ANNEXURE - 2

EIA FOR HONNAVAR BARGE/VESSEL LOADING FACILITY

UTTARA KANNADA DISTRICT
KARNATAKA

FINAL EIA REPORT

FEBRUARY - 2012

TRUE COPY

PREPARED BY

RAMBØLL

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Port Sub-division, Honnavar
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SUBMITTED TO

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C1111304
RP003, Rev 0

RAMBØLL	**L&T-RAMBØLL CONSULTING ENGINEERS LIMITED**
Client:	**Honnavar Port Private Limited**
Project:	EIA for Honnavar Barge/ Vessel Loading Facility
Project No.:	C1111304
Title:	Final Environmental Impact Assessment Report
Document No.:	RP 003
Rev.:	0

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0	27.02.2012	First submission	PBC BRT SAP		PBC BRT SAP		CVS	

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Declaration by Experts contributing to the EIA for Honnavar Barge/Vessel Loading Facility

I, hereby, certify that I was a part of the EIA team in the following capacity that developed the above EIA.

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Name: C.V. Sundara Rajan

Signature & Date: 27.02.2012

Period of involvement: August 2011 – February 2012

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S. No.	Functional Areas	Name of the expert/s	Involvement (Period & Task**)	Signature & Date
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2.	**WP**	C. V. Sundara Rajan B. Ratheesh		27.02.2012
3.	**SHW**	P. Balachander		27.02.2012
4.	**HG**	C. V. Sundara Rajan		27.02.2012

S. No.	Functional Areas	Name of the expert/s	Involvement (Period & Task**)	Signature & Date
5.	**AQ**	B. Ratheesh	Provided the required input for specific functional areas of expertise (August 2011 – November 2011	27.02.2012
6.	**NV**	P. Balachander		27.02.2012
7.	**LU**	Y. Rama Mohan		Dr. Y. RAMAMOHAN Ph.D 27.02.2012
8.	**SE**	Dr. Latha Bhaskar		27.02.2012
9.	**RH**	Susruta Amirapu		27.02.2012

Declaration by the Head of the Accredited Consultant Organization

I, C.V. Sundara Rajan, hereby, confirm that the above mentioned experts prepared the EIA for Honnavar Barge/Vessel Loading Facility. I also confirm that I shall be fully accountable for any mis-leading information mentioned in this statement.

Signature: 27.02.2012

Name: C.V. Sundara Rajan

Designation: City Office Manager & Head of Environment

Name of the EIA Consultant Organization: L&T RAMBØLL Consulting Engineers Limited
NABET Certificate No. & Issue Date: Provisional Accreditation as per QCI-NABET Letter Dated April 18, 2011

S. No.	Functional Area Code	Complete Name of the Functional Areas
1.	**AP**	Air Pollution Prevention, Monitoring & Control
2.	**WP**	Water Pollution Monitoring, Prevention & Control
3.	**SHW**	Solid & Hazardous Waste Management
4.	**SE**	Socio- Economic Aspects
5.	**EB**	Ecology and Biodiversity
6.	**HG**	Hydrology, Ground Water & Water Conservation
7.	**GS**	Geology & Soil
8.	**AQ**	Meteorology, Air Quality Modeling & Prediction
9.	**NV**	Noise &Vibration
10.	**LU**	Land Use
11.	**RH**	Risk & Hazards Management

Chapter 1
Introduction

1 Introduction

1.0 Background

The state of Karnataka is the eighth largest state in the country covering an area of 1,92,000 sq km with a population of 52.73 million in 2001. Karnataka owns a maritime coastline of 155 nautical miles studded by ten minor ports between Karwar in the North and Mangalore in the south, flanked by Uttara Kannada, Udupi and Dakshina Kannada districts. The ten minor ports of the coast are Karwar, Belekeri, Tadri, Honnavar, Bhatkal, Kundapur, Hangarkatta, Malpe, Padubidri and Old Mangalore. Among these ten ports, Karwar is the only all weather port while the other nine are riverine anchorage ports. The entire coastal belt as well as the adjacent districts are rich with mineral and natural resources and hence offer very good scope for industrial investment. This belt is well connected by National Highway and the Konkan Railway (broad gauge line) both running parallel to the coastline.

Karnataka has always been at the forefront of industrial growth in India. With its inherent capabilities coupled with its enterprising citizens, Karnataka provides the ideal choice for investment opportunities. While the national Gross Domestic Product (GDP) grew at 8.7% between 2005 and 2010, the combined growth rate of the four southern states was merely 7.85%, with Karnataka leading at 8.7%, Kerala 8.1%, Andhra Pradesh and Tamil Nadu at 7.4% each (according to a McKinsey survey report, commissioned by the Confederation of Indian Industry in March 2011).

In order to enhance the industrial growth of Karnataka, State Government has introduced Industrial Policy 2006-11 with an aim to increase the growth of GDP, strengthen manufacturing industries, increase share of exports from Karnataka, to generate additional employment of at least 10 lakh persons in the manufacturing and service sectors, reduce regional imbalance and ultimately aim at overall socioeconomic development of the State.

At present, in Karnataka there is only one Major Port viz., The New Mangalore Port. This is located at the southern end of the coastline and hence is predominantly being utilized by the southern districts of the State.

In view of the fact that ships of large sizes are used in transportation for economies of scale in the internationals trade, port would be developed with the required drafts, berthing facilities and efficient mechanical handling facilities so as to reduce waiting period of ships and saving in the Cargo handling expenses. Major aim of port development in Karnataka is to promote regional development. Port based industrial estates would be encouraged along the coast line to facilitate import of raw material and export of finished goods. As more number of Mega projects are coming up in the State, Industrial development shall be synchronized with the port development and the infrastructure development.

The investment in the port sector would demand an equal investment in the infrastructure facilities such as roads and railways for faster and efficient handling of the cargo movement. Along the coastline National Highway-17 and Konkan Railway broad gauge line are available. The Hassan – Mangalore broad gauge line would connect the ports in the Southern coast to the adjacent hinterland and similarly the proposed railway linkage from

Hubli to Karwar / Ankola would connect all the ports on the Northern coast to the rest of the state.

Maritime related industries would be given priority to be located along Karnataka Coast, in the field of ship building, ship repairing, dredging, eco-friendly ship breaking and other flotilla units like tugs, barges, launches and support crafts.

Considering the future endeavours, Government of Karnataka (GoK) willing to develop the Honnavar minor port in to all weather facility.

With this background, the Directorate of Ports and Inland Water Transport Department, GoK signed a lease agreement with Honnavar Ports Private Limited (HPPL), a consortium formed by North Canara Seaports Private. Limited (NCS) and GVPR Engineers Limited (GVPR) to develop Honnavar port located near mouth of Sharavati River in Uttara Kannada district of Karnataka. The consortium also signed a lease agreement for the use of Portland to develop port related activities at Honnavar.

GVPR Engineers Limited is an ISO 9001:2008 certified company that has extensive experience in Infrastructure project, designing, construction, operation and maintenance management. The organisation is involved in constructing world class infrastructure projects in Irrigation, transportation, power, buildings and ports. The company has joint venture and consortium tie up with reputed national and international companies to tender large scale projects.

With this Background, HPPL has appointed L&T-RAMBØLL Consulting Engineers Limited (L&T-RAMBØLL) for Consultancy Services for Development of Barge/vessel Loading Facility at Honnavar, Karnataka.

1.1 Details of Project Proponent

The information for the authorised contact person at HPPL is given below:

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Director
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1.2 Applicable Legal and Policy Framework

The proposed Barge/ Vessel loading facility at Honnavar attract the provisions of Environmental Impact Assessment (EIA) notification, 2006 (as amended) and Coastal Regulation Zone (CRZ) Notification, 2011.

The proposed project is categorised as: ***Ports, Harbours included as Item 7(e) in the Schedule of the EIA Notification. Based on the cargo handling capacity planned at the Port (4.9 MTPA),*** proposed Barge/ Vessel loading facility at Honnavar ***is classified as Category "B"***. The applicable environmental regulations for the project are listed in Table 1-1.

Table 1-1: Applicable Environmental Regulation

APPLICABLE GoI POLICIES & REGULATIONS	YEAR	OBJECTIVE	REASON FOR APPLICABILITY
Environmental (Protection) Act	1986	To protect and improve overall environment	Environment in general
Environmental Impact Assessment Notification (as amended)	2006	Re-engineered EIA notification for a more effective Environmental clearance process	Direct
Coastal Regulation Zone Notification	2011	To protect the Coastal ecological resources and to prevent coastal pollution	Direct
Air (prevention and control of pollution) Act	1981	To control air pollution by controlling emission and air pollutants according to prescribed standards	Air pollution
Noise Pollution (Regulation and Control) rules 2000 Noise Pollution (Regulation and Control) (Amendment) Rules 2010	2001 & 2010	Noise pollution regulation and controls	Control of Noise pollution
Water (Prevention and Control of Pollution) Act and Cess Act of 1977	1974	To control water pollution by controlling emission & Water pollutants as per the prescribed standards	Water pollution

In order to obtain prior environmental clearance from statutory authorities, Environmental Impact Assessment (EIA) Study has been carried out as per approved Terms of Reference (ToR) by State Expert Appraisal Committee (SEAC), State Environment Impact Assessment Authority (SEIAA), Karnataka.

1.3 Project Site

The proposed site for development of Barge/ Vessel loading facility is located near mouth of Sharavati River in Honnavar Taluk of Uttara Kannada district in Karnataka. It is at a distance of about 90 km from Karwar, the district headquarter and about 400 km from Bangalore.

The location map showing the project site is given as **Figure FD0101**.

The location of the proposed Barge/Vessel loading site in Google is presented in Figure 1-1.

Figure 1-1: Google Imagery of the Site

1.3.1 Features of Project Site and its Surroundings

The Honnavar Taluk has a total land area of about 770 sq km. The land available along both sides of river (Pavinkurve and Kasarkod) Sharavati offers good potential for developing the barge/vessel loading facility. The land identified for development of Barge / Vessel loading facility is about 44 ha (mostly un-surveyed coastal sand) within the port limits issued by Government of Karnataka at Kasarkod. Government of Karnataka has allotted the land for the proposed development.

The eastern side of river Sharavati viz. Honnavar side has a commercial wharf which is being used by fishing vessels and few ferry boats. The area north of the wharf is densely populated. The bank of the river along Honnavar side is protected with sea wall and a black topped road that leads to a creek located further north. The area just west along the road is an intertidal region which becomes exposed during the low tide.

The western side of the river viz. Kasarkod side also has a wharf and associated facilities to handle fishing vessels. The sedimentation caused by a dam at Gersoppa being located across Sharavati River has resulted in the formation of a sand spit in the area.

