild	– Will be achieved by systematic planning and implementation.	Promoter, Client, etc.
3	Human resources	No adverse impact	Negligible	– Will be achieved by systematic planning and resources.	Promoter, Client, etc.
4	Ecological resources – Flora & Fauna	No impact anticipated to threatened or endangered plant species. Mild impact on marine species which will be mitigated.	Mild	– Cutting of larger girth size trees are avoided by suitably adjusting the road / rail alignment, if required. – Replantation of trees will be done with the indigenous plant species as per the guidelines of MoEFCC – Greenbelt shall be developed around the site.	Promoter, Forestry Dept. involving NGOs and local people.
5	Environmental aesthetics values	Removal of trees shall have impacts on landscape & aesthetic values of the area	Mild	– Loss of vegetation will be kept minimum as far as possible during site clearance. In case of any loss the same will be compensated by rehabilitation and restoration of the tree species that shall be affected.	Promoter through prospective contractor
6	Utility & infrastructural facilities	Removal of utility line like electrical poles, telephone poles, transformer,	Nil	– --	--

Sr. No.	Environmental Parameters	Impact Attributes	Degree of Impacts	Mitigation Measures	Implementing Organization
		HT & LT lines, if any			
7	Sub-surface hydrology	No wells and hand pumps are existing in project area	Negligible	– Whenever possible, care is taken to avoid its relocation by judicious engineering road design. – Temporary alternative water sources will be provided in case drinking water means are affected.	Promoter through prospective contractor
8	Religious places	--	--	– --	--
9	Geology	Not much affected	Negligible	– Systematic planning and implementation during the construction and dredging. Reclamation will be done with systemic planning and least disturbance to the natural geology.	Promoter through prospective contractor
10	Surface of water	Contamination from solid wastes and sewage generated due to construction labour camp Surface runoff from the ship terminal and parking facility.	Mild	– Installations of lavatory for construction workers out of CRZ area and provision for composting the domestic refuse.	Promoter through prospective contractor
11	Air quality	Short-term deterioration of air quality due to generation of fugitive dust. Dredging activities and other construction activities leading to	Moderate	– Trucks carrying soil, sand, stone, will be covered to avoid spilling. – Fugitive dust sources will be sprayed with water to suppress dust. – Emissions from vehicles & machinery will be checked regularly & maintained properly to confirm to National and State Emission Standards Barriers during construction activities such as dredging will be installed.	Promoter through Prospective Contractor (PC)

Sr. No.	Environmental Parameters	Impact Attributes	Degree of Impacts	Mitigation Measures	Implementing Organization
		fugitive emission.			
12	Noise level	Increased noise levels due to project activities, dredging, blasting etc.	Moderate	– All the equipments will be duly lubricated, maintained in good working condition to minimize noise levels. – Stationary construction equipments will be placed as far as possible from dense habitation. – Green belt barrier. – Provision of protection devices (ear plugs) to be provided to the workers operating in the vicinity of high noise generating machineries.	Promoter through Prospective Contractor (PC)
13	Ecological resources – Flora & Fauna	According to IUCN red list data of threaten species 4 species was recorded as Near Threaten. But these 4 species was observed at Chinchani beach which is 5 km away from the project site.	Moderate	– Necessary steps will be undertaken to reduce the impact on the reserve forest areas that support majority of the avian diversity	Promoter through Prospective Contractor (PC)
14	Land use	Mild impacts on local land use is anticipated	Mild	– Proper management planning will be achieved.	Promoter through Prospective Contractor (PC)
15	Construction workers camp	Impacts on community health	Mild	– Supply of safe drinking water to the construction camp. – Provision of adequate drainage system to avoid undesirable water logging. Provision of hygienic facilities to construction workers camp is made. – A system of regular disposal of domestic waste & sewage.	Promoter through prospective contractor (PC)

