CHAPTER 1

INTRODUCTION

Kerala, one of the most densely populated states in India, has a high concentration of population in its coastal zone. The State has a long history of maritime trade and a number of vital industries such as mineral factories, coir factories, seafood processing units, etc., is situated in the coastal region. This has led to development of port activities at several places along the coast. There are one major port and 13 intermediate and minor ports situated along the coast. Though the coastal zone of Kerala is a boon to the State, its instability due to the erosion of its shoreline, poses a serious problem to the State, requiring frequent attention. Port development may create a wide range of impacts on the environment by construction work, dredging, reclamation, landfills, discharges from ships and waterfront industries, cargo operations, and other port related activities. The potential adverse effects of port development encompass air pollution, noise and vibration, visual pollution, beach erosion, ground water pollution, sea water pollution, contamination of bottom sediment, loss of bottom habitat, damage to marine ecology and fisheries, current pattern change, waste disposal, oil leakage and spillage, hazardous material emissions and other unhealthy socio-cultural impacts. Port development and operation should, therefore, be planned with careful consideration of their environmental impacts.

Minor ports are placed in the Concurrent List of the Constitution and are administered under the Indian Ports Act, 1908. The Act defines the jurisdiction of Central and State government over ports. It lays down rules for safety of shipping and conservation of ports. It regulates matters pertaining to the administration of port dues, pilotage fees and other charges. At the State level, the department in charge of ports is responsible for formulation of water front development policies and plans, regulating and overseeing the management of State ports, attracting private investment in the development of State ports, enforcing environmental protection standards, etc. In order to minimize the adverse effects that may be created by the port development projects, the techniques of Environmental Impact Assessment (EIA) become indispensable. With these in mind the Ministry of Environment and Forests (MoEF), Government of India, issued an “Environmental Impact Assessment Manual” (rev. 2005) and also “Environmental Guidelines for Ports and Harbour Projects” (2010). The present study was undertaken taking in to consideration the above-mentioned aspects.

ENVIRONMENTAL REGULATIONS

At the national level, the environmental clearance to the project is subject to compliance with the stipulated safeguards under the provisions of Environment (Protection) Act, 1986; Forest (Conservation) Act, 1980; The Wildlife (Protection) Act, 1972; The Water (Prevention and Control of Pollution) Act, 1974; The Water (Prevention and Control of Pollution) Rules, 1975; The Water (Prevention and Control Pollution) Cess Act, 1977; The Water (Prevention and Control of Pollution) Cess Rule, 1978; The Water (Prevention and Control of Pollution) Act, 1981; and other rules and regulations in force. Land use on the coastline will be subject to regulation as per the Coastal

Regulation Zone (CRZ) Notification issued by the Ministry of Environment and Forests (MoEF), Government of India in 1991 and subsequent amendments. This notification is administered by the State Department of Environment and Forests. The Port project in Kerala would generally need the following clearances from Govt. of India and Govt. of Kerala.

(a) Environmental Clearance from the MoEF, Govt. of India.
(b) Environmental Clearance from the MoEF under CRZ Regulation.
(c) No Objection Certificate (NOC) from the State Pollution Control Board, Govt. of Kerala.
(d) Clearance from Kerala Forest Department for cutting of trees for site clearance (if necessary).
(e) Clearance of Kerala Ground Water Authority for withdrawal of ground water for construction and operation of the project.
(f) "No Objection Certificate" from the Kerala Pollution Control Board for handling, recycling and disposal of hazardous waste produce from the port operation.

ENVIRONMENTAL IMPACT ASSESSMENT

Environmental Impact Assessment (EIA) is an exercise that aims to identify, predict, interpret and communicate the impact of legislative proposals, policies, programmes, projects and operational procedures on the natural environment and human health and well being. It intends to improve decision-making and ensure environmentally and socially sound and sustainable development. The MoEF promulgated an Environmental Impact Assessment Notification on 27 January 1994, under the Environmental (Protection) Act 1986, declaring EIA a mandatory requirement for development of projects. Ports and Harbours are listed at Sl. No.3 of Schedule – I, List of Projects requiring environmental clearance and the EIA Notification, 2006 has done away with the exemption available earlier under the EIA Notification 1994 to Port projects. The Ports and Harbours with cargo handling capacity ≥ 5 million TPA of cargo handling capacity (excluding fishing harbors) are classified as category-A projects and with cargo handling capacity < 5 million TPA and/or ≥ 10000 TPA of fish handling capacity are classified as category-B projects, subject to the applicability of General Conditions as stipulated in the EIA Notification, 2006 (Table 1.1).

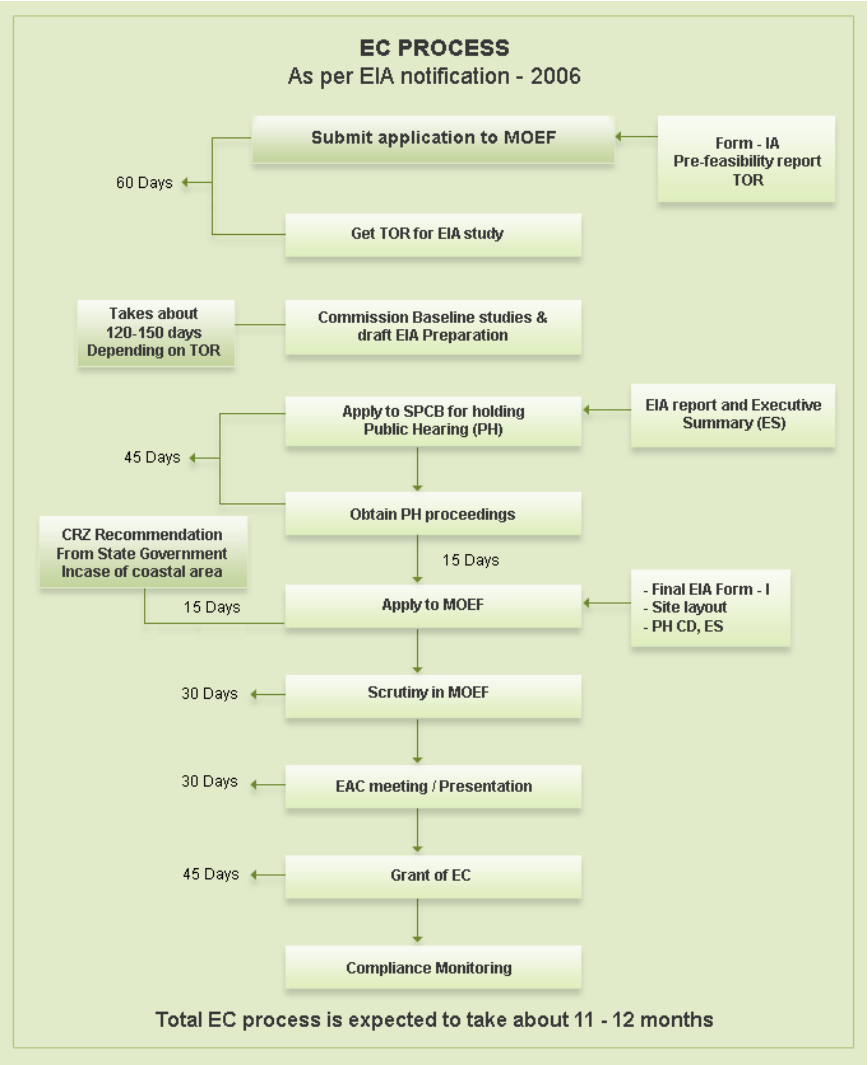
Table 1.1 Categories of ports and harbour projects

Project or activity	**Category with threshold limit**	
	A	B
Ports & Harbors*	≥ 5 million TPA of cargo handling capacity (excluding fishing harbors)	< 5 Million TPA pf cargo handling capacity and/or ports/ harbors ≥ 10, 000 TPA of fish handling capacity
Authority for approval of TOR & issue/reject of EC	MoEF, GOI on the recommendations of Expert Appraisal Committee (EAC)	State/Union territory Environmental Impact Assessment Authority (SEIAA) on the recommendations of State or Union territory level Expert Appraisal Committee (SEAC)
General condition shall apply* General Condition (GC): Any project or activity specified in Category 'B' will be treated as Category A, if located in whole or in part within 10 km from the boundary of: i) Protected areas notified under the Wild Life (Protection) Act, 1972, ii) Critically polluted areas as notified by the Central Pollution Control Board from time to time, iii) Notified Eco-sensitive areas, iv) Inter-state boundaries and international boundaries		

ENVIRONMENTAL APPRAISAL PROCEDURE

MoEF is the nodal agency for environmental clearance. The Environment Division plays a key role, but the Forest and Wildlife Divisions are consulted when projects involve diversion of forestland or the alignment of roads and highways along or within the wildlife areas. The project proponents of new projects must submit an application to the Secretary, Ministry of Environment and Forests, New Delhi in the standard proforma specified in the EIA Notification. The application should be accompanied by a Feasibility/ Project report, including:

1. Environmental Appraisal Questionnaire developed by MoEF
2. Environmental Impact Assessment Report
3. Environmental Management Plan
4. Details of Public Hearing as in Schedule IV (wherever necessary)
5. Rehabilitation Plans (wherever necessary)
6. Forest Clearance Certificate (wherever necessary)
7. No objection Certificate from State Pollution Control Board



The application is evaluated and assessed by the Impact Assessment Agency (IAA). The IAA may consult a Committee of Experts constituted by it or other body authorized by it in this regard, if necessary. The Committee has full right of entry and inspection of the site or factory premises before, during or after the project commences. The IAA prepares a set of recommendations based on technical assessment of documents and data, furnished by the project authorities or collected during visits to sites or factories and details of public hearing. It is to be ensured that none of the activities planned by the project proponents during the investigations/ construction/operational phase

of the project violates the provisions of the CRZ Notification; EIA Notification, 2006; Manufacture, Storage and Import of Hazardous Chemical Rules, 1989; the Forest (Conservation) Act, 1980; The Wildlife (Protection) Act, 1972; Environment (Protection) Act, 1986; and their subsequent amendments and other relevant Acts/ Rules issued by the Central/ State Government.

OBJECTIVES OF THE PRESENT STUDY

The present study aimed to carry out a Rapid Environmental Impact Assessment of the Proposed Alappuzha Port and Inland Marina, and to prepare an Environment Management Plan.

Specific Objectives

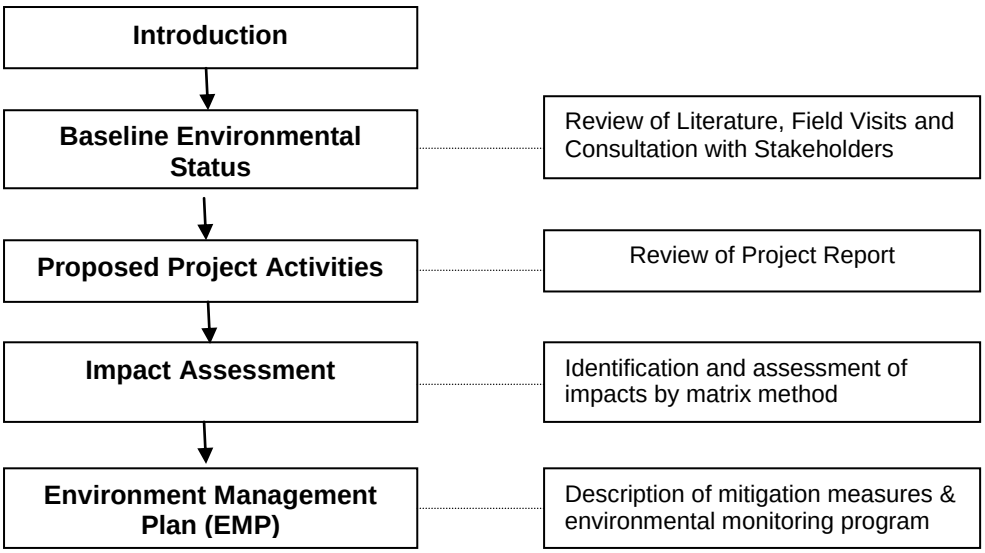
1 To analyze and quantify the project based on the components and identify activities that can have considerable effect on the local environment - be it positive or negative;

2 To carry out an appraisal of the present environmental settings in the area with regard to parameters like land, water quality, biodiversity of the region, socio-economic conditions of the people, infrastructure capabilities of the area, etc.

3 To suggest mitigative / control measures for the major impacts of the Port and Inland Marina on the area and also to prepare an Environmental Management Plan for the Port and Inland Marina.