Pavinkurve, the northern side of Sharavati River extends nearly up to the site. The bank of the river mouth has few dwellings and some sand dunes. Badgani River runs along the eastern side of Pavinkurve, which joins Sharavati River at confluence of Arabian Sea. This area has little vegetation with coconut trees. There are also shoals near the mouth of the river. A 6 km long road connects Pavinkurve to NH 17 near Haldipur. There is a hanging bridge over Badgani River in the vicinity of Pavinkurve set apart for pedestrian purposes.

The area, Topalgere on opposite Bank of Kasarkod, just north of the Honnavar Port office adjoining NH 17 is densely populated and the road connecting to the port office and NH 17 which was used for approach road for barge/vessel operations in earlier days is also congested. The road passes through a densely populated area called Udhyam Nagar.

1.3.2 Connectivity

The site has good road connectivity. NH 17 passes through Honnavar towards East of project site at a distance of about 1 km. The site is connected to Bellary through NH 63 and NH 17. NH 17 meets NH 63 near Ankola at about 45 km from the site. Presently the site can be approached from a single lane black topped road that runs in continuation to NH 17 and then lies parallel to shoreline.

The site can be easily accessed through Konkan railway (Connecting Kerala with Mumbai). The barge/vessel loading facility proposed at Honnavar is at a distance of 5.0 km from Honnavar railway station and 14 km from Manki railway station.

The nearest Airports are at Mangalore and Goa which is about 155 km and 140 km respectively and the nearest seaport is at Karwar which is about 60 km from the project site.

1.4 Need for Development of Honnavar Barge/ Vessel Loading Facility

Liberalization of the Indian economy has led to significant growth and India is fast emerging as one of the largest economies of the world. This growth will provide a major thrust to trade. About 95% by volume and 70% by value of Indian exports are channelled through maritime Route. Foreign Trade Policy envisages doubling of Indian share in the global market. Hence, there is an immediate necessity to augment the Indian infrastructure by expanding or creating new Ports. Since, existing ports are saturated or congested and have limited scope for expansion there is a great need for development of green-field ports along East and West coasts.

Based on the growing demand/export potential in the state, the Government of Karnataka also has estimated that Karnataka coast would need more seaports/barge/vessel loading facility along Coast. Bellary district in Karnataka is blessed with many industrial projects that makes it second fastest growing city in the state .Out of the ports of the state, NMPT, the major port currently caters to the cargo requirements in the southern districts of the state and is operating at 89% capacity (in 2008 – 2009). Cargos such as granite, fertilizer, molasses, iron ore, wood logs, coal with other agro products and steel products also has the potential to grow in demand and supply which will increase the traffic. The capacity at the port is not adequate to cater to the demand of this region. This will increase the traffic across the proposed Barge/ Vessel loading facility.

About 27% of the power demand of Karnataka is met by that generated from coal based power plants. JSW Energy Limited (JSWEL) has commissioned coal based thermal power plant in Karnataka. JSWEL is also proposing to develop another unit of 600 MW in Bellary. Two coastal coal based thermal power plants are also proposed to be set up with capacities of 1015 MW and 4000 MW in Tadri and Mangalore respectively. The demand supply gap of coal is expected to increase in the coming years. The development of Barge/ Vessel loading facility will meet the capacity requirements of the region and Karnataka State and in turn is expected to boost the economy of State.

1.5 Project Development Plan

The proposed barge /vessel loading facility is located at the mouth of River Sharavati towards North west of Kasarkod Tonka village in Uttara Kanada district in Karnataka..

The barge/vessel loading facility is proposed for handling of 4.9 MTPA of cargo to handle dry bulk cargo (3.7 MTPA), general cargo (1.2 MTPA) and development of navigation and back up facilities. Proposed handling capacity is listed in Table 1-2

Table 1-2: Proposed Handling Capacity

S.No	Commodity	Traffic (MTPA)
1.	Coal	2.7
2.	Iron Ore	1.0
	General Cargo	
3.	Granite	0.16
4.	Fertilizer	0.2
5.	Molasses with Agro Products	0.15
6.	Steel Products	0.40
7.	Sugar	0.29
8.	**Total**	**4.9**

The detailed project development plan is discussed in **Chapter 2.**

1.6 Environmental Impact Assessment

The EIA study for the proposed Honnavar Barge/Vessel Loading Facility covers both terrestrial and marine environmental assessment.

HPPL submitted the proposal (Form-1, Draft Terms of Reference (ToR) and Prefeasibility Report) for consideration by the State Level Expert Appraisal Committee (SEAC), Karnataka in its meeting held on August 20, 2011 at Bangalore to determine the Terms of Reference (ToR) for undertaking EIA study for obtaining environmental clearance in accordance with the provisions of the EIA Notification, 2006 (as amended) and CRZ notification, 2011.

The committee approved the ToR vide letter No: SEIAA 22 IND 2011, dated September 13, 2011. A copy of the letter is enclosed as **Appendix A** for reference.

The EIA study has been carried out based on the approved ToR covering both terrestrial and marine environments.

1.7 Approach and Methodology

1.7.1 Project Influenced Area (PIA)/Study Area

An area within 10 km radius with project site as boundary has been earmarked for the study as the general study area. The core study area is the proposed project site. The map showing the study area is given as **Figure FD0102**.

1.7.2 Study Period

The baseline terrestrial and marine environmental surveys were carried out during March to May 2011. 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 at identified monitoring locations once 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.

The baseline marine environmental surveys were carried out by Centre for Advanced Studies in Marine Biology (CASMB), Annamalai University. Marine water quality, sediment quality and marine biology (plankton, benthos) were carried out once during the period at the identified sampling locations within the project area.

1.7.3 Methodology

The EIA study for the proposed barge/vessel loading facility has been carried out covering both construction as well as operational phases. In each phase, the anticipated impacts due to the proposed project on both terrestrial, marine environmental and social components have been addressed. The methodology adopted for the study is discussed in the following sections.

1.7.3.1 Analysis of Alternatives

To ensure sustainable development under the given conditions, the analysis of alternatives considered for layout selection has been discussed in detail and presented in the **Chapter 3**.

1.7.3.2 Baseline Environmental Conditions

The baseline environmental status of the study area was established by carrying out the field surveys covering both the marine and 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.

- Meteorology
- Ambient Air Quality (PM10, PM2.5, SO2, NOX, CO, HC, Hg and Ozone)
- Noise
- Water Quality
- Soil
- Ecology (Flora and Fauna)
- Land use and Land Cover Mapping

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

Marine Environment: Centre for Advanced Studies in Marine Biology (CASMB), Annamalai University, a reputed academic and research institute, has been engaged to monitor the marine environmental attributes near proposed barge/vessel loading facility. The marine environment was monitored in terms of:

- Seawater quality
- Sediment quality
- Marine biology (plankton and benthos)

HTL/LTL and CRZ Demarcation Survey

The physical demarcation of HTL and LTL was carried out by the Centre for Earth Science Studies, Thiruvananthapuram, and an authorised agency by MoEF. Based on the survey, the CRZ set back lines were demarcated.

Socio-Economic Aspects

Data on population, literacy, occupation, amenities, and medical facilities was collected from was collected from District Statistical Handbook of Uttara Kannada District and Primary Census Abstract (Census of India), 2001.

1.7.3.3 Anticipated Environmental Impacts and Mitigation Measures

The environmental and social impacts which are likely to arise due to the proposed Honnavar barge/vessel loading facility 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 and marine environments. The mitigation measures proposed to minimise each of the likely impacts are presented in **Chapter 5**.

1.7.3.4 Environmental Monitoring Programme

Post project environmental monitoring programme has been formulated for the barge/vessel loading facility 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).

1.7.3.5 Additional Studies

Preliminary Risk Analysis and Disaster Management Plan: Preliminary Risk analysis covering the hazard identification is carried out. . Based on which, preventive measures and Disaster Management Plan were prepared outlining various measures to combat accidents and natural disasters. Also measures to safeguard against fire hazards have been provided in **Chapter 7**.

Social Impact Assessment (SIA): The likely social impacts associated with the construction and operational phases of the Honnavar barge/vessel loading facility are detailed out in **Chapter 7**.

Public Hearing: The Public Hearing was conducted on January 27, 2012 at the proposed project site and the issues raised by the public and the responses of the project proponent for the same are provided in **Chapter 7**.

1.7.3.6 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**.

1.7.3.7 Environmental Cost Benefit Analysis

The applicability of the proposed project to incorporate the Environmental Cost Benefit Analysis in the EIA Study is briefly explained in **Chapter 9**.

1.7.3.8 Environmental Management Plan (EMP)

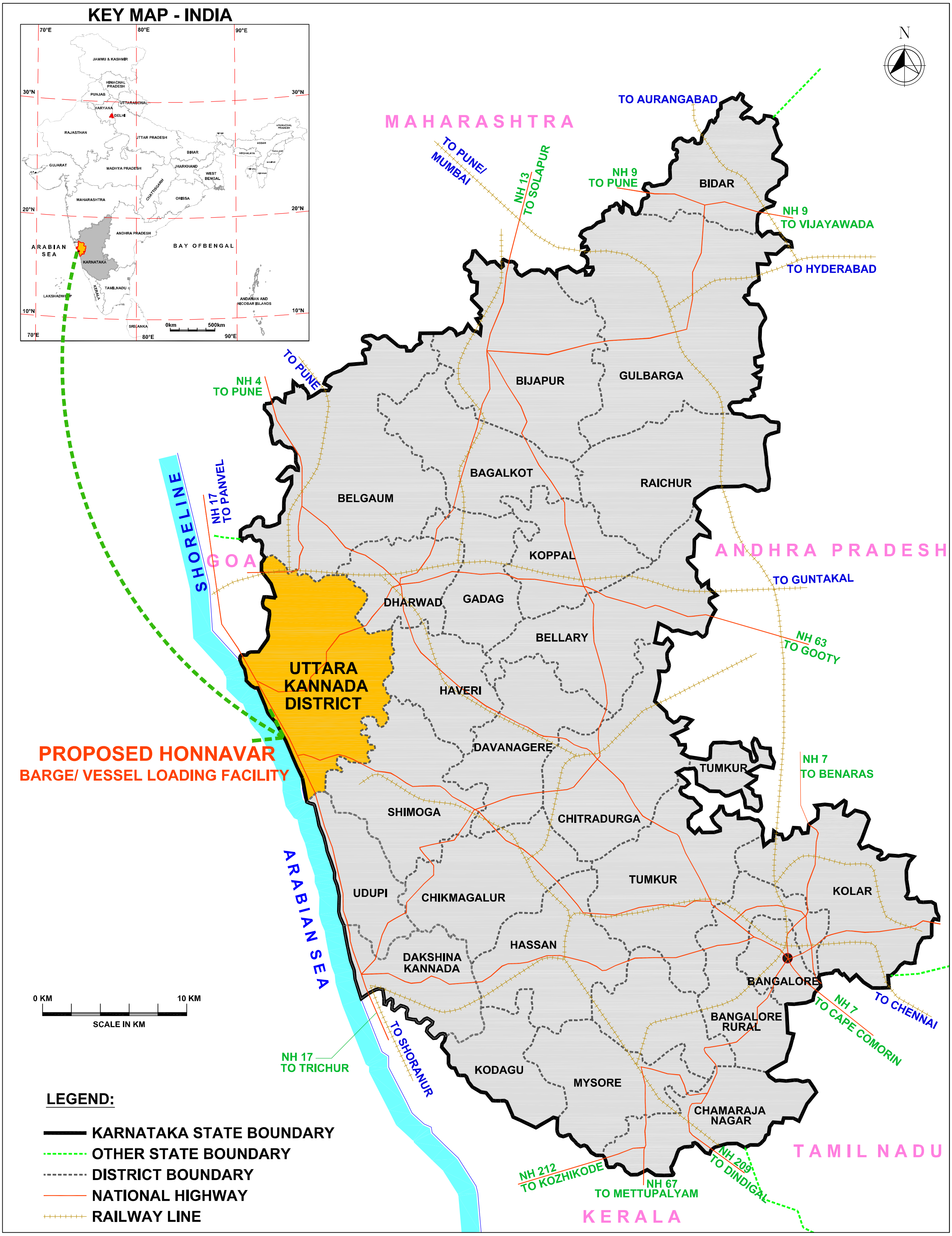
An Environmental Management Plan (EMP) was prepared based on the mitigation measures for the impacts during construction and operation phases and environmental monitoring programme proposed. The mitigation measures have been discussed in **Chapter 5** under the respective sections. The Environmental Monitoring Programme has been discussed in **Chapter 6**. The institutional mechanism responsible for the implementation of the mitigation measures and Green Belt development plan is presented in **Chapter 10**.