Sr. No.	Environmental Parameters	Impact Attributes	Degree of Impacts	Mitigation Measures	Implementing Organization
16	Accident hazards and safety	Short term impacts from road accidents. Impacts from accidents during handling and use of Construction machinery.	Mild	– Proper traffic diversion and management during construction. Construction Safety measures will be employed. – Proper warning signs will be used at construction site. – Workers will be provided with PPE's – Regular Training will be given to the Workers for Safety	Promoter through prospective contractor (PC)

Table 169 - Environmental Impacts and Mitigation Measures - Operation Phase

Sr. No.	Project Related Issues	Actions to be Taken	Responsible Organisation
1	Prevention of Road side Squatters or indirect Urban Sprawls	➢ Involve land use planning agencies like the Revenue Department at all levels during operation stage. ➢ Plan and control development activity. ➢ Removal, cleaning of squatter and temporary hutments of construction workers once construction activities has been completed.	P & C in consultation with the Grampanchayat.
2	Road Safety and Traffic Management	➢ Adequate number of proper & legible signs will be installed along the road. ➢ Prepare and administer a monitoring system on road/ accidents.	P & C in consultation with Traffic Police.
3	Air Quality	➢ Monitor periodically ambient air quality at selected sites. ➢ Confinement and absorption of the pollutants at source by creating vegetation along the length. ➢ Enforcing different control measures to check pollution (e.g. catalytic converters, unleaded petrol, proper serving etc.) ➢ Provision of green belt areas	P & C in consultation with MPCB
4	Noise level	➢ Monitor periodically ambient noise level at selected sites. ➢ Minimization of use of horns near sensitive locations/ silence zones with the help of sign boards at proper places. ➢ Provide noise barriers with plantation.	P & C in consultation with MPCB
5	Water Quality	➢ Monitor periodically water quality for establishing the change of water quality, if any, and assessing its potentiality of	P & C and MPCB

Sr. No.	Project Related Issues	Actions to be Taken	Responsible Organisation
		surviving aquatic flora and fauna and for irrigation use.	
6	Soil Characteristics	➢ Periodic monitoring of soil quality at specified distance for assessing contamination by vehicular spills, operation of machineries, handling of chemicals ➢ Checking the overflow of spillage from the carriageway by promoting growth of vegetation cover along the road shoulders and preventing overflow to green belt.	P & C and MPCB
7	Maintenance of Avenue trees	➢ Plantation will be undertaken by the concession company on an aggressive note along the whole stretches on the both sides of the road. ➢ No mangroves will be cut or affected due to port construction. The port layout is planned in such a manner that mangroves will be unaffected.	P & C in consultation with authorities and forest Department
8	Human Health and Safety	➢ Vulnerable stretches, which are prone to accidents, will be identified. ➢ Adopt Safety measures and other control measure during Operation of the facility. ➢ Installing proper road signs, marking along the whole stretch in the form of cautioning, informatory and mandatory signs of gantry mounted overhead sizes. ➢ Installing fire safety measures, electrical safety measures, Personal protective Equipments and other work-safety measures. ➢ Incorporation of On-site Emergency Preparedness, Off-site Emergency Plan, Disaster Management Plan	P & C in consultation with MPCB. Public Health Department.

11.12 PROJECT BENEFITS

- The development is envisaged to play a significant role in strengthening connectivity along the Maharashtra coastline.
- Enhancement in economy of Maharashtra.
- Substantial positive impact on socio-economic profile of Vadhavan, in Particular, and Dahanu, in general, both in terms of overall employment and skill development of local workforce.
- Direct as well as indirect employment potential is envisaged.

- Probable augmentation in infrastructure resources such as transport, Communication, health facilities & other basic facilities.