METHODS

The EIA study includes the study of various baseline parameters of environment viz. land, water, air, noise, flora, fauna and socio-economics. Integration of these parameters gives an overall perception of positive and negative impacts due to construction and operation of the project, if any. For overall prediction of impacts, the 10 km periphery of the project site was considered as study area. To assess the likely impact of the proposed Port and Inland Marina project on the surrounding area, an integrated multidisciplinary survey was conducted. The sites for Port and Marina amenities like roads, sewage and sanitation facilities etc. were identified. The impact of the Port and Marina construction on flora and fauna of the area was also studied. An overview of EIA study is given below



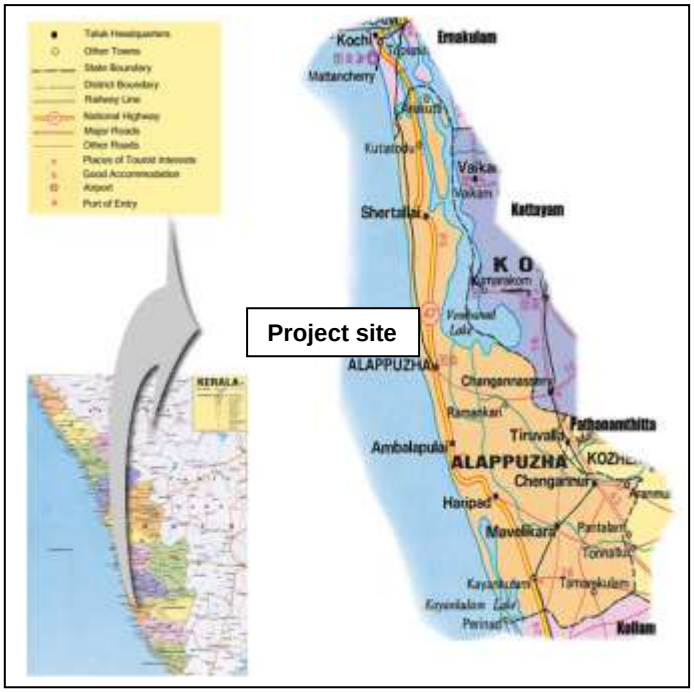
CHAPTER 2

DESCRIPTION OF THE ENVIRONMENT

PHYSICAL ENVIRONMENT

Location

The proposed project site is situated in Alappuzha Municipal area in Alappuzha district (Latitude of 9^{o} 30' N and Longitude of 76^{o} 19' E) about 50 km south of Kochi. Towards the land side of the project site, there are network of canals coming under the west coast canal system which are used for navigation. The important canals are Vadai canal, Commercial canals and the Link canals between these two canals. The inland canal system of Alappuzha would form a part of the proposed Marina project at Alappuzha. The main land available with the port is what exists in the beach. The beach is 1500 m in length and 100 meters in width. Apart from the beach, some parts of land adjacent to the beach road also come under the purview of the Port.



Alappuzha, one of the two intermediate ports on the west coast of Kerala was the first commercial port in the princely State of Travancore. It was established by Raja Kesavadas, the Diwan of Travancore. Shipping operations are carried out rarely since the starting of Kochi port. During the period 1981 to 1991, only 5 ships have come to the port, of which one was during 1982-83, three were during 1988-89 and one was during 1989-90. During the above-said period, 414 tonnes of coir products have been exported and 51808 tonnes of rice and 24517 tonnes of wheat have been imported.

Climate

The climate of the region is characterized as tropical humid, with an oppressive summer and plentiful seasonal rainfall. The hot season, lasting from March to May, is followed by the south-west monsoon from June to September. The north-east monsoon occurs from October to November. The rest of the year is generally dry. The annual rainfall amounts to approximately 3300 mm, of which the most (63.8%) is received during the south-west monsoon. Excessive rain during June to August causes frequent floods in the rivers and canals in the area, submerging low-lying areas (See Table 2.1).

Table 2.1 Monthly rainfall pattern of Alappuzha during 2005-2010

Months	Rainfall in mm					
	2005	2006	2007	2008	2009	2010
January	18.9	11.7	0.0	0.0	1.7	1.9
February	11.8	0.0	30.5	88.2	4.4	3.4
March	39.2	58.4	2.2	175.5	45.3	73.8
April	248.9	73.6	139.7	166.3	131.9	165.6
May	177.4	495.3	284.2	127.8	256.4	305.2
June	552.1	481.5	597.3	366.5	559.8	515.4
July	521.7	442.6	780.2	660.7	503.3	540.9
August	114.2	332.4	368.3	189.4	164.0	294.4
September	344.1	400.2	417.6	332.6	250.9	343.3
October	276.8	450.8	306.8	313.7	210.9	554.9
November	197.3	268.1	173.4	122.3	318.5	205.7
December	96.4	6.0	6.4	41.9	54.6	117.0

(Source: IMD)

The annual mean temperature varies from 23.9°C to 30.7°C with March and April being the hottest months and December and January the coldest. The humidity is high in the area, the annual average of the relative humidity being 82% during the mornings and decreasing to 77% in the evenings. The observation on wind velocity and the dominant wind direction is shown in Table 2.2.

Table 2.2 Wind velocity and wind direction of Alappuzha

Month	Maximum Velocity	Direction	Predominant Direction
January	58	SSE	W
February	53	N	W
March	80	SSW	W
April	88	SSW	W
May	112	WSW	W
June	86	WNW	W
July	93	SW	NW
August	93	NNW	NW
September	77	WNW	NW
October	67	NNW	W
November	69	WNW	W
December	64	SSE	W

(Source: IMD)

Soils and Geology

The study area lies fully in low land region with a sandy strip of land intercepted by lagoons, rivers and canals. Coastal alluvial soils are the main soil type of the study area. These kinds of soils have been developed from marine and estuarine deposits and are very deep and usually have a high water table. The soils have low base saturation and are usually acidic with pH values lower than 6.5. The texture is dominated by sand fractions and the soils are excessively drained with very high permeability. The soil horizon is thin and the usual surface textures are loamy and sandy loam. Coastal alluvial soils have a very low fertility level and a low content of organic matter.

The land slopes gently towards northwest with a few local depressions that are located below mean sea level. The underlined crystalline rocks are mostly composed by charnockite and khondalite. The charnockite group show great diversity in lithology, but the most predominate are charnockite and charnockite gneiss. Khondalite is predominated by garnet-sillimanitegneiss.

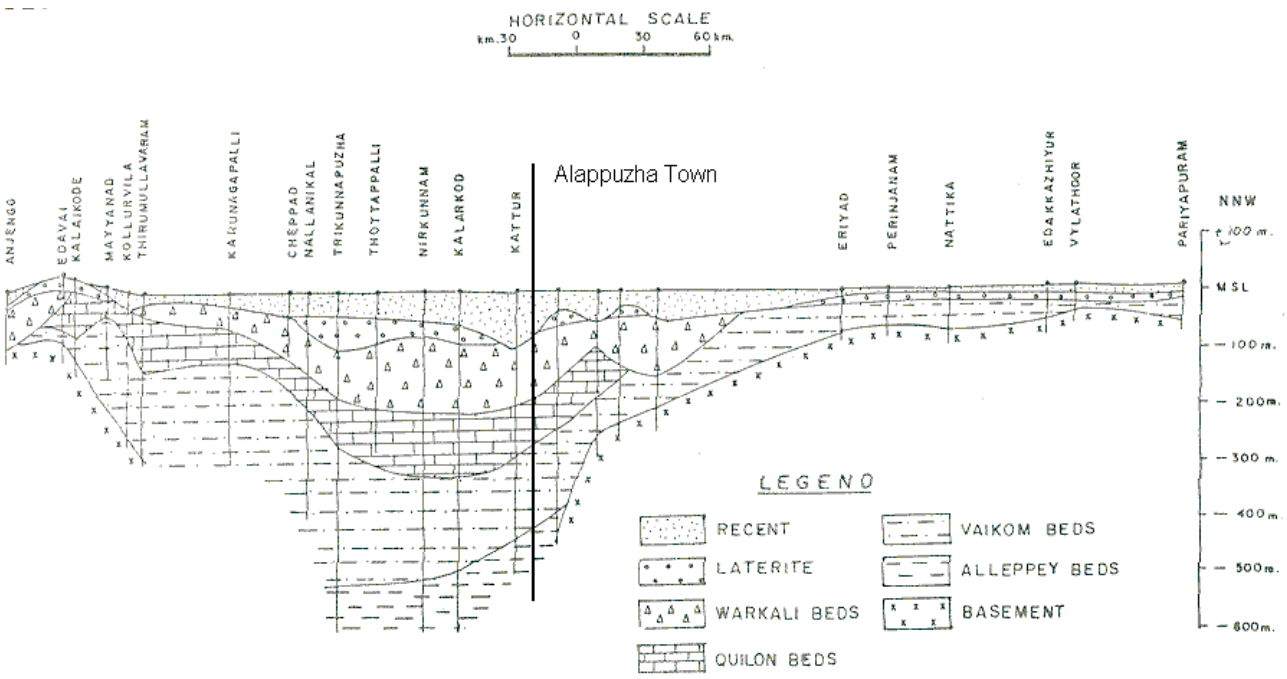


Fig. 2.1 Section over the coast around Alappuzha Town

(Source: Central Ground Water Board 1992)

Table 2.3 Description of the soil and geology of the Alappuzha area, including age, formation and lithology

Era	Age	Formation	Lithology
Quarternary	Recent	Alluvium	Sands and clays along the coast
	Sub- recent	Laterite	Laterite and lateritic clay dervied from Tertiary sadiments and Archaean crystallines
Tertiary	Lower Miocene	Warkali beds	Current bedded friable variegated sandsone interbedded with platic clay variegated clays Carbonaceous and alum clay with (mio-Pliocene) lignite seams. Gravel and pebble beds. Base marked by gibbsitic sedimetary clay
	Lower Miocene	Quilon beds	Fossiliferous shell limestone alternating with thick beds of sandy clays, calcareous clays and sandstones
	Oligoncene to eocene	Vaikom beds	Sandstones with pebble and gravel beds. Clays and lignite bands
	Eocene	Alleppey beds	Carbonaceous clays and sands
		Intrusives	Pegmatites, quartz veins, granites, dolerites and gabbro
Archaean		Migmatite group	Granite-gneisses, hornblende-biotite gneisses and Garnet-biotite-gneisses
		Charnockite group	Cordiorite genisses, charnockites, charnockite-gneisses, pyroxene-granulites
		Khondalite group	Garnet-silliminite gneisses, graphite-gneiss, quartzites and Calc-granulites

(Source: Central Ground Water Board, 1992; Soman, 1997).

Water Environment

The major source of drinking water is through piped distribution network of Kerala Water Authority (KWA) and from wells. About 20% of the tap water samples from Alappuzha are above desirable limits prescribed by Bureau of Indian Standards. The contamination of the source water (due to lack of community hygiene) and insufficient treatment are the major cause for the coliform contamination. Water samples from Alappuzha have high ionic and fluoride content which could be attributed to the geology of the region (Table 2.4).

Quality of underground water in and around Alappuzha Town was not safe due to high concentration of chloride, fluoride and iron. Fluoride content was above the permissible limit of 1 ppm (mg/l) in almost all wells as reported by Kerala Water Authority (KWA). Studies also revealed that 35.64% of the school children in Ambalapuzha taluk were affected by dental fluorosis and its prevalence was 55.28% in urban area.

Table 2.4 Ground water chemistry of Alappuzha

Parameters	Observed values		
	Min	Max	Mean
pH	6.40	8.20	7.31
Temp (°C)	25.9	31.4	27.85
Eh (mV)	-18.00	496.00	67.74
EC (μS/cm)	360.00	3170	920.53
Na^+ (mg/L)	14.96	589.19	147.51
K^+ (mg/L)	4.77	21.07	13.31
Mg^{2+} (mg/L)	5.86	20.20	14.53
Ca^{2+} (mg/L)	7.67	46.71	24.14
F^- (mg/L)	0.30	1.60	0.94
Cl^- (mg/L)	6.21	686.40	129.98
SO_4^{2-} (mg/L)	0.52	51.40	9.43
NO_3^- (mg/L)	0.15	13.80	3.09
HCO_3^- (mg/L)	174.26	325.83	256.09
PO_4-P (mg/L)	0.06	0.42	0.26
Al (μg/L)	22.73	332.55	112.72
Mn (μg/L)	6.19	40.95	16.16
Fe (μg/L)	37.07	1956.70	341.25
Cu (μg/L)	0.44	57.06	4.48
Zn (μg/L)	9.08	122.09	34.79
Sr (μg/L)	249.60	1221.95	593.58
Ba (μg/L)	24.76	172.72	73.71
Si (μg/L)	5727.46	8638.85	6380.00
La (μg/L)	3.31	8.64	5.35

Source: Tomas Blom & Elin Cederlund (2006)

Air Environment

The air environment of the study region is very clean and pleasant because there are not many influencing factors. The number of industries as well as that of vehicles is considerably low.

Noise

The major source of sound pollution in the region is the vehicles and indiscriminate use of loud speakers.

Land Environment

The main land available with the port is what exists on the beach. The beach is 1500 m. in length and 100 m. in width (15,000 m^2). Apart from the beach, there are some lands adjacent to the beach road that also comes under the Port which includes Port office and signal station, the small triangular

patch of area adjacent to the Bank Road, and the godown and the workshop area. Agriculture is the dominant land use type in the nearby coastal belt. Settlement (built-up area), mixed tree crops and coconut are found along the sandy ridges. The soil is less fertile and water-holding capacity is also very low.

ECOLOGICAL RESOURCES

Coastal Environment

As per Sajeev, et al 1997, the drift along Alappuzha coast shows seasonal variations. There is prominent southerly drift during monsoon and in all other months, drift will be northerly. Low magnitude of drift was observed along the mud banks. The mud banks of Alappuzha persist for very long time from the start of the monsoon to the end of the monsoon. They are found 3-4 km along the coast and 1-1.5 km across the coast. By the end of monsoon, the turbulence get reduced and the mud particles settles and the coarser particles settles faster and suspended particles will be taken away by the currents. This leads to the decrease in viscosity of sea water and all the damping effects will be diminished and the water body will be rough again. It was also observed that, the eroded particles get caught in mud banks and because of this the supply of sediment in the shore decreases which leads to erosion. The mud bank extended up to 1.5 km out into the sea and traces of thin layer of mud extended up to 3.5 km.