1.8 Structure of EIA Report

The report is structured as per Appendix III of EIA Notification, 2006 and also EIA Guidance Manual for Ports and Harbours, 2010 released by MoEF.

- Chapter 1: Introduction
- Chapter 2: Project Description
- Chapter 3: Analysis of Alternatives
- 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 & Conclusions
- Chapter 12: Disclosure of Consultants Engaged

FIGURES



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TITLE: LOCATION MAP	DATE: 07.11.2011
	MADE: ASN
L&T-RAMBØLL CONSULTING ENGINEERS LIMITED	FIGURE NO: FD0101 REV: 0

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NOTES:

1. MAP PREPARED BASED ON SOI TOPOSHEETS

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Chapter 2
Project Description

2 Project Description

2.0 General

In this chapter, Development Plan for all weather Barge/ Vessel Loading Facility at Honnavar is presented summarising the following details.

- Location
- Land Availability
- Existing Facilities
- Traffic Studies
- Field Surveys and Modelling Studies
- Dredging and Reclamation
- Material Quantities and Resources
- Utilities and Services
- Environmental Protection Measures
- Coastal Regulation Zone Compatibility
- Project Development Schedule
- Project Cost

2.1 Location

The proposed barge/ vessel loading facility site is located near Sharavati River mouth in Honnavar town, Uttar Kannada district of Karnataka State. The identified shoreline for the development will be within the notified port limits. The location map showing the project site is given as **Figure FD0101**.Existing drainage pattern of the project influence area of the proposed barge/ vessel loading facility is shown in the figure 2-1

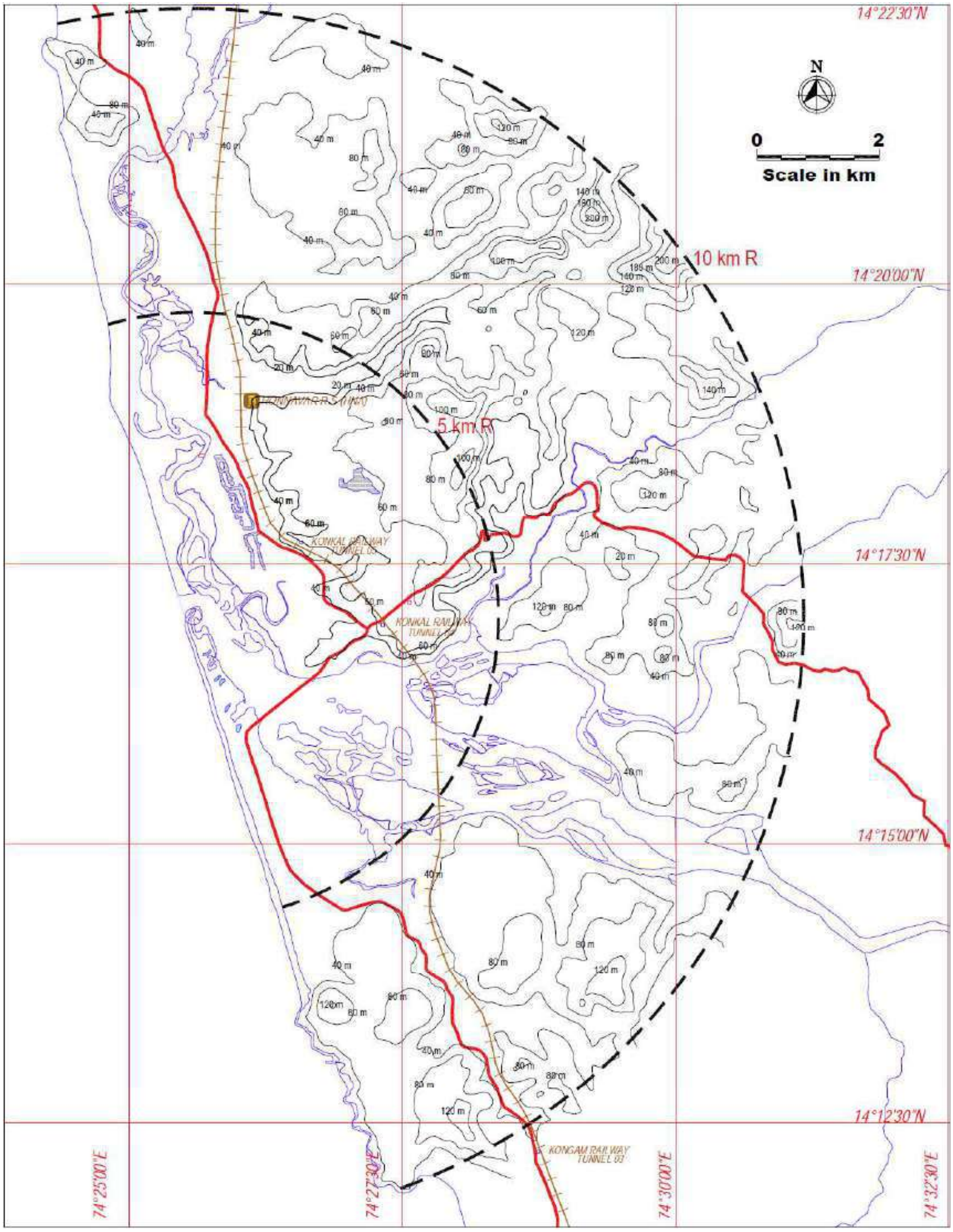


Figure 2-1: Drainage pattern of the project influence area

2.2 Land Availability

The land available along both sides of river (Pavinkurve and Kasarkod) Sharavati offers a good potential for developing the barge/ vessel jetty. The land identified for development of Barge / Vessel loading facility is about 44 ha within the port limits issued by Government of Karnataka at Kasarkod.

Government of Karnataka has allotted the land for the proposed development. The land proposed for Rail / Road Corridor is about 30 Ha, which includes Government / few patches private land and no families are present in the land proposed to be acquired. Hence, No R&R is envisaged due to the proposed development. .

The proposed land use plan/land break up details of Honnavar Barge/Vessel loading facility is given in the Table 2-1.

Table 2-1: Barge / vessel loading facility Land Use Breakup

S.No	Description	Area (Ha)
1.	Coal Stockyard	7.00
2.	Iron Ore Stockyard	1.80
3.	General Cargo Storage (Open)	4.00
4.	General Cargo Storage (Closed)	2.00
5.	Liquid cargo storage	0.10
6.	Roads and Circulation Area	8.15
7.	Operation Building	0.05
8.	Canteen	0.02
9.	Vehicle Parking	0.09
10.	Substation	0.02
11.	Gate House/Security/Weigh Bridge	1.50
12.	Truck Parking	5.40
13.	Fuel Station	0.02
14.	Control Tower	0.01
15.	Green Belt	3.10
	Sub total	33.26
16.	Area available for other Operations and area earmarked for future expansion	6.72
17	Rock armour area(approx)	4.00
	Total	**44.00**

2.3 Barge /Vessel Loading - Traffic

2.3.1 Coal

Coal is the one of most important fossil fuel in India. The majority of energy requirement in India are met through coal, largely mined in the eastern and central regions of the country. Coal accounts for approximately 53 percent of the country's energy need. India is the third largest producer of coal in the world and has the fourth largest reserves of coal in the world. The primary demand of coal is from the power sector though steel and cement plants also require coal for their production.

Though, India is the third-largest producer of coal, the demand for coal in India for its power and steel plants is higher than the supply. Therefore, India is a net importer of coal and its import has been rising over the past 10 years. Total imports have increased from 29 MT in 2004-05 to 59 MT in 2008-09, at a CAGR of 19.5 percent to meet the demand-supply mismatch. The import growth has been primarily driven by increased import of non-coking (thermal) coal, which has grown at 33.3 percent per annum, in response to the growing thermal power plants in India. The main sources for imported coal in India are from Australia, China, Indonesia and South Africa. Export of coal from India has not been significant in the past due to the high domestic demand.

The state of Karnataka is endowed with a number of steel production units and cement plants whose coal requirement is increasing proportionally to their production. JSW steel, Bellary is the largest producer of steel in the hinterland. About 27% of the power demand of Karnataka is met from coal based power plants. In addition numbers of steel and power plants are also coming which will further increase the demand for coal in Karnataka. Majority of the power plants and steel production plants import coal from the eastern part of India via coastal movement. The new SEZ planned by GVPRL in the vicinity of Honnavar Barge/ Vessel loading facility will also have a thermal power plant which will again add to the coal demand of the state.

Considering all these, it is understood that Honnavar, will attract Thermal coal traffic of 2.7 MTPA annually.

2.3.2 Iron Ore

India is ranked fifth in the world in terms of iron ore reserves, with approximately 6 percent of the total iron ore reserves. Brazil, Russia, China, and Australia are the top four countries. Indian iron ore industry is fragmented with around 270 mines spread across country. India is one among the leading exporters of iron ore in the world and competes with Australia and Brazil. Jharkhand, Orissa, Chhattisgarh, Karnataka, Goa & Maharashtra are key major states with iron ore deposits in India.

Karnataka state is endowed with rich deposits of iron ore with about 9 billion tones or about 41% of India's total haematite and magnetite resources. Numerous iron ore mines present in Bellary district account for almost 75% of the iron ore exported from the state. The quantity of iron ore mined from Hospet and Bellary had touched 20 MT and 50 MT respectively. About 80% of this iron ore is being exported and the rest is consumed domestically.