11.13 ENVIRONMENTAL MANAGEMENT PLAN:

The EMP is prepared for Construction and Operation phase of the project**.** Budget Environmental Management Plan is as follows

Construction Phase: Port Area

Capital cost: 302 Lakhs

O & M Cost per Annum: 172.35 Lakhs

Operation Phase for Port Area

Capital cost: 403 Lakhs

O & M Cost per Annum: 113.50 Lakhs

Operation phase Rail-Road:

Capital cost: 222.12 Lakhs
O & M Cost per Annum: 73.17 Lakhs

Operation Phase – Residential Area

Capital cost: 212 Lakhs
O & M Cost per Annum: 55 Lakhs

Corporate Environment Responsibility Budget

As per the MOEFCC Memorandum dated 1st May, 2018 JNPA has proposed an amount of Rs. 190 Crores under Corporate Environment Responsibility (CER).

11.14 PROJECT COST:

The estimated project cost will be INR 76,220 Crores.

CHAPTER 12 - DISCLOSURE OF CONSULTANTS ENGAGED

"Jawaharlal Nehru Port Authority (JNPA)" have entrusted "M/s. Enkay Enviro Services Pvt. Ltd." for carrying out EIA study for the said project.

Enkay Enviro Services Pvt. Ltd is a Consultancy Company founded in 2011 is a respected specialty company, actively partnering with our customers to provide innovative and sustainable technical and management solutions that help creating sustainable and long term solutions for our customers and society.

The organization is accredited as Category-A under the QCI-NABET Scheme for Accreditation of EIA Consultant Organization, Version 3: for preparing EIA-EMP reports in the following Sectors;

1. Mining of minerals including open cast/underground mining
2. Thermal Power Plant
3. Mineral beneficiation
4. Metallurgical Industry (ferrous & non-ferrous)
5. Cement Plants
6. Asbestos milling and asbestos based products
7. Chemical fertilizers
8. Synthetic organic chemicals industry
9. Distilleries
10. Isolated storage & handling of Hazardous chemicals
11. Air ports
12. Industrial estates/ parks/ complexes/areas, export processing Zones, Special Economic Zones (SEZs), Biotech Parks, Leather Complexes
13. Common hazardous waste treatment, storage and disposal facilities
14. Bio-medical waste treatment facilities
15. Ports, harbours, break waters and dredging
16. Highways
17. Common effluent treatment plants (CETPs)
18. Common Municipal Solid Waste Management Facility (CMSWMF)
19. Building and construction projects
20. Township & Area Development projects

Declaration by the head of the Accredited Consultant Organization

I, Sunita Mantri, hereby, confirm that the above mentioned experts prepared the EIA. I also confirm that I shall be fully accountable for any misleading information mentioned in this statement.

Signature	
Name	Sunita Mantri
Designation	CMD
Name of the EIA Consultant Organization	Enkay Enviro Services Private Limited
NABET Certificate No. & Issue Date	QCI/NABET/EIA/2023/RA 0183 dated Nov 23, 2020

Inputs of expertise contributed by the Functional Area Experts

S. No.	Functional Areas	Name of the Expert/s	Involvement (Period & Task**)	Signature & Date
1	AP	Alka Sharma *Neha Bhargava	Period:2 days • Significant sources of air emissions during construction phase and post construction phase have been enumerated. • Stationary sources of emission, Fugitive sources of emissions are quantified to the extent possible and impact of the same are reckoned • Sources contributing to sick building syndrome have also been identified. • The sources of project emission and the surrounding emission sources were identified to compute the incremental load.	अलका शर्मा Neha