Terrestrial Environment

No forest, wild life sanctuaries or other environmentally sensitive area is near to the project site (within 10 km radius of the project site) and no rare or endangered species have been reported from the region. No mangrove or wet land or turtle nesting sites is observed at or near to the site. Coconut trees, Mango trees, Tamarind, Betel nuts, Jackfruits, Casuarina Sp., etc., are very common around the site. Although Alappuzha retains extensive backwater systems, its wetlands have been extensively damaged by reclamation for coconut growing and foreshore developments. Consequently, the district has one of the lowest proportions of mangroves resources in the State.

Socio-Economic Environment

Fishery is the main activity in the region. Cultural significance of the area is remarkable. The area is rich with a large number of historic temples and churches. People belonging to various faiths and creeds are living here in harmony for centuries. The area is also known for its architectural variety, with a number of traditional houses and mansions that represent the famous Kerala architecture.

Tourism

Alappuzha beach is one of the most popular picnic spots in the State. The pier, which extends into the sea here, is over 137 years old. Entertainment facilities at the Vijaya Beach Park add to the attractions of the beach. There is also an old light house which is greatly fascinating to visitors.

Transportation and Communication

The nearest Airport is at Kochi (Cochin International Airport Limited) which is about 60 km north of the study region. The region is connected by rail, the nearest Railway Station being at Alappuzha, only 1 km from the Port site. Alappuzha city is a major intercity junction for road, rail and water transport networks from Thiruvananthapuram, Ernakulam and Kottayam. State Transport buses and private buses operate in the area from nearby towns. Taxis, Auto-rickshaws and other private vehicles are also available. The area has a good network of communication with STD/ISD facilities and mobile phone services. The National Highway (NH-47) is just one kilometer away from the proposed project location. A by-pass connection is being developed on the southern end of the beach road (adjacent to the proposed project site) to NH-47. The other roads connecting the project location to Kerala and Tamil Nadu include the state highways viz: Alappuzha- Changanassery Highway (SH-11), Alappuzha–Madurai road (SH-40), Alappuzha-Arthunkal- Chellanam-Thoppumpady (Kochi) road (SH-66),etc. Alappuzha has a large network of inland canals and hence is the ideal place for backwater tourism.

CHAPTER 3

PROJECT DESCRIPTION

ALAPPUZHA PORT

One pier 387m in length, three pairs of trolley lines and 108 trollies for cargo movement on the pier are available. The existing pier is supported on steel piles which are not in use since 1989. The present condition of the pier is that, the piles are severely corroded in the splash zone and atmospheric zone (Fig 3.1). Due to corrosion, the cross section of the steel member is greatly reduced. This reduction in area leads to even greater reduction of moment of inertia which reduces the capacity of the member to resist the loads coming onto it. So, it may be better to erect new structures for the development of the port.

Fig 3.1 Existing pier structure in Alappuzha

PORT LAYOUT

Keeping in view the site conditions, two possible options for port layout are one with attached breakwater and the other one with detached breakwater. These two differ mainly in the way the breakwaters are constructed in relation to the shoreline. In the first one, protection from incoming waves is due to shore connected breakwaters and in the second layout, protection from incoming waves is due to detached breakwaters. Based on model study, construction of detached breakwater is proposed (Fig 3.2).

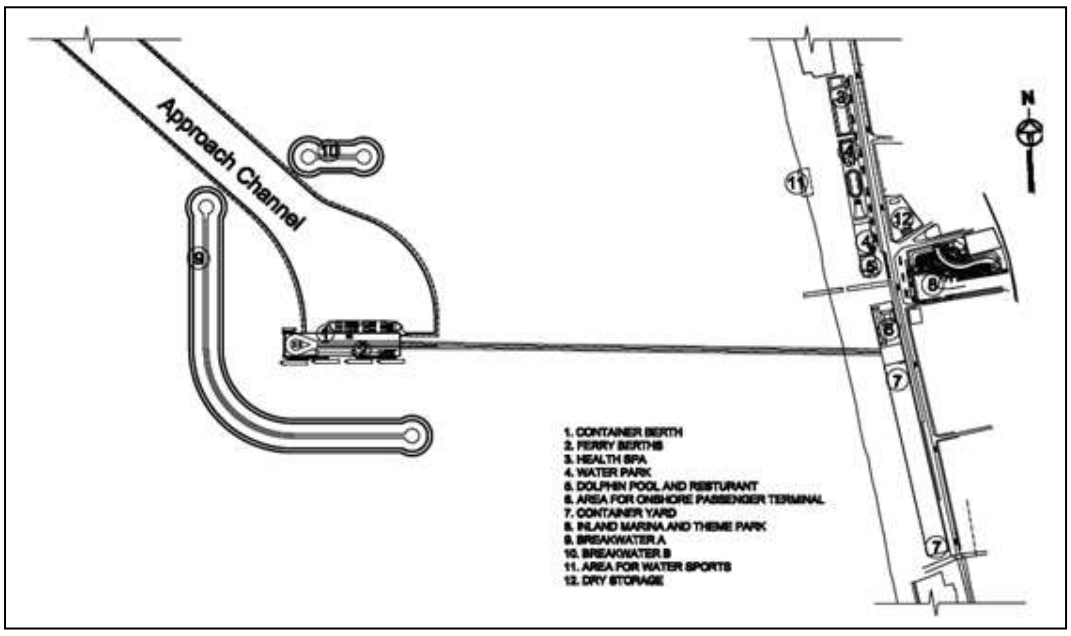


Fig 3.2 Proposed Breakwater Layout Plan of Alappuzha Port

Container berth and passenger berth

Container berth and passenger berth are planned on the jetty of 213 m. length and 45 m (Fig. 3.3). wide which is connected to the shore by a trestle. The jetty alignment is in east-west direction, the Container berth is on the north face and the Passenger berths are planned on the south face of the jetty. Four lane road of width 14 meters is planned on the jetty for movement of tractor trailers and buses. A space of 18 meters width is provided along the length of container berth for the mobile harbour crane operations. A terminal building for container operations of area 160 m. is provided on the jetty in the middle of the turning area of tractor trailers. A mooring dolphin and its approach are provided on the north-east corner of the jetty for mooring container ships. It is planned to have the passenger ferries coming to the port to berth along floating landing pontoons. Fender piles are provided in front of the pontoons to take the impact of the vessels. During phase-1, landing pontoon for only one 250 pax ferry is planned. In phase-2, berthing landing pontoons for another four passenger berths are provided. Three landing pontoons are provided along the length of the southern face of the jetty for accommodating 250 pax ferries and the other smaller landing pontoon for accommodating 100 pax ferries is placed on the northern face.

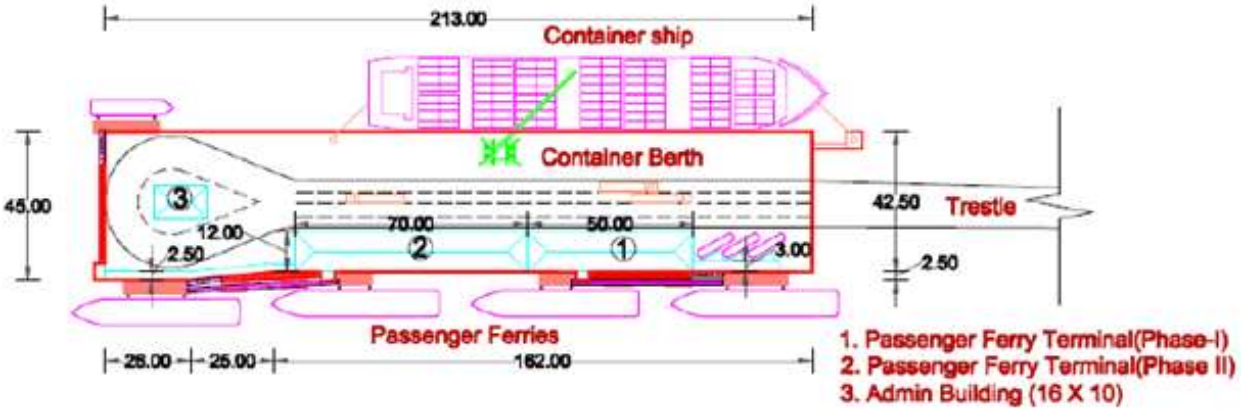


Fig 3.3 Details of Container Berth and Ferry Berth

Container Yard

The proposed width of the yard is 40m in which 14m will be taken by road and 25m is provided for RTG. Within the 25 m, around 15m will be taken by container stacking and the rest is kept for trailers to load and unload. The yard will be developed up to a length of 290m in Phase-1. In Phase-2, the yard should be increased to a length of 362m.

Approach Trestle

Trestle is constructed to connect the proposed container and ferry berths with the land. Trestle contains four lane roads (3.5 m each), in which the two lanes in the north are exclusively for container movement and the other two are for bus traffic. The trestle will have a length of 880 m.

Breakwater

Breakwaters are provided to achieve tranquility in the harbour for safe harboring and operational stability of the ship during loading and unloading. The length of the breakwaters is around 985 m. The height of breakwater is fixed in such a way that, the overtopping will be below 0.05 m^3/s per meter length of breakwater. Another important factor which governs the stability of breakwater is side slope, which is taken 1 in 2. The crest width is 8.5m.

The design wave height is taken as 100 year return wave height which is approximately 5.34 m. As the breakwater is almost at the breaking zone the breaking wave height cannot be counted as design wave height. A crest height of 5.5m. above water level is provided along the breakwater.

Approach Channel

Length of approach channel is 1,524.8 m. and its width is 112 m. Based on the tidal elevation which very rarely goes below 0.1m CD, depth of the channel and berthing area is taken as 9.0 m. The total area for the ship in front of the berth to move freely is equal to 48,299 m^2.

Details of Model Studies Carried out for Breakwater Design

With the objectives of ascertaining the wave tranquility in the proposed Alappuzha Port, determining the alignment, length and cross-section of breakwaters, predicting shoreline changes due to the construction of the breakwaters, Model Studies were carried out by the Port authorities through expert institutions. We have reviewed relevant portions of the Model study report for assessing the environmental impact and to prepare the management plan. The figures 3.4 and 3.5 show the bathymetry of the model without and with the detached break water respectively.

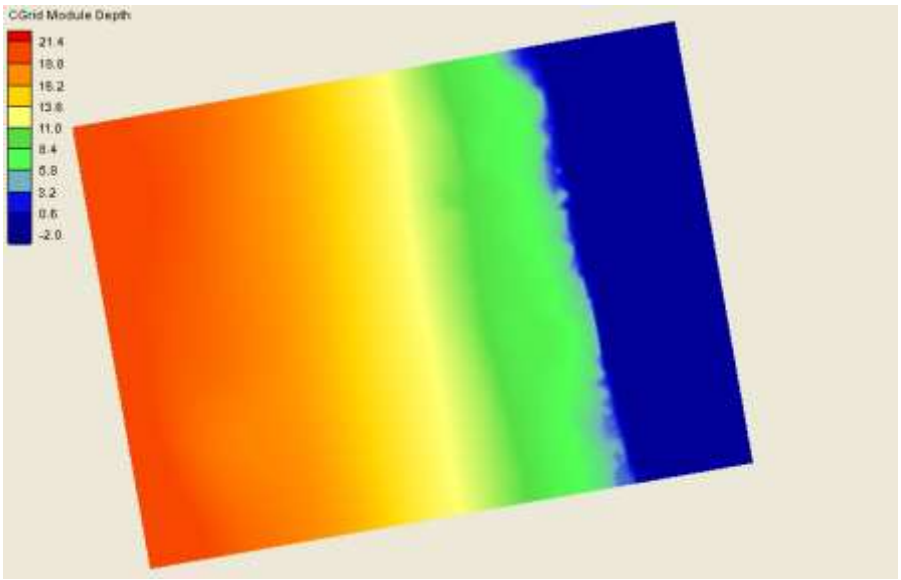


Fig 3.4 Bathymetry of the Modeled Domain without Breakwater and Approach Channel

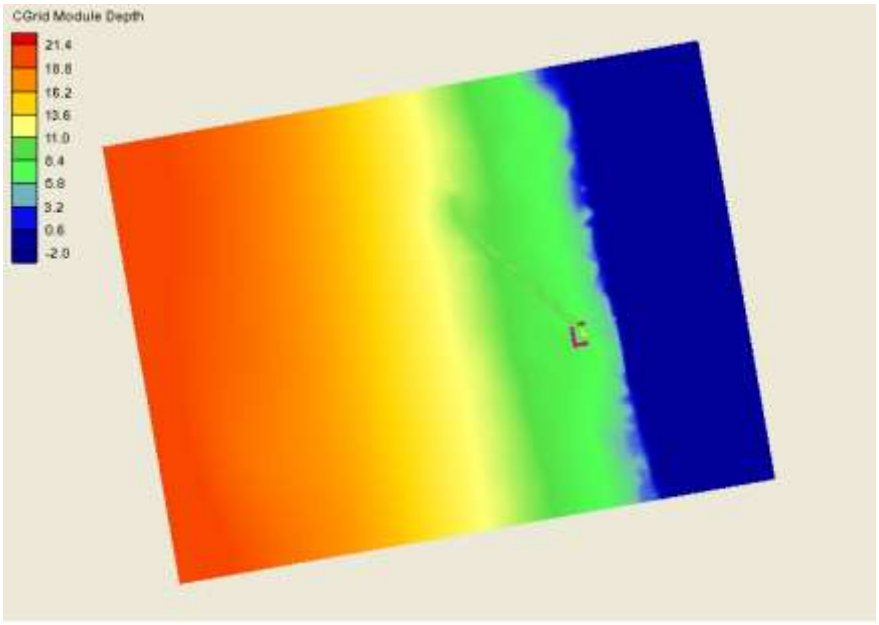


Fig 3.5 Bathymetry of the Modeled Domain with Breakwater and Approach Channel

Shoreline Changes

Annual morphological changes in elevation for the existing condition (without any construction of breakwater) and due to construction of detached breakwater are shown in figures 3.6 and 3.7. The predominant changes are marked by shown in the figures.