Honnavar has a very good prospective in exporting iron ore being located in close proximity to Bellary Hospet belt. Taking into account all the above said factors, the facility being developed in Honnavar is expected to handle around 1.0 MTPA of iron ore annually. However, considering the recent ban on iron ore, HPPL is committed to the national regulations and therefore Iron ore will be handled as and when the handling is legally permitted.

2.3.3 General and Other Cargos

The General cargoes proposed for the barge/vessel loading facility includes steel products, molasses, edible oil, granite, sugar and fertiliser.

2.3.3.1 Steel Products

Karnataka's annual output of iron ore is around 45 MT with around 70-75% of it being exported. Based on this the average annual output of steel from Karnataka is around 27 MT. But due to the ban in the iron ore mining in Bellary by the Supreme Court, the steel industry for which iron ore is the basic raw material got affected. This threatened the production output of the steel. In September 2011, India's Supreme Court allowed state-owned NMDC Ltd to mine 1 MT of iron per month in Karnataka's Bellary district to meet domestic steel maker's needs. This has helped steel industry to recover to an extent. As per expert's opinions, it is expected that the amount of iron ore supply to the steel industry will be further increased and the ban on the iron ore mining will be partially or fully recovered sooner or later. Keeping in view of the prevailing situation, Honnavar barge/vessel loading facility will handle 0.4 MTPA of steel products.

2.3.3.2 Fertiliser

Chemical fertilizers play a key role in the agricultural productivity growth of India. However, the demand-supply gap of fertilizers in India has increased in recent times, thereby leading to increased dependency on imports. Indian imports, which were about 2 MT in early part of 2000, increased to 10.2 MT in 2008-09. India is the second largest consumer of fertilizers in the world after China, consuming about 26.5 MT in 2009 - 10.

Fertilizer consumption in Karnataka state is increasing while the production is less which necessitates the import of fertilizers. Considering, the potential for fertilizer, Honnavar barge/vessel loading facility plans to attract 0.2 MTPA.

2.3.3.3 Granite

Karnataka produces 25% of India's total granite production followed by Jharkhand (24%), Rajasthan (23%), Andhra Pradesh (6%), Madhya Pradesh (5%) and Orissa (5%) which altogether accounts for 88% of the resources. The quarries in Karnataka are located in Chamarajnagar sector, Kollegal sector, Kanakapura sector, Hassan sector, Mandya sector, Mysore sector and Ilkal sector. Considering the potential for granite, Honnavar barge/vessel loading facility plans to export 0.16 MTPA.

2.3.3.4 Sugar

India is the second largest producer of sugar next to Brazil. With a hold of 13.5% of country's sugar production, Karnataka ranks fourth in the country in terms of sugarcane production and third in the country in terms of production of sugar. Increase in the sugar projection was owing to the availability of large quantity of sugarcane in the state. Considering the potential for sugar, Honnavar plans to export 0.29 MTPA.

2.3.3.5 Molasses

Molasses is produced by sugar factories during the sugar manufacturing process. Godavari Sugar Mills located in Bagalkot is the largest producer of molasses in the hinterland. Demand for ethanol in the petroleum sector and potable alcohol industry is the driving forces for high molasses consumption.

Brazil, the world's largest exporter has banned molasses exports in order to produce ethanol to be used as a bio fuel; hence India could cater to the international demand for molasses. Growing demand for ethanol which is blended with petroleum will be the major factor that will fuel molasses exports in future.

In order to cater to international demands, sugar factories in the hinterland supply to local distilleries as well as export a part of their volumes. Considering the potential for molasses, Honnavar plans to export 0.08 MTPA.

2.3.3.6 Edible Oil

Indian vegetable oil economy is the fourth largest in the world, accounting for about 14.5% of the world's oilseeds area and 6.65% of the production next to U.S.A, China and Brazil. The per capita consumption of edible oil is about 11.5 kg which is very low compared to world average of 20 kgs. With steady growth in population and personal income, Indian per capita consumption of edible oil has been growing steadily. However, oilseeds output and in turn, vegetable oil production have been trailing consumption growth, necessitating imports to meet supply shortfall. Hence India being deficient imports 40% of its consumption requirements, making it the world's third-largest importer of edible oil. The country buys soya oil from Argentina & Brazil and palm oil from Malaysia & Indonesia. Exemption on import duty on edible oils (since 2008) has resulted in a huge rise in imports and has also boosted the per capita consumption of oil in the country.

In Karnataka Edible Oil is imported from Argentina, Indonesia, Brazil, Malaysia, etc through New Mangalore Port. The edible oil imported at the Port is despatched to various destinations like Karwar in Karnataka State and to Ruchi Oil refineries in Mumbai and in some parts of Kerala State. The crude Palm oil imported is processed locally and sent to various destinations in the hinterland. Considering the potential for edible oil, Honnavar barge/vessel loading facility plans to export 0.07 MTPA.

The total general cargo handled will be 1.2 MTPA.

2.3.4 Traffic for Honnavar

Based on the hinterland potential analysis, the overall traffic figures for proposed barge/ vessel loading facility are provided in the Table 2-2.

Table 2-2: Cargo Throughput for Honnavar Barge/Vessel Loading Facility

S. No.	Commodity	Traffic (MTPA)
1.	Coal	2.70
2.	Iron Ore	1.00
	General Cargo	
3.	Granite	0.16
4.	Fertilizer	0.20
5.	Molasses with Agro Products	0.15
6.	Steel Products	0.40
7.	Sugar	0.29
8.	**Total**	**4.90**

2.4 Field Surveys and Investigations

Comprehensive field surveys and investigations were carried out covering oceanographic measurements, marine geotechnical investigations and topography at the location of project site. Detailed investigations that included seabed surveys (viz. bathymetry), Oceanographic measurements (tide measurements, current meter observations) and seabed sediment sampling were carried so that the results were used for the planning of the proposed facilities at Honnavar Barge/vessel Loading facility. These surveys were carried out by M/s. Indomer Coastal Hydraulics (P) Ltd., Chennai and M/s. Fugro Geo-Tech Pvt. Limited.

2.4.1 Bathymetry

The bathymetric survey was carried out for 3.5 km along the shoreline and 3.5 km into the sea. From the analysis of the survey data it is observed that the contours run parallel to each other in the project area. Bathymetry of the study area exhibits a gentle bed slope of 1:180 up to 5 m contours beyond which it flattens to 1:350. The 10 m water depth occurs at a distance of approximately 3350 m from the coast.

The bathymetry survey carried out on the river side of the project site illustrates that the river bed is shallow and there are few deeper portions depending on the current. A maximum river depth of 3-4 m is observed, otherwise the whole of the bed seems to be very shallow and few islands in the river course. Mouth/estuary of the river also seems very shallow with maximum water depth of 2-3 m in the river mouth. Large area of shallow depth of 0.7 m is observed on either side of the river mouth which is mainly due to the deposition of the sediments brought by the river.

The bathymetric chart surveyed by Indomer is presented in Figure 2-2.

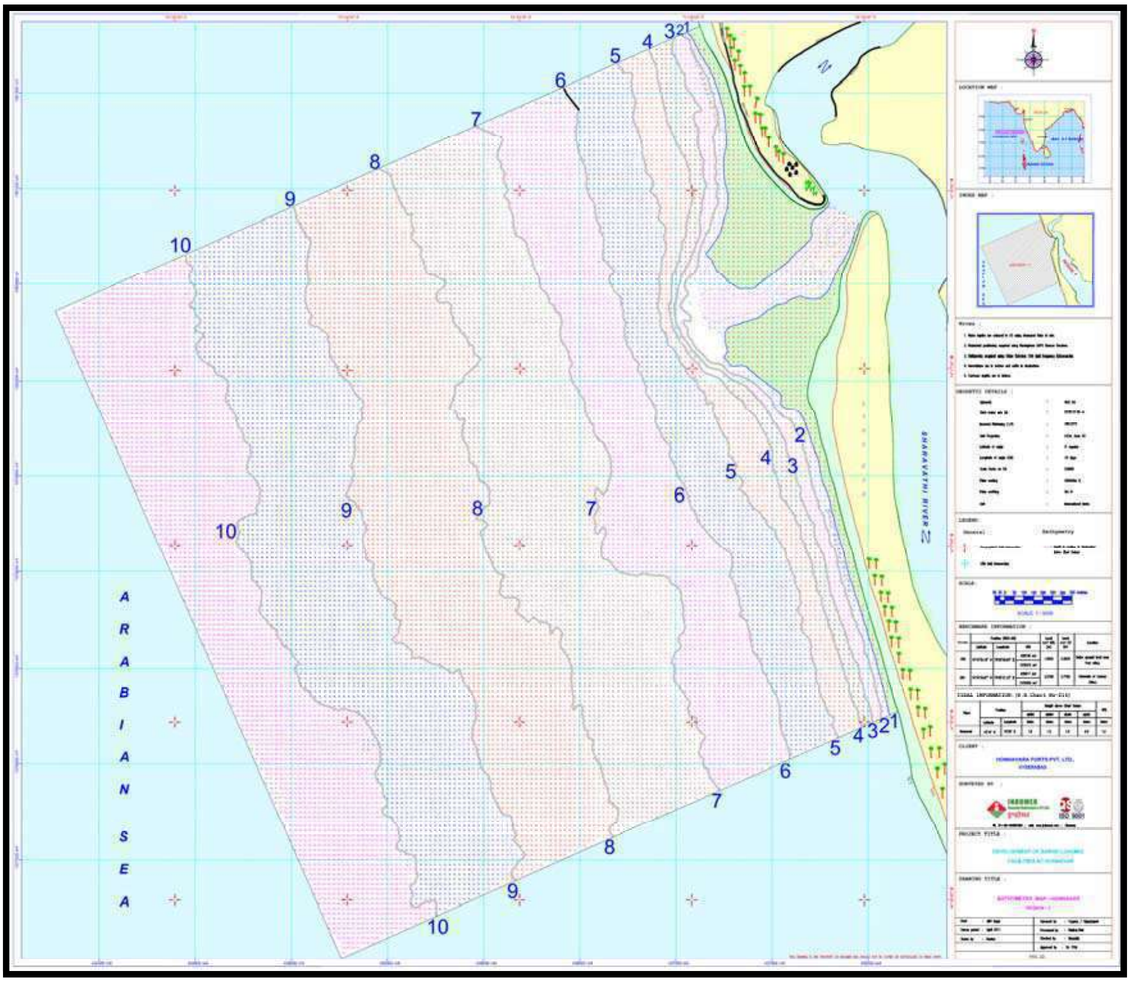


Figure 2-2: Bathymetry

The National Hydro graphic Office chart showing the depth contours of the Project region is given in Figure 2-3.