2	AQ	Neha Bhargava	• There are no continuous sources of emission in the post construction phase. • Only source of point emission and line sources of emissions are from stack attached to D.G. Sets and vehicular emissions. • The limitations with the identified key sources of pollutants have been considered to derive at the incremental load due to the project.	
3	WP	Sunita Mantri	• Fresh water requirement in the post construction phase has been spelt out. With conservative use of fresh water at all requisite use. The waste water generated has been quantified with appropriate treatment and usage of treated w/w has been judiciously determined. • All the layouts of fresh water, treated w/w, sewerage and storm water layout has been delineated in the mosaic plan • The storm water capture has been studied and suggested for implementation.	
4	SHW	Alka Sharma *Neha Bhargava	• Waste generated per capita as defined in NBC Code as per the urban population has been computed and bifurcated in the requisite category as per applicable legislation. • The waste generated is proposed to be segregated in the defined are with proper collection and segregation. • The disposal as per the segregation is suggested for apt disposal. • Quantification of the waste has been done.	
5	HG	Vikrant Mahendran	• The inputs from the secondary data on the available ground water has been stated with the impact of water on the water table with proposed with drawl of ground water and similar augmentation of ground water with proper recharge of captured storm water is stated. • Design of Rain Water Harvesting.	
6	Geo	Vikrant Mahendran	• Based on the local geology the building materials have been suggested. • Low energy embodied stones have been suggested. • The excavated soil quantification has been determined.	

7	NV	K.N. Sudershan Rao	• The sources of noise emission have been identified to determine the continuity. • The monitored data at site have been verified for any additional contribution by the project in all phases. • Identification of impact and suggestion of mitigation measured	
8	LU	Vikrant Mahendran	• The land use of the project site has been studied to drive at its consistence with local land use plan. • The change in land cover with extent of impact has been studied. • The topography with building foot print coverage has been examined for any alteration and slope variation. • Inference	
9	SE	Puran Singh Gurjar (FAA)	• Secondary data of Census of India, 2011. • Socio- Economic observations • CSR/ ESR	
10	RH	Sunita Mantri	• Construction risks with occupational safety measures have been mentioned. • Potential domestic hazards have been highlighted with trigger and limitations • Identification of potential threat & risk. • Preventive measures adopted.	
11	EB	Dinesh Bohra	• Biological Survey. • Identification of species, trees uprooted, habitations disturbed if any. • Proposal to balance the biodiversity with post project tree plantation. • Ways to minimize the impacts.	
12	SC	Vikrant Mahendran	• Type of soil, quantity of soil excavated. • Disposal of soil removed. • Conservation of top soil and its reuse in plantation • Identification of existing quality of Soil. • Prediction of Impact and its management.	

Quality Council of India

National Accreditation Board for Education & Training

CERTIFICATE OF ACCREDITATION

Enkay Enviro Services Pvt. Ltd., Jaipur

92, Heera Nagar-A, Near Shalimar Bagh, Ajmer Road, Jaipur – 302021

The organization is accredited as Category-A under the QCI-NABET Scheme for Accreditation of EIA Consultant Organization, Version 3: for preparing EIA-EMP reports in the following Sectors –

Sl. No.	Sector Description	Sector (as per) NABET	MoEFCC	Cat.
1.	Mining of minerals including opencast and underground	1	1 (a) (i)	A
2.	Thermal power plants	4	1 (d)	A
3.	Mineral beneficiation	7	2 (b)	A
4.	Metallurgical industries (ferrous & non-ferrous)	8	3 (a)	A
5.	Cements plants	9	3 (b)	A
6.	Asbestos milling and asbestos based products	12	4 (c)	A
7.	Chemical fertilizers	16	5 (a)	A
8.	Synthetic organic chemicals industry	21	5 (f)	A
9.	Distilleries	22	5 (g)	A
10.	Isolated storage & handling of Hazardous chemicals	28	-	B
11.	Air ports	29	7 (a)	A
12.	Industrial estates/ parks/ complexes/areas, export processing Zones, Special Economic Zones (SEZs), Biotech Parks, Leather Complexes	31	7 (c)	A
13.	Common hazardous waste treatment, storage and disposal facilities	32	7 (d)	A
14.	Bio-medical waste treatment facilities	32 A	7 (d a)	A
15.	Ports, harbours, break waters and dredging	33	7 (e)	A
16.	Highways	34	7 (f)	B
17.	Common Effluent Treatment Plants (CETPs)	36	7 (h)	B
18.	Common Municipal Solid Waste Management Facility (CMSWMF)	37	7 (i)	B
19.	Building and construction projects	38	8 (a)	B
20.	Townships and Area development projects	39	8 (b)	B

Note: Names of approved EIA Coordinators and Functional Area Experts are mentioned in RAAC minutes dated Oct 23, 2020 posted on QCI-NABET website.