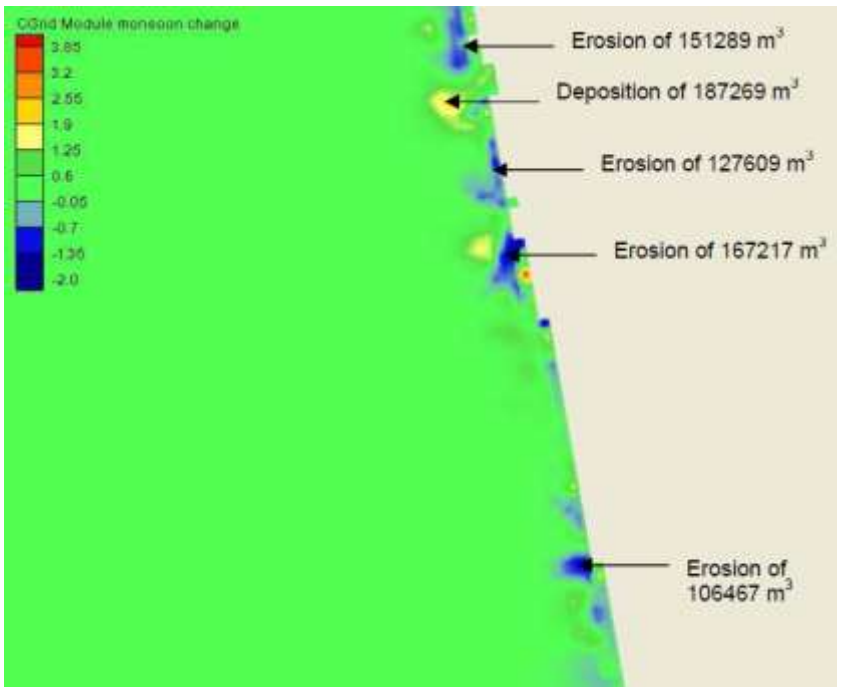


Fig 3.6 Annual Morphological Changes in Elevation for the Existing Condition

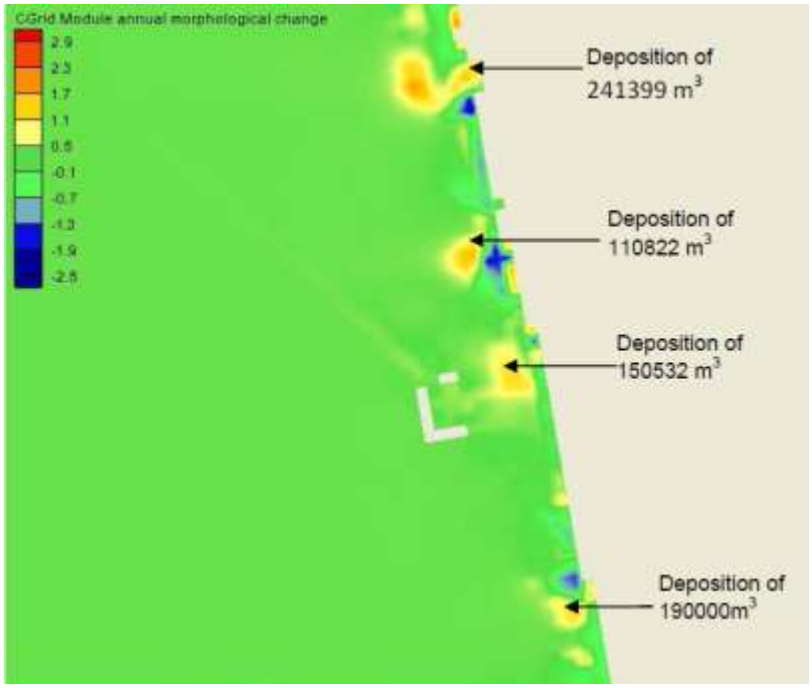


Fig 3.7 Annual Morphological Changes in Elevation with Breakwater and Channel

Wave Characteristics

The wave characteristics of Alappuzha area is shown in Table 3.1. The variation of the significant wave height due to the detached breakwater is shown in the Fig 3.8. The incident significant wave height is 3.0 m which is the maximum wave height occurring in a year and it reduces to height of 0.2-0.4 m behind the break water.

Table 3.1 Wave characteristics at Alappuzha

Parameters	Rough season	Fair season
Significant wave height, H_s	3.00m	1.40m
Height of the highest wave, H_{max}	3.40m	2.00m
Time period of predominant waves	8-10s	9-11s
Percentage of times H_s exceeds specified wave heights		
30%	1.30m	0.65m
50%	0.95m	0.52m
75%	0.62m	0.42m
Percentage of times H_{max} exceeds specified wave heights		
30%	1.90m	0.90m
50%	1.35m	0.72m
75%	0.85m	0.58m
Wave Direction considering majority of waves	230-265^{o}N	235-240^{o}N
Predominant wave direction and time period	250-265^{o}N, 8-10s	230-240^{o}N, 10-11s

(Source: Wave climatology and littoral processes at Alleppey by T S Shahul Hameed , 1988)

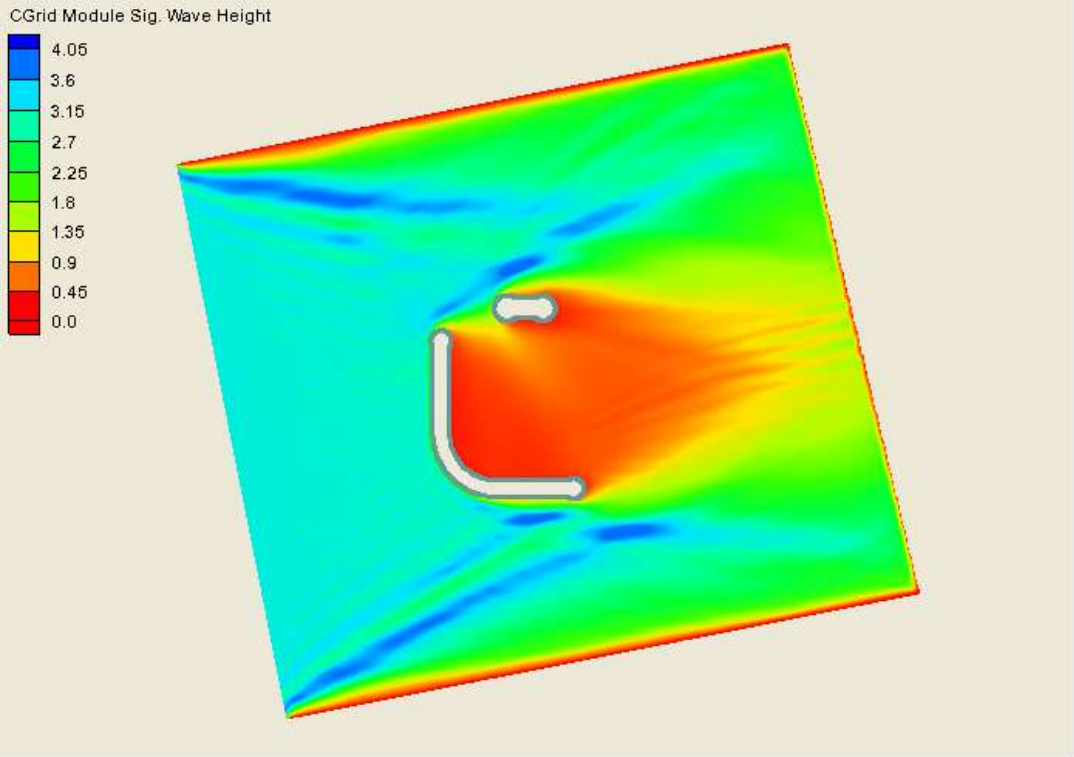


Fig 3.8 Variation of the Significant Wave Height due to the Detached Breakwater

DREDGING OPERATIONS TO BE CARRIED OUT

Capital dredging as well as maintenance dredging varies for both the options considerably.

Capital Dredging

Dredging quantity for the Approach Channel for Option-C including the bank slopes is around 1.6 million m^3 where as for Option-D is around 0.73 million m^3. Total quantum of capital dredging required for Option-C is around 1.73 Million m^3 and for Option-D is around 0.83 Million m^3.

Maintenance dredging

Maintenance dredging needs to be conducted periodically to maintain the navigational channel as it is prone to lose depth because of sedimentation. The sediment transport at the site location is predominantly due to littoral drift. The annual sedimentation in the approach channel and the turning basin is around 12612 m3 of which the sedimentation in the turning basin is 5970 m3 and the maximum height of deposition is around 0.13 meters

INLAND MARINA

As part of the development of the Port, an Inland Marina and a Theme Park is proposed. The layout showing both Marina and Theme Park is given in Fig 3.9.

The location selected for marina development is bounded by a railway bridge on the east, road on the west, road on the south and port buildings on the north. The width of the canal at this location is around 25 m. Total canal area available at the proposed location for the development of marina is 2000 m^2. Since, this area is not sufficient to accommodate the number of boats proposed, it is proposed to demolish the buildings and dredge some more area to the North of the proposed location to widen the Canal so that an area of 3500 m^2 will be made available for the development of Marina. For this purpose a dredging of 7918 m^3 of soil needs to be done.

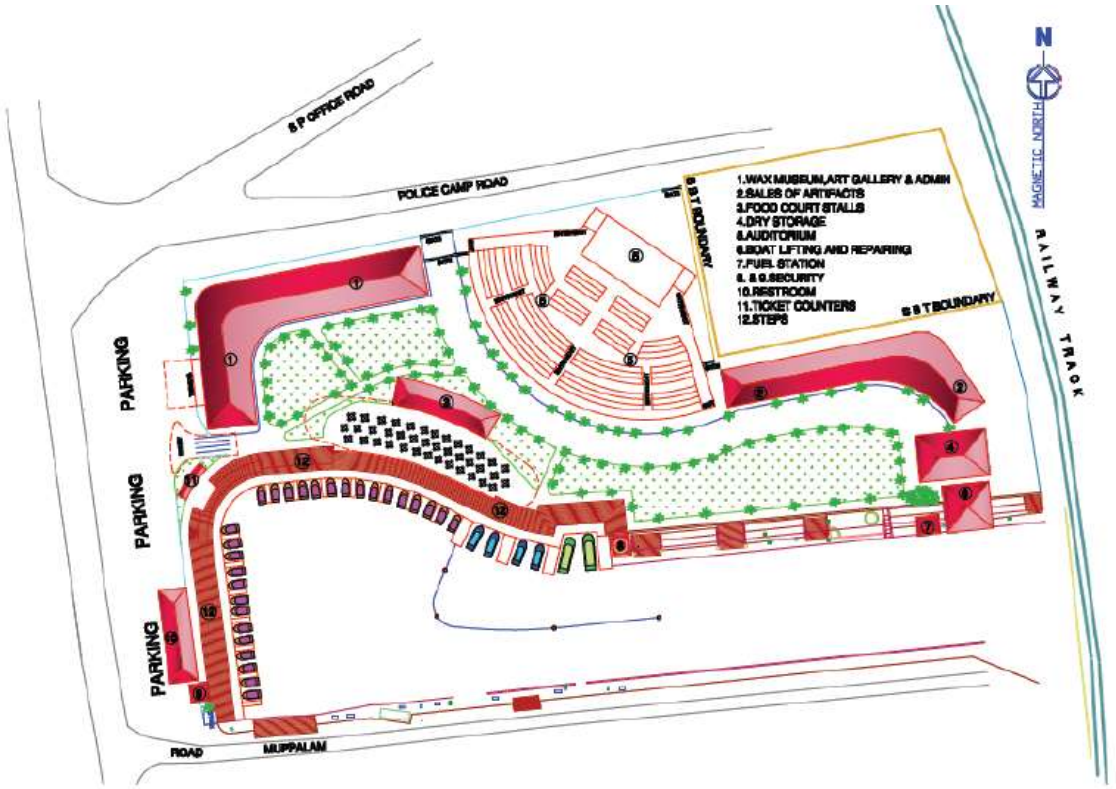


Fig 3.9 Layout Showing Inland Marina and Theme Park

Berthing facilities

It is proposed to provide double berthing facilities using finger piers. A total of 14 finger piers are provided for small boats, 3 finger piers for medium boats and 1 finger pier for large boats. The widths provided for small finger pier and larger finger piers are 1.0m. and 2.5 m. respectively. The lengths for the small, medium and large finger piers are 4m, 6m and 8m respectively. The finger piers should be provided with bollards to tie the boats securely to them. A person landing on the finger pier is led on to a walkway of 2m width. Please note that the number of berths mentioned above is for the traffic expected to come to the marina by 2030. The marina can start with 8 number of small finger berths, 3 numbers of middle size finger berths and 1 large finger berth and the number of berths can be increased as and when new boats are purchased to cater to the increase in the traffic. The width between each small finger piers is taken as 5 meters and 7.2 meters for the larger piers.