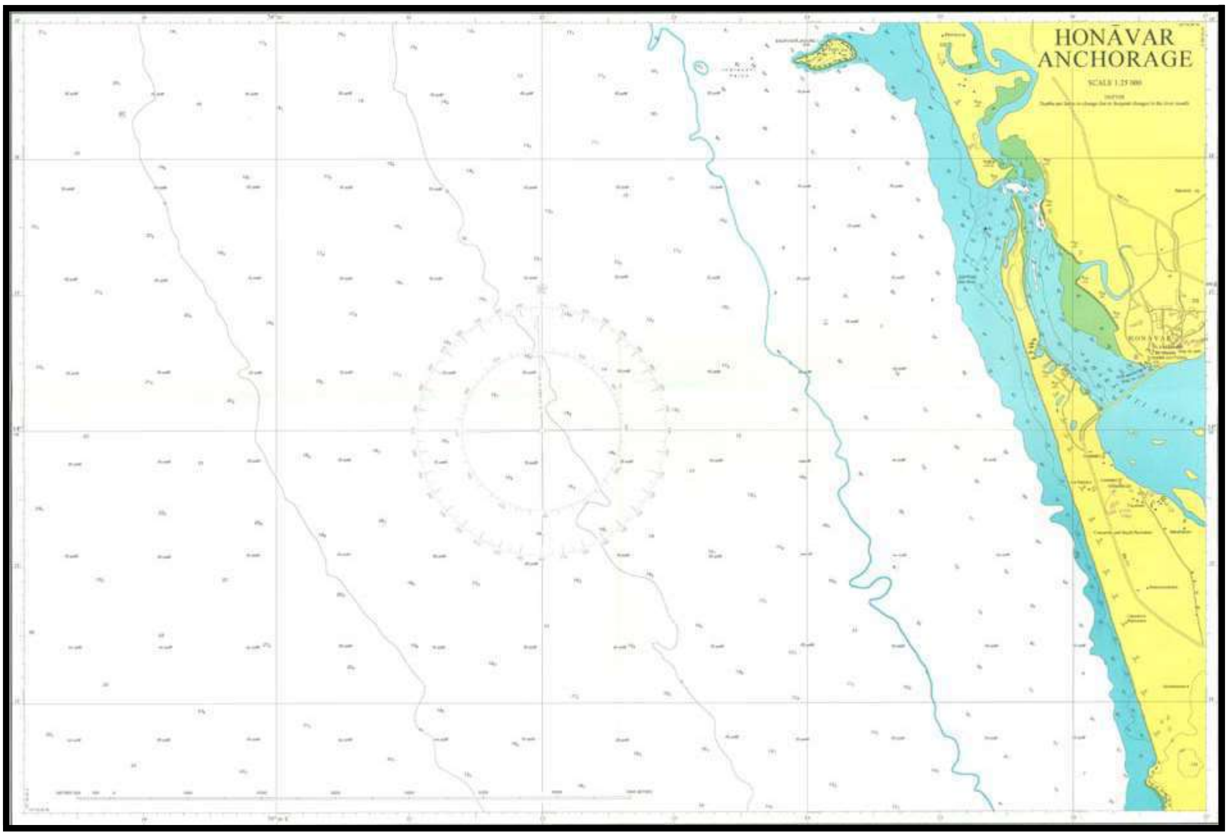


Figure 2-3: NHO Chart

2.4.2 Geotechnical Investigation

Geotechnical investigations were carried out to determine various soils/rock parameters at the proposed project location by M/s Fugro Geo-tech Pvt. Ltd. 4 land boreholes and 11 marine boreholes were explored to assess the geotechnical parameters.

The soil profile of the four land boreholes reveals that medium dense to dense yellowish brown fine to coarse sand up to 13.5 m, stiff dark grey clay from 13.5 to 16.5 m, dense yellowish brown coarse sand from 16.5 to 18 m, very dense whitish grey gravels with some sand from 18 to 22.5 m, hard reddish clay with few gravels from 22.5 to 28.5 m, highly reinforced greenish weak chloride schist from 28.5 to 31.5 m and moderately weathered greenish weak to moderately weak chloride schist from 31.5 to 35 m.

The soil profile of the eleven marine boreholes reveals that loose to dense yellowish brown fine to coarse sand up to 4.5 m, soft to firm dark grey clay from 4.5 to 6.0 m, loose to dense yellowish grey sandy clayey gravels from 6.0 to 9.0 m, medium dense whitish greyish sand with gravels from 9.0 to 12.0 m, stiff to very stiff whitish grey clay from 12.0 to 19.5 m, hard whitish grey clay with minor silt from 19.5 to 27.0 m, hard greenish clay from 27.0 to 30.15 m and moderately weathered greenish moderately weak to weak chloride schist from 30.15 to 35.0 m. Weathered rock is encountered in all boreholes at varying depths. The observed bedrock is moderately weathered at surface and rapidly grades into sound rock as depth increases.

2.4.3 Oceanic Investigation

The oceanographic conditions such as tide, wave, current, bathymetry etc, and meteorological conditions such as climate, temperature, relative humidity, rain fall, wind, visibility, cyclone etc are discussed in detail in **Chapter 4**.

2.5 Mathematical Model Studies

2.5.1 Wind-wave Model and Nearshore Wave Transformation and Wave Tranquillity

The wave transformation model has been run for deep-water waves approaching from six directions (S, SSW, SW, WSW, W and WNW). However, due to the typical orientation of the coastline and the nearshore bathymetric pattern, the waves undergo refraction and approach the coast predominantly with a westward component (WSW, W and WNW). To examine the effect of the proposed breakwaters and other structures on the waves and other parameters in the study area, models were run for the existing conditions without breakwaters (case-I) and for the future conditions incorporating the proposed breakwaters (case-II).

For case-I (without breakwaters), during monsoon season, when the deep water wave directions are S, SSW, and SW the wave heights along the coast are between 1.0 to 1.5 m up to a distance of about 1 km offshore. For WSW waves, wave heights greater than 1.75 m are noticed in the region. However, in the neighbourhood of the inlet channel (river mouth), on the seaward side the wave heights are less than 1.0 m and this is due to wave divergence in the region. On the riverside of the entrance channel good, tranquility conditions with wave heights less than 0.5 m are noticed.

For case-II (with breakwaters), the wave conditions along the coast outside the port area are almost same as in case I. But near the mouth adjoining the breakwaters somewhat rough conditions with wave heights ranging from 1 to 1.5 m are noticed. This could be due to the diffraction and reflection of the waves by the breakwaters.

The wave transmission factor is important for the study of wave tranquility. Higher transmission factor indicates low tranquility and vice versa. During the non-monsoon season when W and WNW waves prevail, the transmission coefficients are quite low (0.15) and the tranquility conditions are quite good. During monsoon months when WSW and SW waves prevail the transmission coefficients are significantly higher (>0.3) near the entrance channel; but the values rapidly decrease on the riverside of the channel.

For case-II, with breakwaters, the transmission coefficients are generally less than 0.15 indicating good tranquility conditions for non-monsoon months. But during monsoon months when S and SSW waves prevail, the inlet channel adjoining the breakwaters show higher transmission coefficients (>0.75) and the tranquility conditions are not so good.

However, the tranquility conditions on the riverside of the channel are quite good during all seasons. The model studies show that the tranquility conditions have improved on the riverside where barge/ vessel loading facilities are located, when the breakwaters are incorporated in the model.

2.5.2 Hydrodynamic Model Studies

The changes in the current patterns near the inlet and inside the river up to the point of the proposed barge/ vessel loading facilities were studied by using hydrodynamic models. The model results show that the ebb currents are strong during wet season when the river discharge is very high. The current strengths increase further during spring tide periods compared to neap tide.

For case-I (without breakwaters), during wet season with peak river discharge (300 m^3/s) strong currents of about 1.0 to 1.2 m/s are observed inside the channel as well as on the seaward side of the channel. Inside the river also up to 5 km upstream, the ebb currents are strong (0.4 to 0.6 m/s). During flood period, also the currents continue to be in the ebb direction and no reversal is found. However, there is slight reversal outside the channel to the south. The currents in the river also show no reversal with tide; they continue to be in the ebb direction even during flood period. This is due to the overwhelming effect of the river discharge, which totally controls the circulation. Similar variations of currents are observed during neap tides also.

For case-I during wet season, the impoundment of water within the river and the inlet area is observed. During ebb period, the water levels in the river are at about 0.6 to 0.75 m while on the seaside the water levels are around 0.3 to 0.45 m. However, during the flood period the water levels in the river and in the sea remain almost same at around 0.9 m. During dry season the magnitude of currents has generally decreased to about 0.2 m/s and a clear reversal in tidal currents is noticed.

For case-II (With Breakwater) in the wet season strong currents directed seaward are observed near the inlet during ebb period. The ebb current strength in the river is found to be stronger compared to case-I. With the inclusion of breakwaters, the effective cross sectional area at the entrance has decreased resulting in the increase of current strength. The water levels during the flood period remain almost same as case-I and so it may be inferred that the construction of breakwaters will have negligible effect on the water level changes in the Barge / vessel loading facility.

The increase in current strengths prevents any increase in water levels and no flooding is expected. Since, the currents show higher values only during ebb period, the riverine sediments could be carried offshore by such currents and sedimentation problem within the proposed facility is expected to be lesser. For case-II during dry season reversal of currents in the river are observed from ebb to flood periods. The water levels also do not show any variations compared to case-I.

2.5.3 Cohesive/Mud transport (MT) Model

Cohesive or mud transport studies are essential for coastal regions where river or tidal inlets are present. The Flow model (HD and MT) has been simulated for different wave directions obtained from wave radiation stresses output from NSW fine-resolution model simulations. The model setup is divided into two parts one with low discharge conditions (dry monsoon) and the other with high discharge conditions (wet monsoon). For dry monsoon season, the Sharavathi river discharge is very less (50 m^3/s) and for the wet monsoon season, it varies from 200-500 m^3/s during peak discharge periods.

For case-I (without breakwaters) in the wet season, on the 5th day of the model run higher Suspended Sediment Concentration (SSC) values are noticed both inside the river and near the inlet entrance, which gradually decreased and by 10th day became negligible except on the southern end of the river. By 15th day the SSC is completely flushed out and higher SSC values are noticed only far away on the sea side of the channel. For dry season the SSC values continue to be less throughout the model run up to 15 days. The model run for bed level changes shows negligible bed level changes up to 5th day throughout the entire area; but by 10th day slight deposition is noticed on the right bank of the river to the north of the channel entrance and by 15th day the deposition seems to have increased further. For dry season however the bed level changes are negligible for the entire area.

For case-II (with breakwaters) during wet season slightly higher values of SSC are noticed inside the region of breakwaters and also inside the river. But by 10th day the SSC is flushed out and by 15th day the entire area is free of any SSC. During dry season the SSC is negligible throughout the study area. The bed level changes during wet season indicate the sedimentation is negligible up to 10th day; but by 15th day slight deposition appears on the right bank of the river facing the channel inlet. But this siltation is not severe and it shall be concluded that the construction of breakwaters will not have any significant effect on siltation in the proposed project area.