The Accreditation shall remain in force subject to continued compliance to the terms and conditions mentioned in QCI-NABET's letter of accreditation bearing no. QCI/NABET/ENV/ACO/20/1537 dated Nov 23, 2020. The accreditation needs to be renewed before the expiry date by Enkay Enviro Services Pvt. Ltd., Jaipur following due process of assessment.

Sr. Director, NABET	Certificate No.	Valid till
Dated: Nov 23, 2020	NABET/EIA/2023/RA 0183	Dec 12, 2023

For the updated List of Accredited EIA Consultant Organizations with approved Sectors please refer to QCI-NABET website.

List of Annexures:

Annexure 1	Detailed Project Report for Development of Greenfield Vadhavan Port by Royal HaskoningDHV (May 2023)
Annexure 2 Annexure 2a	TOR letter dated 7th October 2020. Amended ToR letter dated 2nd June, 2023
Annexure 3	Demarcation of HTL and LTL for preparation of CZMP report by Institute of Remote Sensing, Chennai (October 2023)
Annexure 4	Mathematical Model Studies to assess the impact of proposed capital dredging on tidal hydrodynamics of nearby area of proposed port at Vadhvan by Central Water and Power Research Station (T. R. 5970 – November 2021)
Annexure 5	Mathematical Model Studies to assess the impact of Proposed Port Development at Vadhavan on Flooding in Dahanu Creek and Nearby Control area under Cyclonic Conditions by Central Water and Power Research Station (T. R. 6173 - October 2023)
Annexure 6	Marine biodiversity management plan for the proposed greenfield port at Vadhavan, Palghar district, Maharashtra by CSIR – National Institute of Oceanography (SSP 3374 – October 2023)
Annexure 7	2D Desktop Navigation Simulation Study by DHI/ Force (March 2022)
Annexure 8	Traffic analysis in the vicinity of proposed port at Vadhavan by Indian Institute of Technology, Mumbai (May 2021)
Annexure 9	Dispersion of silt during dredging from marine Burrow pit for reclamation by Department of Ocean Engineering, Indian institute of technology Madras, Chennai (October 2022)
Annexure 10	Impact of Breakwaters and Transport Carrier on the Erosion/ Accretion for the Vadhavan Port' by National Centre for Coastal research (NCCR) and Indian National Centre for Ocean Information Services (INCOIS), Ministry of Earth Sciences. (September 2023)
Annexure 11	Biodiversity study for the proposed Burrow pit region in arabian sea with Reference to development of vadhavan port, Palghar, Maharashtra by Zoological Survey of India (October 2023)
Annexure 12	Impact study of proposed Vadhavan Port on Coastal Fisheries by Central Marine Fisheries Research Institute (October 2023)

Annexure 13	Impact Assessment of Proposed Sand Mining on the Marine Fisheries and Fishermen Community of Daman Union Territory is carried out by Central Marine Fisheries Research Institute (October 2023)
Annexure 14	Social Impact Assessment Report – Vadhavan Port by Southern Enviro Engineers Pvt. Ltd., Hyderabad (March 2022)
Annexure 14a	Vadhavan Port Project - Public Awareness Program by JNPA
Annexure 15	Dahanu Taluka Environmental Protection Authority (DTEPA) Order dated 31st July 2023 granted permission to JNPA to establish and develop the Vadhvan port in the Dahanu Taluka
Annexure 16	Letter From Ministry Of Earth Sciences, Government of India dated 25th May, 2023
Annexure 17	Marine Biodiversity at Shankodhar Point, Dahanu Taluk, Maharashtra conducted by CSIR – National Institute of Oceanography (June 2023)