Landing facility

The ground surrounding the canal is around 4.0 m above the level of the water in canal. The existing depth at the canal is around 0.6 m. It is proposed to increase this depth to 1.2 m to provide sufficient under keel clearance for the boats to move around in the canal. For negotiating this difference in depth of 4 meters, 16 steps are provided with 0.2 m rise and 0.3m width all around the water area. These steps lead to a walkway of 2 m. width. This walkway leads to the finger berths from where passengers can get on to the boats. A retaining wall needs to be constructed at the interface of water and finger jetties to retain the soil for building the steps and walkway. The finger berths should be made of RCC deck of 150mm thick. The deck rests on beams of size 300mm x 450mm connecting pile foundations. The general span considered for this purpose here is 6m. All the facilities should be designed for a live load of 4.5 kN/m^2.

Other facilities

Two security buildings need to be provided at both ends of the main marina walkways to accommodate security persons. Buildings such as Ticket counter, Fuel stations, dry storage and Boat lifting and maintenance should also be provided for the marina.

Operations

The area of the bigger boats and the small boats should be separated using buoys and markers. The trips by the bigger boats can be planned in such a way that they completely traverse the two channels and the backwaters and come back to the starting location. Such a trip takes around 1.8 hours or 109 minutes. By the end of 2030, 25 trips can be planned by the bigger boats from morning to evening every day with an interval of 15 minute between departures of boats. By planning the departures in this manner it can be assured that sufficient distance is maintained between the boats so that there is no clogging of boat traffic in the channel. The smaller should have departure at every five minutes to achieve the expected traffic figures.

Man power for Marina

The marina can start with a man power of 21 people and later add more personnel as and when required with the growth in traffic.

THEME PARK

The Theme Park is planned in the same plot as the Marina and will provide the visitors a glimpse of the vibrant culture of Kerala. The proposed facility includes an Exhibit area, an Amphitheater, an Artifact space and Open spaces.

Exhibit Area

The area will house a Wax Museum and an Art Gallery. The building will cover an area of 745 m^2 which includes the administration office and ticket counter. The Wax Museum will consist of wax

figures of personalities or installation of art depicting local art forms. The Art Gallery will have paintings by the much acclaimed personalities like Raja Ravi Varma; Kerala Murals which are paintings mainly seen on the walls, ceiling, of temples and palaces showing events of pre-historic times and many themes from Indian mythology.

Amphitheatre

The Amphitheatre or Auditorium with a seating capacity of nearly 650 and will host plays and various performances like Kathakali, Kalarypaiyattu, Mohiniyattom etc. The Auditorium is planned for an area of 1610 m^2.

Artifact Area

The Artifact Area will consist of stalls which will sell the specialties such as handicraft, handloom products and spices of Kerala. The building is planned in an area of 510 m^2.

Open Spaces

Open spaces with landscaping and walkways are essential for any park. The proposed open spaces come up to an area of 2750m^2. The landscaped area will be beautified with varities of trees, gardens, fountains and sculptures. These open spaces can be used by the tourists visiting both Marina and Theme park.

Old Signal Station

The old signal station in the vicinity of the theme park can be refurbished and turned into a museum. Marine related instruments and accessories which were used in the olden days can also be displayed in the centre.

Other Facilities

Facilities like food courts and restrooms are provided. An area of 520m^2 is allotted for table space and food court stalls are occupied by 135 m^2. The food court roofing will be of glass which adds to the beauty and ambience. It will be large compared to table space area so that during rain it shields the entire area of food court and it comes around 745 m^2.

WATER PARK

The proposed Water Park has an area of 6510 m^2 in the midst of natural beauty and a clean environment. It is packed with fun filled activities for all age groups. It is proposed to have water slides, wave pool and lazy river along with other facilities like separate changing rooms, lockers, first aid center, indoor games section and food courts serving various delicacies. The water park will consist of 5 adult slides; each of them will drop the slider in the landing pool and kid's pool. The park will have a special section for the kids with an interactive play area where they can have all the fun

with slides of lesser heights making it safe for them. The park will also consist of a wave pool of length 26.5 m and its shore end will be 22m wide. There will be a machinery room with a complete wave pool mechanism set and an air chamber located at the back end of the pool which will push the water up at regular intervals thus creating waves of maximum 5 ft height. The wave pool is deeper at the end where the wave generating machine is located, from there it shallows down until it reaches zero depth which is the beach area. Approximately 225 KW of power will be required and the initial water requirement will be around 2000 m^3 which will be recycled through filtration system. Later, there will be a daily requirement of water of 2% - 3% of water to make up for evaporation losses. An additional quantity of 40-60 m^3/day should be supplied to the water park to counter the evaporation losses. This water can be sourced from municipality.

Dolphin Pool

The Dolphin Pool is an aquarium meant for dolphins. Normally, the dolphins are kept in a large pool for public performances. The dolphins are trained to do acrobatic maneuvers in the pool on various themes and props. The dolphin pool require expert trainers and life support staff who specialize in its training and daily operations.

Ayurvedic Health Spa

The Spa facility comprises of 140 platforms or enclosures. These enclosures will cater to the ayurvedic massages of various kinds. Specially trained and supervised staff shall be responsible for these massage therapies for the guests. As per the layout, 84 platforms/enclosures will be on the ground floor and 56 platforms/enclosures on the 1st floor, each with an area of 7 m^2.

Restaurants

The pool side restaurant and the terrace restaurant shall be open to guests and normal public. The swimming pool and the sea shore will be visually pleasing for the guests here. These restaurants shall cater to Indian and Continental cuisine.

Sauna & Swimming pool

The guests may also avail facilities like a swimming pool, sunbathing near the swimming pool or the sauna on the 1st floor. A 400 m^2 (20mx20m and 3 m depth) swimming pool is provided for the guests at the forefront. A sauna facility of 200 m^2 is provided on the 1^{st} floor which can comfortably accommodate 10 to 15 people.

WATER SPORTS

There are several rides within the water sports namely: banana boats, water scooters and speed boats. The ideal sailing conditions are variable for all the sporting vehicles. The rides proposed at the planned facility are as follows;

Banana Boats

The demand for such boats at the facility has been estimated to be around one in the initial year of operation and is expected to increase to four by the year 2040. A Banana boat 5.18 m long, 1.3 m wide and having a seating capacity of five can be proposed. These are inflatable and have main tube-like structure on which the riders sit along and rest their feet onto the adjacent smaller supporting tubes. They do not have an automated mechanism for the functioning. Hence they are attached to the water scooters and dragged along. The water depth required for it to stay afloat ranges from 0.46 m to 0.6 m.

Water Scooter

Based on the demand assessment for such rides in the proposed facility, it has been estimated that in the initial year of operation four water scooters would be in operation and is expected to increase to 10 by the year 2040. The water scooters shall be 3.16 m long, 1.62 m wide and have a seating capacity of 2 people (one driver + one tourist). This scooter is run by an out board motor of 25 horse power which can achieve a speed of 12-17 knots.

Speed Boat

A speed boat of length 5.4 m, breadth 1.72 m and a seating capacity of 8-10 people have been planned. This speed boat can achieve a speed of 20-22 knots with a 40 hp engine and 28-30 knots with 115 hp in calm waters. All the above mentioned rides shall have the retrieval and launch from the beach front itself, i.e. it wouldn't have any pontoon like structure for embarking and disembarking. A temporary arrangement such as footboard can be provided for the tourists to get into the speed boats. It is proposed that the boats and water scooters shall be stored in a store house across the beach during the monsoon season. During non monsoon season, it is proposed that the boats be held at the passenger jetties during nights.

Storage Area

The proposed waterside facility will also house a storage space for the above mentioned rides. The area required for a water scooter is approximately 3.4 m^2; banana boat 6.8 m^2 and 9.4 m^2 for a speed boat. The total area required for the storage is 173 m^2. A closed storage shed shall be constructed to store boats and water scooters at ground level. To service the operation at the storage area, equipments such as trailer for stacking and retrieving the boats from water will be used. The storage area will have a single entrance, to cater to the security of the storage and firefighting equipments.

WATER DEMAND AND SUPPLY

Water Demand

The water demand for container berth, ferry berth, container yard and passenger terminal on shore is calculated on the basis of number of tourists supposed to visit and total man power required for all facilities. The per capita water demand for various purposes is calculated as 143 litres (Drinking- 3

litres; Flushing- 25 litres; Restaurants- 70 litres; and Manpower- 45 litres). It is forecasted that 1575 in Phase-1 and 4725 tourists in Phase-2 will visit per day in which 60% are assumed to use the food courts. The total Manpower arrived is around 400 persons. Hence the water demand is calculated as 128 m^3 in Phase 1 (Water demand, Phase 1 =89 m^3; and Flushing demand, Phase 1=39 m^3) and 348 m^3 in Phase 2 (Water demand, Phase 2 = 230 m^3; and Flushing demand, Phase 2=118 m^3).

Water Supply

The components for water supply include over head tanks, sump, pump and pipes. Over head tanks will be synthetic tanks of capacity 5 m^3 each and the number of tanks calculated according to the required water demand and flushing demand. A 40 mm G.I. pipe is used to carry water to the sump. A sump of dimension of 4m x11m x 11m with top covers and wall thickness of 0.35m was provided. Arrangements need to be made with Kerala Water Authority to supply the port with the required water.

Sewage Treatment Plant

Quantity of effluent generated per day determines the capacity of the STP. 80% of the daily water demand is taken as effluent generated per day. For Phase-1 the effluent quantity is 75.6 m^3. For Phase-2 the effluent quantity is 195.5 m^3 (KLD). PVC pipes are employed to carry water to STP and treated water back to overhead tanks for flushing purpose. Assuming that 20 % of the treated water will be lost in the process and the rest will be 150m^3 per day. In that 118 m^3 can be used for flushing and remaining 32 m^3 can be used for watering the landscaping.

Power supply to the container berth and passenger berth

Total load to be connected to the container berth and passenger berth will be equal to 706 KW in the first phase. This means a transformer of 882kva needs to be established to cater to container berth, passenger berth and container yard. For the phase-2 an additional 250 KW load will be required to cater to the facilities. Then a transformer of capacity 1133 needs to be established to cater to the facilities in the second phase.

DESIGN PARAMETERS FOR THE CONTAINER BERTH AND FERRY TERMINALS

Container Berth

The length of the berth should be greater than the length of the vessel. In view of this, a berth of length 175 m is proposed. The deck of the berth is supported on a grid of beams of depth 1 m. Each grid point is supported on a 1.2 m diameter pile. A mobile harbour crane is mounted on the berth to

unload and load the containers. Lanes are provided along the berth for waiting and smooth movement of traffic during the operation. The turning radius required for the trailers (20m) is provided at one end. The island created for the turning radius is utilized by creating an admin block. In the design of berthing facility, the following loads are considered viz., Dead Load, Live Load, Berthing Load, Mooring Load, Earthquake Load, Wave Load and Wind Load.

Trestle

The trestle shall be a deck (12.5 m wide) supported on main beams (12 m span). These main beams shall be connected with cross beams to transfer any unsymmetrical load on the deck, to all the main beams. Crash barriers, designed for vehicular hit, shall be provided along the trestle to avoid any vehicle plunging into the sea. The deck has to be so designed such that, there will not be any major damage due to such incidents. All the main beams rest on the girder, which connect the piles. 5 piles of 1.2m dia. were considered under each girder. The number of piles required can be assessed better after a detailed geotechnical investigation. The cutoff level of the piles shall be at least 1m above the highest high tide. Due consideration has been given for storm surge and free board.

The maximum traffic coming on the trestle is due to the passenger ferry. The ferry berth is to be designed for the following Live loads viz., IRC loading, Berthing loads, Mooring loads, Wave loads and Wind loads. The ferry berth is designed for IRC loading, for the movement of buses. Ferry berths have passenger terminals which will host the passengers. The ferry terminals will be a halt for the passengers who are boarding or alighting the ferries. Passengers are separated based on the time of departure or arrival and are led to the gangways or buses. These terminals will have restrooms, food courts, counters, and other stalls.

INFRASTRUCTURE PHASING

Container berth

144 vessel calls are expected to call at the berth in 2014 and 238 vessel calls are expected in 2040. One mobile harbour crane is sufficient to handle this traffic and its peak capacity is achieved in 2040. Four tractor trailers will be required to handle the containers in 2014 and will be sufficient to handle the same up to 2040. Accordingly, the development of the Container berth will be undertaken during the initial period of the Phase -1 and the infrastructure so established should be able to cater to the traffic projected for the thirty year period.