2.5.4 Non- Cohesive Sediment transport

The littoral sand transport studies conducted through MIKE 21 (ST) model gave information on sand transport rates along the coastal stretch and near the tidal inlet.

For case-I (without breakwater) the rates of sediment transport for deep water waves from S and SSW are much less (<200 m^3/yr/m) along the entire coastal stretch. However slightly higher values (about 400) are noticed on the seaward side of the entrance where shoals are present. The bed level changes indicate deposition at the mouth and to the south of the inlet. For SW and SSW waves during monsoon season high values of sand transport (>2000) are noticed along the entire coastal stretch due to high and steep waves during this season. The bed level changes indicate significant deposition (0.005 m/day) both to the south and north of the entrance channel. During non-monsoon season, when W and WNW waves prevail the sediment transport as well as the bed level changes are not significant.

For case-II (with breakwaters) during monsoon season when SW and WSW waves prevail the sediment transport is significant (>2000) to the north as well as to the south of breakwater. Bed level changes indicate deposition to the northern and southern coastline in general; but there is also erosion just to the north of northern breakwater, some deposition is observed inside the breakwaters zone just at the mouth of the entrance channel, which must be cleared periodically in maintenance dredging.

Model studies indicate an annual deposition of about 10,300 m^3/yr in the dredged channel. Again, during non-monsoon months there is no significant deposition. On the whole the sand transport model studies indicate depositional trend near the mouth of the channel as well as to the north of the channel for case-I. But for case-II, the depositional trend in the channel has somewhat decreased due to breakwaters while some erosional trend is noticed towards the northern shores.

The predominant direction of alongshore sediment transport is towards north due to S, SSW and SW waves and the net transport of sediment is around 0.6×10^6 m^3 directed towards north.

2.5.5 Shoreline Changes Study

The coastline evolution with the breakwaters and other interventions can be well modelled with state of art LITPACK model in the MIKE 21 software. The model has been simulated for two cases: (1) with breakwaters and without shore protection on the northern side of inlet and (2) with breakwaters and with sea wall on the northern side of inlet.

Case (I):

It is observed that severe erosion may occur towards the northern side of the north-breakwater with shoreline recession of around 20-30 m for 10 years (2-3 m/yr). Whereas, on the southern side, deposition occurs with a shoreline advancement of 50-60 m.

Case (II):

When a shore protection strategy like sea wall is constructed on the northern side of the barge/ Vessel loading facility, it is observed that the coast is almost stable and no net change in shoreline is observed. Whereas, on the southern side, slight deposition occurs with a shoreline advancement of 30-40 m.

2.5.6 Dredge Disposal study

Mathematical model study has been carried out to assess the fate of dredged spoil during dredging and dumping and its impact on the project area and near-shore regions. The dredging quantity during the proposed development is estimated to be 3.9 million m^3. Around 1.0 million cum of dredging quantity will be used for reclaiming purpose and the remaining quantity will be disposed in sea. MIKE 21 hydrodynamic model (with mud transport) has been used to simulate the suspended sediment concentration (SSC) and bed level changes when the dredged material is discharged in to the sea.

As the sediment transport and littoral drift studies revealed that the net transport along this coast is towards north, an appropriate disposal site towards north of the northern breakwater were chosen such that the disposed material does not come back towards the port entrance and at the same time it could be helpful in nourishing the eroding beaches in the area. After examining several locations along the northern coast, the most suitable site for dredge disposal is recommended at a distance of about 2 km to the north of port entrance channel located at latitude 14.308^0N and longitude 74.415^0E. It is observed that during wet season, the suspended sediment concentration (SSC) is relatively high for a few days after dredge disposal but later it spreads along the coast towards north without any impact to the port entrance area and the nearby environment. However, during dry season with WNW waves, the discharged sediment (SSC) spreads along the coast towards south, but it does not extend up to the entrance channel. It is evident from the rate of bed level changes that during wet season, there is very little increase in bed level in the nearshore regions at the disposal site. During dry season, the supplied sediment is carried towards south supplying sediment to the northern part of the north breakwater. This positive feedback from the natural nearshore current system is quite helpful for nourishing the northern beaches.

During periods of strong near shore currents (during peak wet season), it is suggested to dispose the sediment offshore at greater depths (>30 m). Based on the studies it is concluded that the dredge disposal at the recommended site will not cause any natural imbalance to the nearby shoreline and will not affect the coastal eco-system in any way. The details of the dredge spoil study such as Deposition pattern, Average suspended sediment concentration at dumping areas are discussed in Section 5.4.2.1 of Chapter 5.

2.6 Honnavar Barge/Vessel Loading Facility Development Plan

The following attributes have been considered during the planning of barge/vessel loading facility layouts:

- Bathymetry
- Type of seabed at the proposed site
- Wind and current condition at the site as well as in its vicinity
- Wave incidence
- Required tranquillity in harbour areas
- Littoral drift and sediment transport at the project site
- Traffic volume
- Availability of backup land for the terminal
- Expansion in stages
- Environmental and Social aspects

Based on the data collected on planning parameters and analysis of alternative layouts, development plan layout has been prepared for the proposed facilities at Honnavar. The barge/ vessel loading facilities is proposed near the mouth of Sharavati River. The facilities will be located at the northern end of the Kasarkod Sand spit. The berth is proposed parallel to the coastline. The berth is oriented in North south direction. The facilities proposed are as follows:

- Breakwater
- Turning circle, Approach channel
- Berthing area
- Stockyard

2.6.1 Barge/Vessel Loading Facility Layout

The salient features of barge/ vessel loading facility Layout are presented in Table 2-3

Table 2-3: Salient Features of Barge/ Vessel Loading Facility

S. No	Parameter	Description
1.	Land Area	44 Ha (108 acres)
2.	Cargo handling capacity	**Handling Capacity: 4.9 MTPA** • Coal - 2.7 MTPA • Iron Ore – 1.0 MTPA • General cargo – 1.2 MTPA • Granite – 0.16 MTPA • Fertilizer – 0.2 MTPA • Molasses with Agro Products – 0.15 MTPA • Steel Products – 0.4 MTPA • Sugar – 0.29 MTPA

S. No	Parameter	Description
3.	Cargo Storage	• Iron Ore – 1.8 Ha • Coal – 7.0 Ha • Other General Cargo – 6.10 Ha
4.	Cargo handling equipment	Barge/Vessel loader, mobile harbor cranes, pay loaders
5.	Berthing facilities	Berth of length 440 m and width 30 m
6.	Length of Northern Breakwater	820 m
7.	Length of Southern Breakwater	865 m
8.	Navigation Facilities	Approach Channel (Inner/ Outer): Length: 1395/2280 m; Width: 100/100 m; Depth:(-) 10/10 m Turning Circle: Diameter: 250 m; depth: (-)10.0 m
9.	Dredging and Reclamation	• Capital dredge material: 3.9 MCM • Reclamation: 1 MCM of dredged material will be used • Remaining dredge material will be disposed at the identified disposal location, recommended through mathematical modelling studies at a distance of about 2.0 km to the north of port entrance channel. During periods of strong near shore currents (during peak wet season), it is suggested to dispose the sediment offshore at greater depths (>30 m).
10.	Navigational Aids	• Channel marker buoys; Fairway marker Buoy; Breakwater marker lights; Berth Corner Lights
11.	Connectivity	• Proposed Rail Corridor Connecting project site to Manki Railway station of about 15 km • Road Corridor connecting project site to NH17

A layout showing the planned barge/vessel loading facilities is given as **Figures FD0201.**

2.6.2 Cargo Handling Capacity

The cargo planned to be handled at Barge/ Vessel Loading Facility is provided in Table 2-4.

Table 2-4: Cargo Handling Capacity

S. No.	Commodity	Traffic (MTPA)
1.	Coal	2.70
2.	Iron Ore	1.00
	General Cargo	
3.	Granite	0.16
4.	Fertilizer	0.20
5.	Molasses with Agro Products	0.15
6.	Steel Products	0.40
7.	Sugar	0.29
8.	**Total**	**4.90**

2.6.3 Design Vessel Size and Dimension

Detailed vessel (Barge) size analysis covering lighterage operations being carried out in various Indian ports such as Mormugao (Goa) Port, Hazira Port, Gopalpur Port, Redi Port and Belekeri port was carried out to estimate the vessel size, which is an important factor in planning of barge/ vessel loading facility at Honnavar. The design vessel size considered for planning of facilities is given in the Table 2-5.

Table 2-5: Design Barge/Vessel Size and Dimension

Type of Vessel/Barge	Design Vessel Size (T)	LOA (m)	Beam(m)	Draft (m)
Vessel	10,000 DWT	156	21	8.8
Barges	10,000	110	26	6.7

2.6.4 Berthing Facilities

The requirements for berths are worked out taking into consideration of throughput, parcel size, cargo handling rates, vessel size/parcel size, operational downtime, effective working hours per day and number of barges. Proposed barge/ vessel loading facility involves the development of Two (2) berths to handle various types of cargo.

- Each berth with length 440 m will be provided with a width of 30 m.
- Each Berth will accommodate 2 vessel or 4 barges of 10000 DWT Size
- The dredged depth at the berthing area will be (-) 10.0 m CD.

2.6.5 Operation Downtime and Effective Working Hours

The effective working days are considered as 260 days considering the weather downtime including monsoon and public holidays. The cargo handling and barge servicing will be carried out 16 hours a day in two shifts. The productive cargo handling hours on an average in a day when a barge is at berth has been taken as 15 hours to account for shift changes and for any unplanned stoppages.

2.6.6 Breakwaters

To protect the approach channel from siltation and to maintain tranquillity in the harbour basin, two (2) breakwaters are proposed for Honnavar barge/vessel loading facility. The southern breakwater of length 865 m starts from shore and extends upto (-) 5 m contour. It is aligned in North West direction. The top level of breakwater is maintained at (+) 6 m CD at head portion and tapered to (+) 4.3 m towards HTL. The northern breakwater of length 820 m is aligned in South West direction. The top level of breakwater is maintained at (+) 6 m CD head portion and tapered to (+) 4.3 m towards HTL. Siltation pattern near the mouth of the harbour will be observed for 1 to 2 years and will be extended to (-6) m contour if required.

Quantity of quarry stones required is about 4.5 Million Tonnes, which will be transported by road from Bhatkal which is about 60 km from the site.

2.6.7 Approach Channel and Turning Circle

The channel alignment is oriented considering the following aspects:

- To avoid cross winds and currents on the barges.
- In a straight line as far as possible.
- To reach the deep-water contours in shortest possible distance (this is to optimise the quantity of dredging).

The dimensions of the navigation channel to barge loading terminal are dependent on vessel size, the behaviour of vessel when sailing through the channel, maritime environmental conditions (winds, currents and waves) and channel bottom conditions. Channel design primarily involves the determination of the safe channel width and depth for the dimensions of design vessel.

The estimated width and depth of the channel is presented in the Table 2-6.

Table 2-6: Width & Depth of Channel for Honnavar Barge/ Vessel Loading Facility

Description	Width in meters	Depth in meters	Length in meters
Outer Channel	100	10	1395
Inner Channel	100	10	2280

The diameter and depth of turning circle for safe manoeuvring of design vessel for the proposed barge loading facility is presented in Table 2-7.

Table 2-7: Diameter & Depth of Turning Circle for Honnavar Barge / Vessel Loading Facility

Description	Diameter in meters	Depth in meters
Turning Circle	250	(-) 10.0

2.6.8 Dredging and Disposal

2.6.8.1 Capital Dredging and Disposal

For a safe manoeuvring of the vessels through navigational channel, harbour basin and berths, dredging depths is required. The capital dredging quantity for development is estimated at 3.9 MCM. It is observed from the geotechnical investigations that the sea-bed soil profile varies from medium sand to clay, a major portion of which can be used for reclamation.

The entire landside facilities (viz., stockyard, operation buildings, etc.) will be developed in an area of 44 Ha. The entire area selected for the port back-up area is a low-lying land which will require reclamation upto (+) 4.30 m CD. It is proposed to use the 1.0 MCM of material (dredge spoil) for reclaiming the backup area and remaining material will be dumped at the identified disposal location, recommended through mathematical modelling studies at a distance of about 2.0 km to the north of port entrance channel. During periods of strong near shore currents (during peak wet season), it is suggested to dispose the sediment offshore at greater depths (>30 m).The dumping location or the disposal area is selected on the basis of the following parameters:

- Less adverse effect on the environment particularly on marine life
- Seabed levels (within the disposal area) should not get reduced, affecting thereby the depth requirements for safe navigation at all times.
- The material should not flow back to the channel and the dumping area should be along the direction of the most prevailing littoral current
- The lead distance should be the minimum possible to save on cost of disposal
- Least / minimum disturbance to the natural hydraulic regime/equilibrium

2.6.8.2 Maintenance Dredging and Disposal

The total maintenance dredging quantity is estimated to be around 10,300 m^3/year. The material collected will be dumped in the identified disposal ground. The details are discussed in Chapter 5.

2.6.9 Cargo Handling

The major commodities to be handled at Honnavar barge/vessel loading facility are iron ore, coal and other general cargo. The barge-shore cargo handling rate is generally selected on cost optimisation analysis, which takes into consideration reasonable barge time at berth, parcel size, the derived berth occupancy factor, relative cost of installing equipment of different rated capacity and barge time costs.

2.6.9.1 Cargo Handling Equipment

Selection of the equipment essentially depends on the through put. The iron ore will be transferred to barges from berth through barge loaders. The barge to shore transfer of coal will be using grab type mobile harbour crane. The type, capacity and number of equipments required for unloading and loading coal and iron ore are presented in Table 2-8.

Table 2-8: Summary of Cargo Handling Equipment

S.No.	Type	Cargo to be handled	Capacity	No. of equipments
At Mid sea				
1.	Barge unloader	Iron ore export	1200 TPH rated capacity	2
		Granite and Molasses export Fertiliser import	960 TPH rated capacity	2
		Sugar and Steel export	600 TPH rated capacity	2
2.	Barge Loader	Coal import	1200 TPH rated capacity	
At Berth				
3.	Mobile Harbour Crane	Coal import	1200 TPH	1
		Granite	960 TPH	1
		Molasses (Pipeline)	600 TPH	1
		Fertilizer	960 TPH	1
		Steel and sugar	960 TPH	1
4.	Loader	Iron ore export	1440 TPH	1
	Payloaders	Iron ore/coal		8

2.6.9.2 Cargo Transfer System

The iron ore will be brought from Bellary-Hospet region through trucks which will directly dump on the feeder of the barge loaders which will be transferred to barges. The additional iron ore will be stocked in the stockyard just behind the berth. Whenever the ore from the stockyard is to be loaded to barges, trucks can be used to transfer the iron ore to the berth. The coal brought by the barges is proposed to be unloaded on the jetty by mobile harbour crane. The conveying of coal from the platform to the stockyard will be done by trucks. Other cargo will also be handled in a similar way. The general cargoes will be stored in the space allotted for their storage.

2.6.10 Cargo Storage Area

The size of the storage areas have been worked out based on the criteria like the annual throughputs, design barge sizes, stowage factor, angle of repose, maximum and average stacking height, aisle space, reserve capacity factor, peaking factor, etc. Suitable space has been allocated in the backup areas in the form of open and covered storage facilities. The storage area requirements for various cargos are given in Table 2-9.

Table 2-9: Cargo Storage Area Requirements

S. No.	Cargo	Storage Area (in hectares)
1	Coal	7.0
2	Iron Ore	1.8
3	Other General Cargo	6.10
	Total	**14.9**

2.6.11 Shore Protection Works

The stockyard which will be developed by reclaiming the portion of the sand spit on the Kasakod side. Since the area is directly exposed to sea, the interface of sea land has to be protected by appropriate protection works.

As all port facilities are planned inside the river, area near the river mouth need to be protected from erosion. It is proposed provide shore protection work on both side of the river mouth and sea side of the storage area.

It is proposed to use geo-textile and rock boulders in gabions for protection of shore. The length of protection worked out as 1750 m. A typical cross-section of the protection work is presented in Figure 2-4.

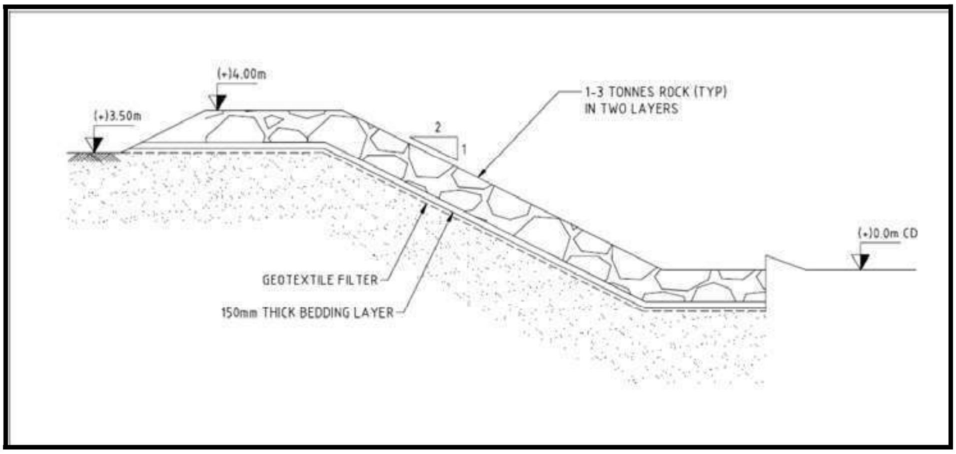


Figure 2-4: Typical Cross-section of Shore protection works

2.6.12 Fendering and Mooring Systems

Fenders are provided to absorb the berthing energy, which arise from the berthing of barge to avoid damage either to the structure or the vessel. Adequate numbers of fenders at adequate spacing has to be provided to avoid excessive load on the structure. Selection of fender will depend on the following parameters:

- Vessel size
- Berthing velocity
- Absorption capacity of fender
- Reaction force and deflection of fender
- Disposition of fender

2.6.13 Navigational Aids

The proposed development involves creating an approach channel, turning circle and manoeuvring area. Approach channels must be delineated by appropriate navigational aids. Navigational aids proposed for Honnavar barge/ vessel loading facility are Channel Marking Buoys, Star board size (2 Nos.), Port-hand side buoys (4 Nos.), Fairway marker Buoy, Breakwater marker lights and Berth Corner Lights.

2.6.14 Port Crafts

To handle the proposed vessel sizes in the short-term development, two tugs of about 20 T bollard pull capacity with fire-fighting arrangements are proposed. Also, the tug would have pollution control equipment on board. It is also proposed to provide the one pilot launch for the Honnavar barge/vessel loading facility.

2.6.15 Existing Hinterland Connections and Road/Rail Network

Good road and rail connectivity is an essential requirement for the efficient functioning of any barge/ vessel loading facility. As far as Honnavar barge/ vessel loading facility is concerned, the main commodities proposed to be handled are iron ore and coal. The iron ore handled at Honnavar is expected to come mainly from Hospet-Bellary belt of Karnataka state. At present, 30% of the iron ore exported from this belt is taken to the respective port by means of road and the rest 70% via rail. Similarly, the coal being imported at Honnavar is taken to the respective destinations, mostly power plants, through road and rail.

2.6.15.1 Road Connectivity

The site has good road connectivity. NH 17 passes through Honnavar towards East of project site at a distance of about 1 km. The site is connected to Bellary through NH 63 and NH 17. NH 17 meets NH 63 near Ankola at about 45 km from the site.

Presently the site can be approached from a single lane black topped road that runs in continuation to NH 17 and then lies parallel to shoreline.

2.6.15.2 Rail Connectivity

The site can be easily accessed through Konkan railway (Connecting Kerala with Mumbai). The barge/vessel loading facility proposed at Honnavar is at a distance of 5.0 km from Honnavar railway station and 14 km from Manki railway station.

2.6.15.3 Airport & Seaport-Harbour

The nearest Airports are at Mangalore and Goa which is about 150 km and 220 km respectively and the nearest seaport is at Karwar which is about 60 km from the project site.

2.6.16 Proposed Dedicated Rail/Road Corridor

Proposed road connectivity to the barge/vessel loading facility is discussed below and shown in Figure 2-5. All these options will have to be laid afresh.