Container Yard

In the initial year (2014) the container yard handles 53,908 TEUs. Number of containers to be handled increases to 82,998 and 149,457 by the year 2025 and 2040 respectively. Initially one RTG is required in the yard to handle the containers, with its utilization factor being 51% in 2014 and by year 2024, the utilization factor would be 75% , when one more additional RTG would needs to be

provided to handle the containers up to 2040. So the container yard is proposed to be developed in two phases i.e. phase-1 from 2013- 2024 and phase -2 from 2025 –2040.

Passenger Ferry Terminal

In the initial year (2014) traffic estimated is 58,800 passengers. Traffic is estimated to increase to 92,400, 142,800 and 579,000 passengers by 2019, 2025 and 2040 respectively. It is proposed to build two landing pontoons in first phase i.e. from 2013 to 2024 and add three more landing pontoons in phase-2 i.e. from 2025 to 2040. Similarly a terminal building of area 600m^2 in first phase needs to be augmented by another building of area 940 m^2 in second phase. 6 buses need to be purchased in first phase and 9 additional busses in phase-2.

Traffic Flow Assessment

There is currently a two lane national highway which runs along the proposed facility .The NH road at present is not fully operational and is expected to be operational by 2011. It can be estimated that the existing NH road along the facility has a life of 30 years and is designed to handle a maximum of 2400.

CHAPTER 4

ENVIRONMENT EXAMINATION AND ANTICIPATED ENVIRONMENTAL IMPACTS

The present study was carried out through both primary as well as secondary data collection. Various sources of pollution with respect to wastewater, the process emission, hazardous waste and noise generation along with their qualitative and quantitative analysis as well as measures taken to control them are discussed herein with details. The network method was adopted to identify potential impact, which involves understanding of cause-condition-effect relationship between an activity and environmental parameters. An impact can be defined as any change in physical, chemical, biological, socioeconomic environment that can be attributed to activities related to alternatives under study for meeting the project needs. The nature of the impacts due to said project activities are discussed here in detail and the impact is quantified using numerical scores 0, 1, 2, 3, 4 and 5 in increasing order of activity. In order to assess the impact accurately, each parameter is discussed in detail covering the project activities likely to generate impact; and quantification and prediction of impact.

LAND ENVIRONMENT

The possible impact of the project components on land environment is shown in Fig 4.1.

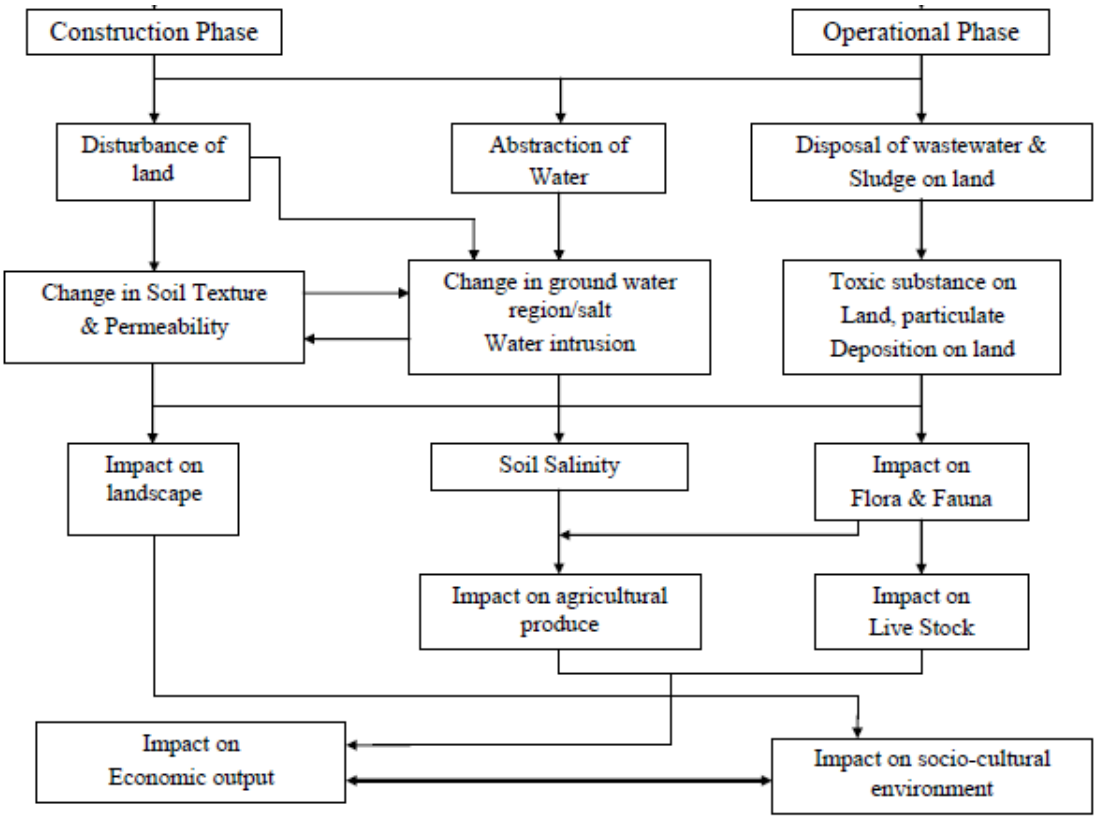


Fig 4.1 Possible Impacts on Land Environment

Construction Phase Impacts

The proposed project activities are within the premises of Port Department and there will not be any cutting of trees at the site. Since this area is not a significant habitat of valuable flora or fauna, adverse impacts on the ecological environment are considered to be minor. As the proposed activities shall be on a non-agricultural land, it shall not alter the crop production of the area. Further, necessary environmental protection measures have been planned under EMP e.g. air pollution control systems shall be designed to take care of even emergency releases of the gaseous pollutants and regular environmental surveillance shall be done, so as not to have any short-term or cumulative effect on the crops and the natural vegetation of the area.

Operation Phase Impacts

As the proposed activities are done in an area where there is no significant flora or fauna, adverse impacts on the ecological environment are considered to be minor. The Port authorities need to develop a green belt on the surrounding periphery.

WATER ENVIRONMENT

With respect to water environment three aspects are generally considered in Rapid EIA, the raw water availability, consumption and wastewater generation that has to be disposed. The first priority in water quality assessment is to maintain and restore the desirable level of water quality in general. The possible impact of the Project component on land environment is shown in Fig 4.2.

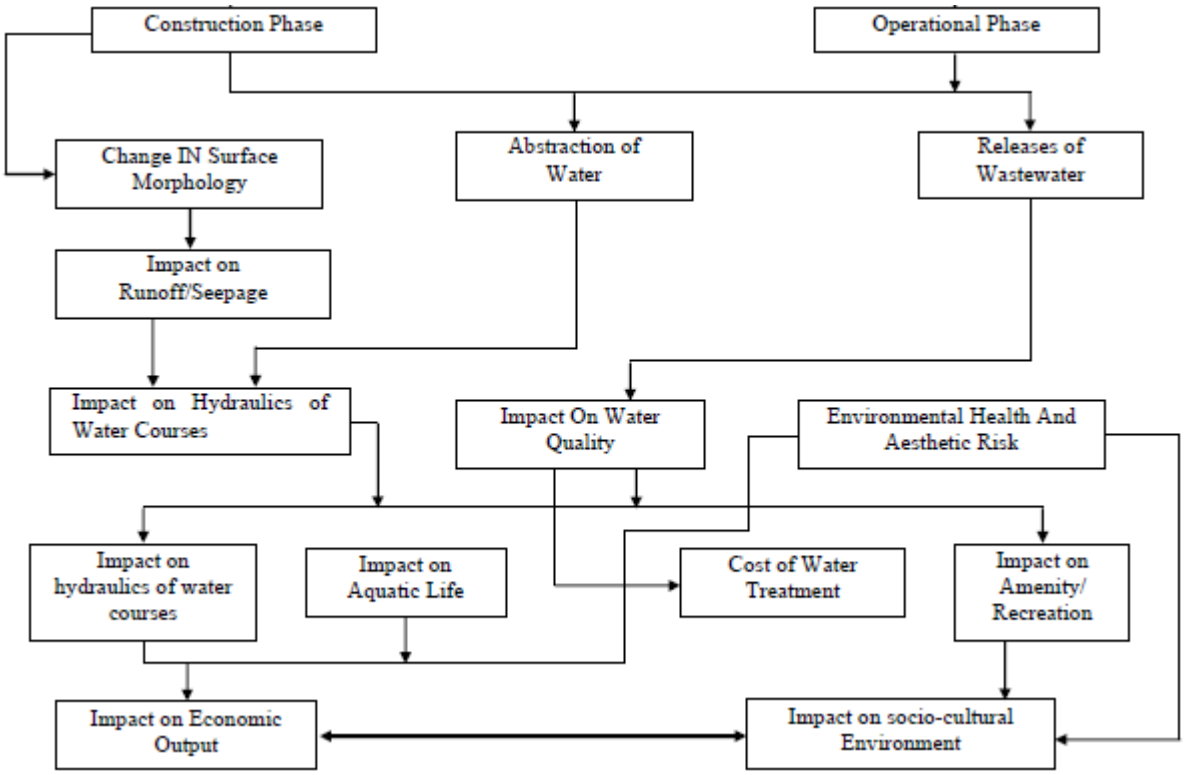


Fig 4.2 Possible Impacts on Water Environment

Construction Phase Impacts

As the Port and Inland Marina will be constructed with various facilities, impacts will be anticipated. During Construction**,** drainage pattern and water supply system of overland water flow will be somewhat changed. Potential impacts on surface water quality during this phase could arise from dust emissions (from vehicles and disturbance of soil); such Suspended solids can be controlled by sprinkling water and by employing enclosures to construction area to allow the particles to settle down, prior to discharge. There would be no significant effect on water quality and quantity during construction phase.

Operation Phase Impacts

Water requirement shall be met from water supplied by KWA and the details of water consumption are given in Chapter-3. Thus, it can be concluded that there will not be any significant adverse impact on the water environment. Ships calling at the port might generate oily wastewater such as bilge water. Other solid and liquid wastes will also be generated by the port community including ships' crews. A waste reception facility will be established to deal with such liquid and solid wastes. Oily liquid wastes are expected to be handled by third parties. Solid wastes generated at the port area will be collected and disposed of by the Port Authority. Sewage generated at the port area will be treated in septic tanks.

AIR ENVIRONMENT

The possible impact of the Project component on air environment is shown in Fig 4.3.

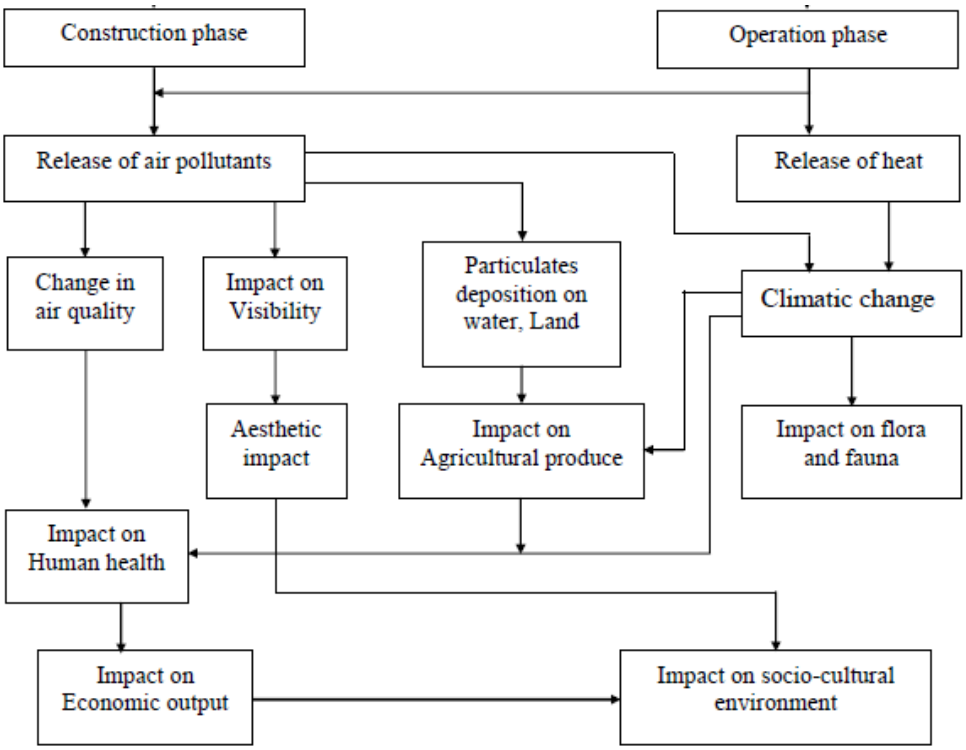


Fig 4.3 Possible Impacts on Air Environment

Construction Phase Impacts

Generally Construction phase involves site cleaning, excavation, construction, erection or installation of equipment and machinery, transportation, material handling,etc. Dust will be the main pollutant affecting the ambient air quality of the surrounding area during the construction phase. Some construction work like piling and demolition may generate dust, noise, and vibration. However, since these temporary works will be confined to the port area and there are few residences near it, disturbance to local people will be minimal. The pilling of sand will be done uniformly and proper storage will be maintained to avoid dusting because of wind. Fume generation will be there due to welding and allied activities; this impact will be negligible and restricted to project site. Motor vehicle transportation (to, from and around the site) particularly the traffic of trucks at the site, material movement into the site will introduce particulates and other exhaust gases into the local ambient air and there is some likelihood that during the construction period local air quality may be temporarily affected by these emissions. However, these activities will be intermittent and hence, significant adverse impact is low. Providing suitable surface treatment to ease the traffic, flow and regular sprinkling of water will reduce the fugitive dust generation significantly.

Operation Phase Impacts

Potential sources of air pollution are ships and vehicles for the transportation of cargo and other port operations. However, such impacts will be limited to the hours of port operation, and the intensity will be relatively low; hence no significant impacts are anticipated. Also, no dusty or hazardous cargo will be handled in the port. Competent authorities should strictly monitor all operational phase activities and rules and regulations should be strictly adhered to. All environmental parameters must be checked regularly by an Environmental Safety Officer and should be maintained within permissible limits.

NOISE ENVIRONMENT

The possible impact of the Project component on noise environment is shown in Fig 4.4.

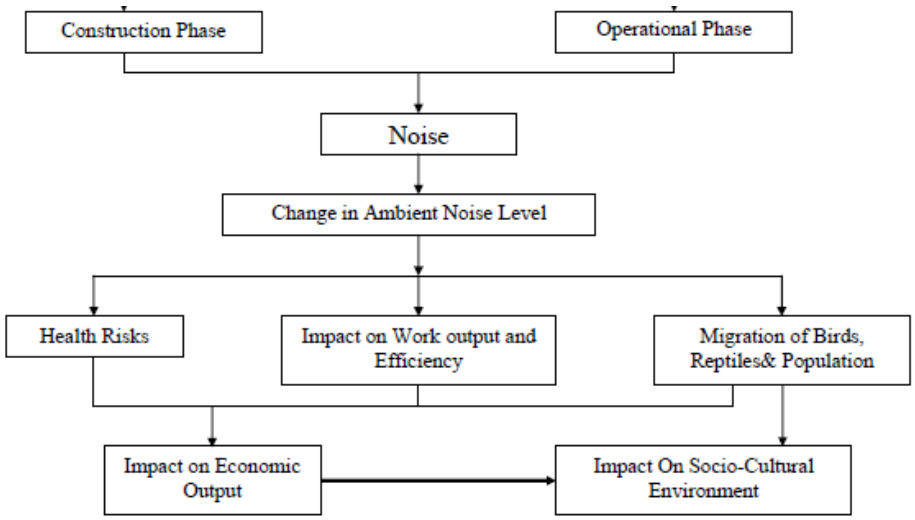


Fig 4.4 Possible Impacts on Noise Environment

Construction Phase Impact

Some construction work like piling and demolition may generate dust, noise, and vibration. During construction, construction equipment, including dozer, scrapers, concrete mixers, generators, vibrators and power tools, and vehicles will be the major noise sources. Most of construction activities are expected to produce noise level within the prescribed limit. The noise generated from various sources will be of short duration. Therefore, no significant impact is envisaged on the construction force and since these temporary works will be confined to the port area and there are few residences near it, disturbance to local people will be minimal.

Operation Phase Impact

During the operational phase, transportation activities will increase and also the ambient noise will get affected due to the various operational activities like berthing, unloading, auctioning and transportation. The impact of noise depends mainly on the characteristic of the noise generating sources, topography and atmospheric conditions. Vehicular movements during operation phase for loading/unloading of raw and finished materials and other transportation activity may increase noise level. The noise generating sources will be enclosed with acoustic proof material to cut down the noise levels. Further, green belt will be developed in and around the proposed plant. So, the significant adverse impact of noise will be minimized. Even though all the operational activities will affect the noise quality, the impacts are considerably negligible and will not cause much direct or indirect harmful effect on any living form around the area. Authorities should strictly monitor all operational phase activities and rules and regulations should be strictly adhered to. All environmental parameters must be checked regularly by an Environmental Safety Officer and should be maintained within permissible limits.

BIOLOGICAL ENVIRONMENT

The impact due to the project and its activities on the ecological parameters like terrestrial environment, fisheries and aquatic life, forests and species diversity is summarized as below.

Terrestrial Environment

No endangered or endemic plant species were recorded in the region during the field survey. Since the project area is not a significant habitat of valuable flora or fauna, adverse impacts on the ecological environment are considered to be minor.

Marine Environment

The major port related activities that could bring any change in the biological communities are: Capital dredging during construction and maintenance dredging during operation; offshore disposal of dredged material mainly during the construction phase; Construction of breakwaters and Wharves; Construction of shoreline protection groins; Anchoring of Vessels; Oil spill; and Discharge of solid and liquid waste. 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 environment damages the ecosystem/habitats which are formed by the extra cellular product of symbiotic plants. Piles, concrete surfaces, rubble mounds and other similar structures in water could form new habitats, which would help substratum for sedentary species.

Forest, National Parks / Sanctuaries

There is no Reserved Forest, National Park or Wildlife Sanctuary within 10 km radius of the Port area. As the project site is not situated within or adjacent to any protected areas, buffer zones of protected areas, or special areas for protecting biodiversity, there shall be no impact on the same.

Places of Archaeological/ Historical Interest

There is no place of archaeological or historical interest within the study area i.e.10 km radius of Port area. Hence, there shall be no impact on places of interest

SOCIOECONOMIC ENVIRONMENT

To evaluate the socio-economic aspects of *the* local fishing community, informal consultations were carried out covering all the fishermen hamlets in the area. The survey results indicate that the majority of local community strongly favours the construction of a Port. A few people, who occupy the southern end of the proposed area, expressed their apprehension over quitting their occupied area. In addition to direct employment; indirect employment shall generate ancillary business to some extent for the local population. Also, the construction activities will provide some business opportunities for suppliers of materials and transportation, and for traders to cater to the employees' requirements such as food, daily needs, and medical care. There is a positive effect due to improved communication and health services, which have lead to economic prosperity. There shall be no displacement of any population in Port area. Hence, there is no permanent impact on this account. The increasing industrial activity will boost the commercial and economical status of the locality up to some extent.

DREDGING

Direct Impact

The proposed construction of Alappuzha Port and Inland Marina involve dredging of substrate. Table 4.1 summarizes the potential impacts related to dredging operations at Alappuzha Port and Inland Marina. The main impacts associated with dredging and disposal activities relate to direct loss of habitat of aquatic biota. Capital and maintenance dredging leads to increase in fine sediment suspension in the waters which results in increasing sediment deposits in marine habitats, and a lowering of light conditions. It is likely that the spread of these sediments is dependent on a combination of particle size, local current patterns and weather conditions. The penumbra of influence of the dredging operations is likely to extend far beyond the dredging zone itself, and may increase the sediment and nutrient loads in nearby marine systems. Secondary effects are related to the formation of sediment plumes, which may affect fish or benthos because of the smothering and

clogging effect of highly turbid waters on the gills of bivalves or fish, inability to detect predators or the limiting of the photosynthetic process in plants. Nets placed in very silty areas tend to accumulate fine mud particles on their weave, and fish can see the net and avoid it or they slide easily off the net instead of becoming entangled in its mesh.

Table 4.1 Dredging – Summary of Potential Adverse Environmental Impacts

Activity	Potential negative impacts	Direction		Impact Significance	Mitigation Possible	Duration		Location		Magnitude		Extent	
		Positive	Negative			Long	Short	Direct	Indirect	Large	Small	Wide	Local
Dredging	Loss of benthic biota		✔ *	Mod^	No	✔		✔		✔			✔
	Modification of current & wave pattern		✔	Low	No	✔		✔			✔		✔
Sediment disturbance and overfilling of dredger	Settlement of suspended solids		✔	Mod	Yes		✔		✔		✔		✔
	Attenuation of light in water column		✔	Low	Yes				✔		✔		✔
	Dispersion of contaminated sediments		✔	Low	Yes		✔		✔		✔		✔
	Degradation of pelagic habit		✔	Low	Yes		✔		✔		✔		✔
	Damage to fishing gear		✔	Low	Yes		✔		✔		✔		✔
Presence / location of dredges	Increased ambient noise level		✔	Low	Yes		✔	✔			✔		✔
	Impaired visual aesthetics / seascape		✔	Low	Yes		✔	✔			✔		✔
	Hindrance to other boat traffic		✔	Mod	Yes		✔	✔			✔	✔	
Leakage of sediments during transportation	Increased turbidity over sensitive inshore habitats		✔	Mod	Yes		✔		✔		✔		✔
Reclamation	Sedimentation of deep-water benthic habitat		✔	Mod	No		✔		✔		✔	✔	
	Degradation of pelagic habitat		✔	Mod	No		✔	✔			✔	✔	

* The ✔ mark indicates the existence of impact, ^ Mod - Moderate

The adverse effects of capital dredging and construction work could be minimized by appropriate selection of equipment in pile driving and dredging, proper use of silt curtains, careful planning of settling ponds and overflow weirs for reclamation and landfills and suitable transport of construction materials and dredged material. Proper disposal of dredged material plays a critical part in preserving the environment. The dredging method will have the greatest influence on impacts related to loading. Overflow dredging techniques may produce turbid plumes at the dredged site, however, management techniques, such as discharge at water level or below, can greatly reduce turbidity. Targeting particular tidal conditions can also reduce the impacts at sensitive receiving environments.

Specialised dredge equipment, such as turtle-excluding devices or silt curtains, can reduce the likelihood of impacts, particularly from mobilisation of contaminated sediment. Silt curtains are ineffective in high wave or current conditions, and are likely to be impractical in large scale dredging. Visual inspections will be undertaken in order to note the extent of sedimentation and siltation from the activity, and in order to determine further adjustments. In the event of sediment plume moving away from the immediate site, then work will be halted until conditions for wave action improve.

The turbidity induced during the dredging can be minimized using controlled dredging techniques using appropriate bucket/cuter suction dredgers. The net enclosures with booms may be placed around the dredging area in order to control the spread of the turbid plume. The lowering of buckets can be done slowly in order to avoid accidental impact on the fishes.

In order to minimize effect on sub tidal benthic community while dredging, the controlled method of dredging may be carried out confined to only port area. The main mitigation measure is to limit the period of dredging to as short as possible by avoiding delays once the dredging commences. Another measure to reduce the period of impact is to operate the dredge in a standard overflow mode. Requirements of maintenance dredging and cycle of such maintenance dredging should be arrived, based on appropriate studies including physical/mathematical models. Areas for disposal of materials from maintenance dredging should be identified by proper studies including modeling. Quality of dredged spoil should also be monitored during operational period.

Excavation and Sediment Dispersal

The rotary action of the dredger and the dragging of the suction pipe along the bottom will disturb the substrate and place sediments into suspension. These suspended sediments may then smother nearby bottom-living flora and fauna as and when they settle. The effect will be significant in areas with fine sediments, which are more easily placed into suspension. The suspension of sediments would be minimized to the extent that the powerful suction pumps on the dredgers are able to suck up these materials out of the water column.

Water Turbidity

The suspension of fine sediments in the water column creates turbidity, which scatters and attenuates light levels and potentially affects the growth of plants indirectly by reducing the availability

of light and consequently the photosynthetic process in plants. High levels of localised turbidity can be expected during dredging of the mud in the basin area. Due to the weak water currents in this part of the basin, the turbidity is not expected to move very far. From our study, there is no sensitive biota in the vicinity of the area to be adversely affected by light attenuation. It should also to be noted that the turbidity regularly occurring in the harbour after prolonged rainfall, would potentially have a much more deleterious effect than that caused by the proposed short-duration dredging works.

Dredger Spillage and Leakage

Deliberate spillages: It is a practice in some dredging operations to maximize the amount of solid material in the hopper hold by allowing the slurry water mixed with the dredged material to overflow from the vessel. In the case where fine sediments are being dredged, this results in high turbidity of the water surrounding the vessel, which could then be transported by surface water currents over sensitive habitats. A second means of deliberate spillage occurs when the bottom gates of the hopper hold are opened slightly so as to release sediments while the vessel is on route to the reclamation site. However, in Alappuzha as the dredging and reclamation site are very close to each other, this potential impact is not expected to occur.

ii. Accidental spillages*:* The amount of material leaking from the bottom gates of a dredger would normally be insignificant. However, if a hard object or rock becomes lodged between the gates, then material will steadily spill out of the holder into the water column. In some cases measures can be taken to avoid or reduce the severity of the impact, and the appropriate mitigation measures are identified. In other cases the impacts cannot be avoided or successfully mitigated if the project is implemented and these represent irreversible impacts.

INGRESS OF SEA WATER INTO CANALS

Although introducing saline water with salinity levels more than 7 ppt in the canals appears to be the most effective and economical solution, there are many adverse impact which need to be studied in detail before implementing the same. It is proposed to set up a sump for saline water on the beach and there by pump this water into pipe lines which will run along the length of the canals.

Kuttanad region which represents the low-lying lands is often termed as the *rice bowl* of the state. Originally it was part of the coastal area of the Arabian Sea, which became a shallow bay due to a geological uplift. The incessant inflow of silt carried by the rivers Meenachil, Pamba, Achencoil and Manimala over thousands of years accumulated in this shallow bay and gradually made it an extensive brackish water lagoon and backwater system extending from Alappuzha in the south to Kochi in the north. By considering the rainfall pattern of Alappuzha region, which receives rain throughout the year except for the month of January and February (See Table 2.1), the damage costs of saline intrusion to farmers due to the proposed ingress of sea water into canals are very hard to quantify. Soil salinity is one of the principal limiting factors in crop production, especially for rice, as crops are intolerant of salinity in the soil and water beyond 0.4% or 4 grams per litre. Salinity intrusion also restricts the use of canal water for domestic and industrial uses and causes corrosion of all

metal materials in engines, construction artifacts and elsewhere. As an impact, more saline intrusion has to lead more salinity in groundwater layers. The intrusion of salinity in to the larger backwaters towards the eastern side of the canal and the change in salinity level of the backwaters will affect the flora and fauna of the system in addition to the above mentioned areas.

SUMMARY OF IMPACTS

Port construction, Inland Marina and its associated activities and their probable impacts on the various ecosystems and environmental processes have been outlined in detail in the previous sections. These are summarised in Tables 4.2, 4.3, 4.4 and 4.5. The various impacts can be reduced considerably through proper mitigation measures and implementing Environmental Management Plan, including good house-keeping practices.

Table 4.2 Environmental Impact Matrix – Construction Phase

Activities / Impact on	Dredging	Excavation and Sediment Dispersal	Breakwater construction	Container & Passenger berth	Construction of yards	Transportation of Raw materials	Power supply	Water supply
Landscape	1	1	2	1	1	0	2	2
Ground water	0	0	0	0	0	0	0	0
Surface water	1	1	0	0	0	0	0	2
Air quality	1	2	2	2	2	2	0	0
Noise quality	2	1	2	2	2	2	0	0
Flora	2	1	1	1	1	0	0	0
Fauna	2	1	1	1	1	0	0	0
Settlements	0	1	0	0	0	2	1	2
Transportation	0	0	0	0	0	2	0	0
Economy	+2	+2	+2	+2	+2	+2	+2	+2
Tourism	1	1	2	2	2	2	+2	+2
Culture	0	0	0	0	0	0	0	0
Employment	+2	+2	+2	+2	+2	+2	+2	+2
Aesthetic	1	2	2	2	2	1	2	2
Health & Safety	2	2	2	1	1	2	1	0

0 = no impact, 1 = low impact, 2 = moderate impact, + = positive impacts

Table 4.3 Environmental Impact Matrix – Operation Phase

Impact on	Anchoring of vessels	Loading & Unloading	Transportation	Urbanization	Immigration	Settlements
Landscape	2	2	2	2	2	2
Ground water	0	0	0	0	0	0
Surface water	1	2	1	2	0	0
Air quality	2	2	2	2	1	1
Noise Level	2	2	2	2	1	1
Flora	1	0	0	2	1	2
Fauna	1	0	0	2	1	2
Transportation	+2	+2	0	0	0	0
Economy	+2	+2	+2	+2	+2	+2
Tourism	2	2	2	1	1	1
Culture	1	1	0	0	1	0
Employment	+2	+2	+2	+2	1	0
Aesthetic	2	2	0	2	0	0
Health & Safety	2	2	2	0	1	1

0 = no impact, 1 = low impact, 2 = moderate impact, + = positive impacts

Table 4.4 Environmental Impact Matrix – Activities pertaining to Inland Marina

Activities / Impact on	Capital Dredging	Excavation and Sediment Dispersal	Land Development	Ingress of Sea water into Canals	Construction Activities	Transportation of Raw materials	Power supply	Water supply
Landscape	1	1	2	1	2	0	2	2
Ground water	0	0	0	2	0	0	0	0
Surface water	1	1	1	2	2	0	0	2
Air quality	1	2	2	0	2	2	0	0
Noise quality	2	1	2	0	2	2	0	0
Flora	2	1	1	2	1	0	0	0
Fauna	2	1	1	2	1	0	0	0
Settlements	0	1	0	2	0	2	1	2
Transportation	0	0	0	0	0	2	0	0
Economy	+2	+2	+2	2	+2	+2	+2	+2
Tourism	1	1	2	+2	+2	2	+2	+2
Employment	+2	+2	+2	+1	+2	+2	+2	+2
Aesthetic	1	2	2	2	2	1	2	2
Health & Safety	2	2	2	2	1	2	1	0

Stakeholder Consultation

Stakeholder consultations helped us to incorporate the views and ideas of the local population regarding the Port and Inland Marina, its impacts – be it positive or negative. Major stakeholders like fish catchers, fish sellers, boat owners and the like were given the opportunity to openly express their views regarding need for a harbour and its positive and negative impacts. The views and suggestions expressed by the community were considered and critically analyzed by the study team. A critical analysis of the opinion from the community points to the fact that the majority of the community is in favour of constructing the Port. A few groups had the apprehension that the construction of Port may lead to their evacuation from the presently occupied areas.

Table 4.5 Project Activities and its Impacts

Sl. No.	Environmental Attributes	Project Activity	Nature of Impact
1.	Landscape	• Construction work • Transportation	Minor degradation Minor degradation
2.	Ground water resource	• Civil works	No major effect
3.	Water Quality	• Waste Disposal • Oil Leakage	Major impact Major impact, but infrequent
4.	Air Quality	• Transportation • Civil Works	Temporary effect Temporary effect
5.	Noise Quality	• Dredging & Reclamation • Civil Works • Transportation • Working Phase	Temporary impact Temporary impact Temporary impact Permanent impact
6.	Natural Vegetation	• Site Clearing	Permanent impact, but not significant
7.	Natural Fauna	• Construction works	Permanent impact, minor
8.	Transportation	• Increased access for transportation of Port	Degradation due to emission of exhaust from transportation vehicles
10.	Economy	• Increased economic activities	Financial status of the local people as well as government will improve
11.	Tourism	• During the construction & operational phase	Negative, but minor
12.	Employment	• During the construction & operational phase	Positive
13.	Aesthetic	• During the construction & operational phase	Will alter the scenic beauty
14.	Hazard	• During the construction & operational phase	Chances of fire and occupational hazards

CHAPTER 5

ENVIRONMENT MANAGEMENT PLAN

Formulation of Environmental Management Plan is one of the key criteria for the success of any type of project. This requires detailed study about the various factors of the project and its impact on the environment and it is based on this environmental impact study that future management plan has to be generated. It is necessary to provide detailed description for the proposed measures, indicate how they would actually be put in place and proposes how they might be modified if unforeseen post-project ecological impacts manifest themselves. Two aspects viz., the impact of the project on the environment and the action plan for limiting the environmental impacts, need to be considered in formulation of Environmental Management Plan of any development project including the construction of ports.

MITIGATION

Though the proposed activities on the port and inland marina development lead to certain adverse impacts on short term and long term basis on the marine environment, there is sufficient scope for taking up the mitigations measures.

i) Construction of Breakwaters, Berths and Yards and Inland Marina

The construction of breakwaters and other components, its interference with the littoral drift and the anticipated change in shoreline are modeled. During the construction of breakwaters, the sub tidal benthos will get temporarily disturbed. It will be a temporary phenomenon, and the benthos is expected to re-colonize once the construction is over. In order to limit the damage at initial stage, the bed should not be disturbed much. Explosives should not be used. The construction materials should be placed one above another by using proper hoisting machineries and should not be dropped on the seafloor. Once the breakwater is built, the honey comb voids in it would serve as a suitable substratum for marine flora and fauna. The change near shore current due to obstruction caused by the breakwaters will be for initial period and the sea bed will adjust itself for the new flow regime. There should not be any sudden increase in flow velocity close to the shore, which will pose danger for the human being and fishing boats. Beacon lights are to be fixed along the breakwater alignment, so that the boats can sail safely at night.

ii) Dredging

In order to minimize destruction on sub tidal benthic community while dredging, the controlled method of dredging may be carried out confined to only port area. The turbidity induced during the dredging can be minimized using controlled dredging techniques using appropriate bucket/cuter suction dredgers. The net enclosures with booms may be placed around the dredging area in order to control the spread of the turbid plume. Regular monitoring of the turbidity and sediment concentration may be carried by water sampling and OCM satellite imageries. The lowering of buckets can be done

slowly in order to avoid accidental impact on the fishes. Regular monitoring on the heavy metals in the water column may be carried out during dredging in order to watch any rise in concentration due to dredging. The dredge spoil disposal will also cause temporary displacement of sea bottom living communities.

iii) Spillage during Cargo Handling

In order to avoid any spillage of cargo into the sea, it is essential to handle the entire operation in more controlled manner with sophisticated hoisting equipments. The trained and certified crane operators are to be employed. In order to avoid wind drift, it is essential to plan all stack yards on the down drift side after studying the predominant wind direction.

iv) Port and Inland Marina Installations

All port and Inland Marina installations on the shore in connection with handling, stacking, offices and other facilities may be located and constructed as per the CRZ regulations.

The proposed activities in marine environment under this project will have impacts on: i) Coastal morphology, ii) Marine ecology, iii) Seawater, iv) Land use and v) Community. In a broad sense, the construction of breakwater and berths and yards would affect the down drift shoreline, littoral drift, near shore flow and in turn the sea bottom initially. The sea bottom living organisms would get affected during the construction period. The dredging in the port region would initially destroy sub tidal benthic communities and the turbidity induced during dredging will affect the sea water quality and marine life. During berthing of ships and loading bulk cargoes, there can be a spillage into the sea, which may change the water quality and damage the marine living organisms.

iv) Ingress Sea water into Canals

Although introducing saline water with salinity levels more than 7 ppt in the canals appears to be the most effective and economical solution for water hyacinth eradication, there are many adverse impact which need to be studied in detail before implementing the same.

Suggested Mitigation Activities

1. Green Buffer Zones, wherever possible, should be encouraged in and around the Port and Inland Marina area.
2. An Environment Cell should be made operational within the port area with adequate facilities/ equipment/ mobile van/boat for collection and analysis of air, water, solid waste samples,etc. Immediate corrective measures should be taken if level of any constituent is higher than the prescribed limits.
3. Dredging and reclamation operations should be, undertaken only where it can be conclusively proved that these are required for operation purposes related to the activities permissible under Coastal Regulation Zone Notification. These operations, wherever necessary, should be undertaken in consultation with reputed institutes such as Central Water and Power Research

Institute, Pune, National Institute of Oceanography, Goa,etc., which in turn should ensure that environmentally safe technologies/practices are adopted to minimise adverse environmental impacts.

4. Best practicable technology and operating methods should be used for dredging/ reclamation to minimise adverse environmental impact.
5. Disposal of dredged material should be on the basis of proper scientific/ modeling studies at designated sites and during fixed time interval so that there are no damages to surface, ground water quality and marine productivity. Dumping of dredged material on coast should not be permitted in case it is likely to cause adverse impact on marine ecology.
6. Disposal sites should be so chosen that dumping should not cause interference with the natural drainage.
7. During dredging, construction and maintenance stages, water quality parameters should be inspected at different levels and periodic records maintained. Tests should be carried out to measure water quality parameters such as turbidity, dissolved oxygen, ammonia, nitrogen and other nutrients so as to ensure that these are maintained within the prescribed limits.
8. Screening of the pollutants in the harbour waters should be undertaken and periodical reports and water quality parameters should be forwarded to the State Pollution Control Board/Committee at least once in six months.
9. Temporary bunds should be constructed to contain surface run-off from the land sites. Collected run-off should be passed through retention ponds to collect suspended solids before discharge.
10. It should be ensured that proper treatment facilities are available and the quality of treated effluents, emissions and solid wastes conform to the standards laid down by the Centre/ State Pollution Control Board.
11. To prevent discharge of sewage, oily wastes and other liquid wastes into marine environment, adequate system for collection, treatment and disposal of liquid wastes including shoreline interceptor for receiving liquid wastes from the shoreline installations and special connections to receive wastes from ships must be provided.
12. It should be ensured that effluents/wastes from ships/barges are not discharged into sea, in accordance with national/international laws.
13. Some special arrangements wherever necessary for dusty cargo can be made to avoid pollution.
14. Burning of wastes should not be permitted.
15. Adequate noise control measures must be taken to maintain levels within prescribed limits in the work places as well as port areas to avoid adverse effects on the workers as well as marine life.

PROPOSED SCHEDULE OF ENVIRONMENTAL MONITORING

Environmental monitoring programme is a vital process of any management plan of the development project. This helps in assessing the potential problems that resulting from the proposed project, changes in environmental conditions and effectiveness of implemented mitigation measures. Continuous monitoring needs to be carried out for regulatory permit requirements, environmental effects and performance of EMP implementation. Monitoring programme has to be continued during the construction and operational phases of the port. It should be repeated at periodic intervals after the commencement of the project, when the project is fully operational. The monitoring has to be organized with qualified and experienced environmental team. Wherever the automation is possible in measuring the quality of discharged water, it has to be implemented. Standard procedure shall be followed in sample collection and analysis.

Parameters to be monitored

a) *Underwater ecology:* Once in a year the sea bottom fauna by engaging divers.
b) *Water quality:* Sampling can be carried out at 3 depths if the depth is exceeding 10 m. The parameters which are to be analyzed are: temperature, salinity, pH, dissolved oxygen, BOD, nutrients like ammonia, nitrite, nitrate and inorganic phosphate.
c) *Biological parameters:* Phytoplankton population, zooplankton population, benthic fauna, seaweeds, and the nature of fisheries in the area.
d) *Shoreline:* The shoreline for 5 km on either side of the breakwater has to be monitored.