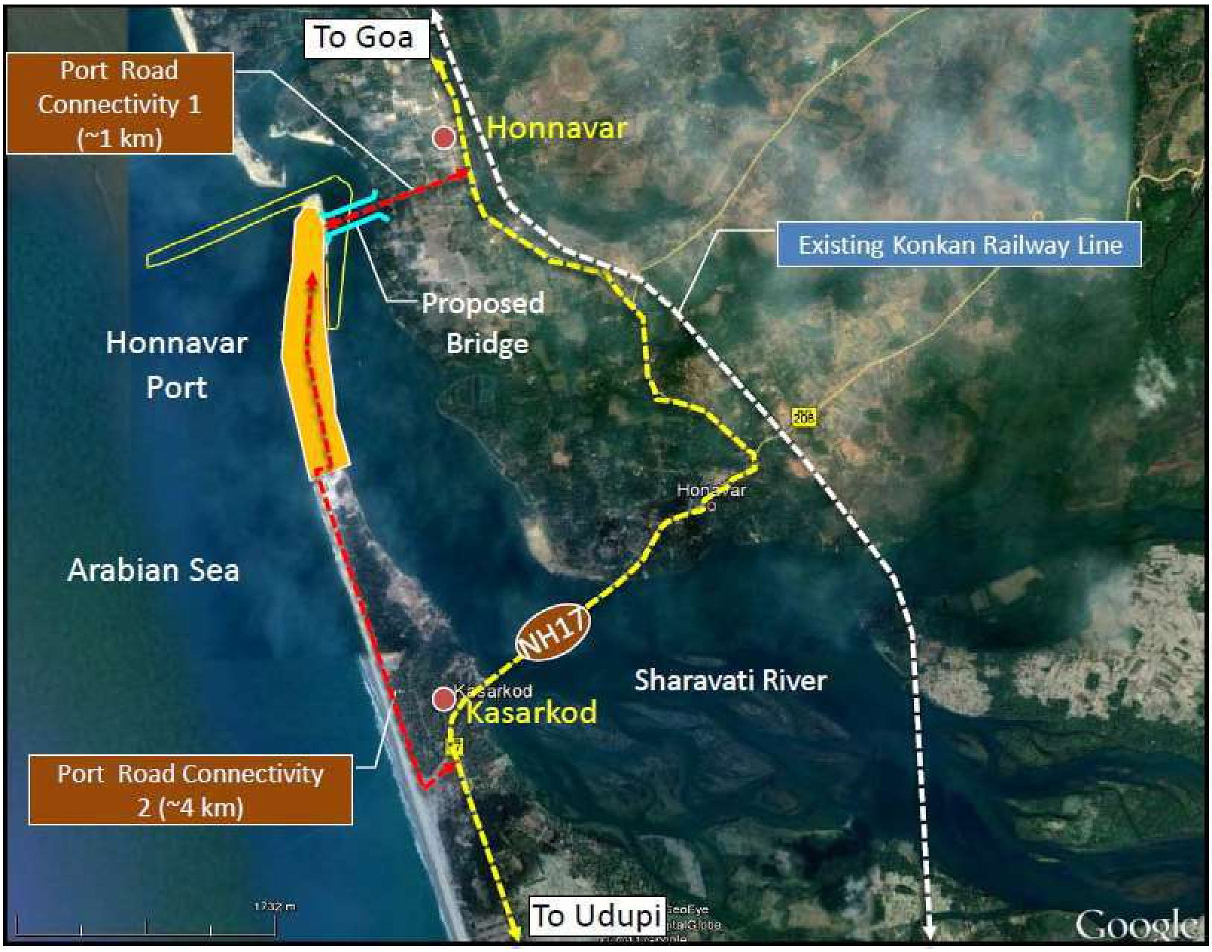


Figure 2-5: Proposed Road Connectivity to the Barge/ vessel loading facility

2.6.16.1 Road Connectivity Option: I

The road in this option takes off from NH 17 at Topalgaere and then traverses southeast a distance of around 0.90 km. A proposed bridge passing over River Bagdani will connect the road to the project site. Thus the overall length of this connectivity option will be around 1 km with a width of 25 m with a provision of double lane road.

2.6.16.2 Road Connectivity Option: II

In this option the proposed road starts from NH 17 at Kasarkod. This road will then run south east for some distance and then aligns parallel to the shoreline till it reaches the proposed project site. This option will be parallel to the existing single lane road at an offset distance of 100 m. The total length of this road from NH 17 to the proposed site is 4 km. This road connectivity will have a width of 25 m.

2.6.16.3 Conclusion

As the barge/ vessel loading facility is proposed in the Kasarkod side, Connectivity option II i.e. road from NH 17 to Kasarkod side is found to be best suited for this facility.

Proposed rail connectivity to the project site is discussed below and shown in Figure 2-6

.

Figure 2-6: Proposed Rail Connectivity to the barge/vessel loading facility

2.6.16.4 Rail Connectivity Option: I

In this option, the connectivity will be provided to the proposed site from Topalgere side. Proposed railway siding will takes off from Honnavar railway station and will run parallel to the existing line for a length of about 1.6 km and then will turn south west towards the proposed site. Total length of the proposed railway line to be laid through this option is about 2.8 km. River Bagdani crossing is envisaged due to proposed alignment (connectivity option I) which in turn requires building a new bridge across the river.

2.6.16.5 Rail Connectivity Option: II

In this connectivity option, railway line will take off from the existing railway station at Manki. The new railway line will have to be laid for a distance of 14.6 km from Manki railway station to the proposed project site. Proposed railway line will run parallel to existing railway line for a length of about 8 km and then will take a turn towards sea coast which will then run parallel to the sea coast till the proposed project site for the remaining 6.6 km.

2.6.16.6 Conclusion

As the proposed barge/ vessel loading facility is coming up in the Kasarkod side, rail Connectivity Option II i.e. rail connectivity from Manki to Karsarkod side is found to be best suited for this facility.

2.6.17 Utilities and Services

2.6.17.1 Water Supply

Water is required at the Honnavar barge/vessel loading facility for the following activities:

- Supply to barges
- Supply to facility staff
- Miscellaneous purposes
- Dust Suppression and fire fighting purposes
- Green Belt Development

Water requirement during the construction is expected to be around 15m^3/day. Water demand during operational phase of barge/ vessel loading facility is estimated as 7m^3/day.

The break-up of the demand for each of the activity is presented in Table 2-10.

Table 2-10: Break-up of Water Requirement

S. No.	Activity	Water Requirement (m^3/day)
1.	Supply to barges	3
2.	Supply to barge loading facility staff and users	2
3.	Miscellaneous	2
	Total	**7**

The water requirement will be met from Karnataka Rural water supply and sanitation agency which includes supply to Barge/vessels, staff and users. In addition to that water required for dust suppression system and fire fighting will be sourced from Sharavati River.

2.6.17.2 Power Supply

The power supply is required for the following barge/vessel loading facility operations

- Lighting of the berth and storage yard
- Fire Fighting Equipments
- Operation Building
- Substation Lighting
- Miscellaneous

Power requirement during construction phase is expected to be around 1 MVA. The power demand is estimated at 1 MVA during operation. Construction phase power requirement will be met from DG sets and operation phase power will be drawn from Substation located at Honnavar (~2 km).

2.6.17.3 Buildings

Various buildings envisaged in the proposed barrage/vessel loading facility are as follows:

- Administrative buildings including the administrative office and officer's amenities, operational buildings / offices and the office space for major facility users.
- Maintenance buildings comprising a workshop, functional work stations and fire station.
- Substations to provide distribution of power.
- Navigational control centre, plant operational buildings, customs and security buildings, traffic offices, medical centre and amenity buildings / conveniences.

2.6.17.4 Fire-Fighting Facilities

Fire fighting system will be provided to both control and extinguish fires. It is proposed to install Fire Hydrant System, which will be designed to give adequate fire protection for the facility based on Indian Standards or equivalent and will conform to provisions of Tariff Advisory Committee's Fire Protection Manual. Fire hydrant system is provided for the following areas in the barge/ vessel loading facility:

- Berth areas
- Coal Stockpile area
- Main substation
- Control room
- Fuel depot area
- Generator power house
- Main administration office
- Workshop Areas
- Operation building

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. The hydrant service shall consist of two or more interconnected ring mains to cover the facility, each with its individual pump, located in a common pump house. Adequate arrangement with jockey pumps, pressure switches, etc., shall be provided to maintain the required pressure in the hydrant system.

Commonly used fire-fighting agents are water, foam, carbon dioxide and powder. In most of the cases when water is used as the fire-fighting agent, the intake mains should be below water at any point of time and protected from damages. A fire station will be provided for attending to all calls which will house required mobile fire tenders. One fire tender will be provided with snorkel attachment.

2.6.18 Pollution Control Aspects

2.6.18.1 Dust Suppression System

Dust suppression equipment will be provided for efficient control of dust pollution on environment during storage and handling of coking Coal and Iron ore at berth and stockyard. An efficient dust suppression system will contain dust particles before it is airborne.

A common system consisting of suitable pump, storage tank, nozzles have been proposed for efficient dust control system. Dust control is envisaged at following locations:

- barge/ vessel loading /unloading area

- Stockyards

Water sprinkling system at high pressure with swivelling type nozzles will be installed to cover entire stockpile. Nozzles will be installed on pipes at different levels from ground. Nozzles will be installed along stockpile at regular intervals to cover stockpile height and width.

2.6.18.2 Wastewater Management

The wastewater and sewage generated during construction at site and at labour camp will be collected in holding tank and periodically transferred to nearby Treatment Plant. During operation, the sewerage system will be provided to collect the sewage from Barge/ vessel loading facility administration building, canteen and operation buildings and it will be collected in septic tank followed by soak pits. The cargo storage area will be provided with an extensive drainage and treatment system so that the contaminated water from the stockyard area does not flow directly into the natural water bodies or into the groundwater system. Drainage pits will be provided in the workshop areas, which will be connected to an oily wastewater tank. Oily wastewater if any will be collected and will be treated (if required) to meet the discharge standards.

2.6.18.3 Rainwater Harvesting System

Rain water collected from roof of buildings will be channelized through rain water down comers and routed to garland drain around the buildings. These garland drains are connected to the plant storm water drainage network system all around the proposed barge/ vessel loading facility area. Recharge wells will be located at strategic locations within the site and will be interconnected to the storm water drain network system.

2.6.18.4 Solid Waste Management System

Solid waste from the utilities such as canteen shall be segregated as biodegradable and non-biodegradable waste and collected separately by providing bins at respective places. The collected biodegradable waste shall be subjected to composting and the compost will be used as manure for the development of green belt within the facility. The non-biodegradable waste like plastic shall be disposed off to approved vendors of KSPCB/CPCB in a scientific manner.

2.7 Coastal Regulation Zone Compatibility

Physical demarcation of HTL, LTL and delineation of CRZ setbacks for the project site were carried out by Centre for Earth Science Studies (CESS). Based on the perusal of the CRZ Notification, 2011 and the HTL/LTL survey outcome, following are the inferences:

- Proposed site falls on the sandy beach near the river mouth.
- CRZ Setback lines indicate that the proposed barge/ vessel loading site mostly falls within the CRZ I (B) (i.e. Area between LTL and HTL) , CRZ (III) undeveloped rural area and CRZ IV(near shore waters and backwaters).
- Proposed location does not contain environmentally sensitive areas such as National parks / marine parks, sanctuaries, wildlife habitats, corals / coral reefs. It also does

not include breeding and spawning grounds of fish and other marine life, area of outstanding natural beauty / historically / heritage area, area rich in genetic diversity.

Based on perusal of Coastal Regulation Zone (CRZ) Notification, 2011 and Karnataka Coastal Zone Management Plan (CZMP), Proposed Honnavar barge/vessel loading is a permissible activity in CRZ as it requires waterfront and foreshore facilities.

The project layout superimposed on HTL, LTL and CRZ setbacks is given as **Figure FD0202**.

2.8 Green areas and Greenbelt Development

An area of about ~3.10 Ha is proposed to be developed as greenbelt. Greenbelt will be developed at stockyards, administration building and along the road areas. The tree species to be used for the green belt development will be in line with the local ecology (indigenous species).

2.9 Project Cost

The capital cost estimate for development proposed barge / vessel loading facility is estimated at **513.00 Crores**.

2.10 Project Implementation Schedule

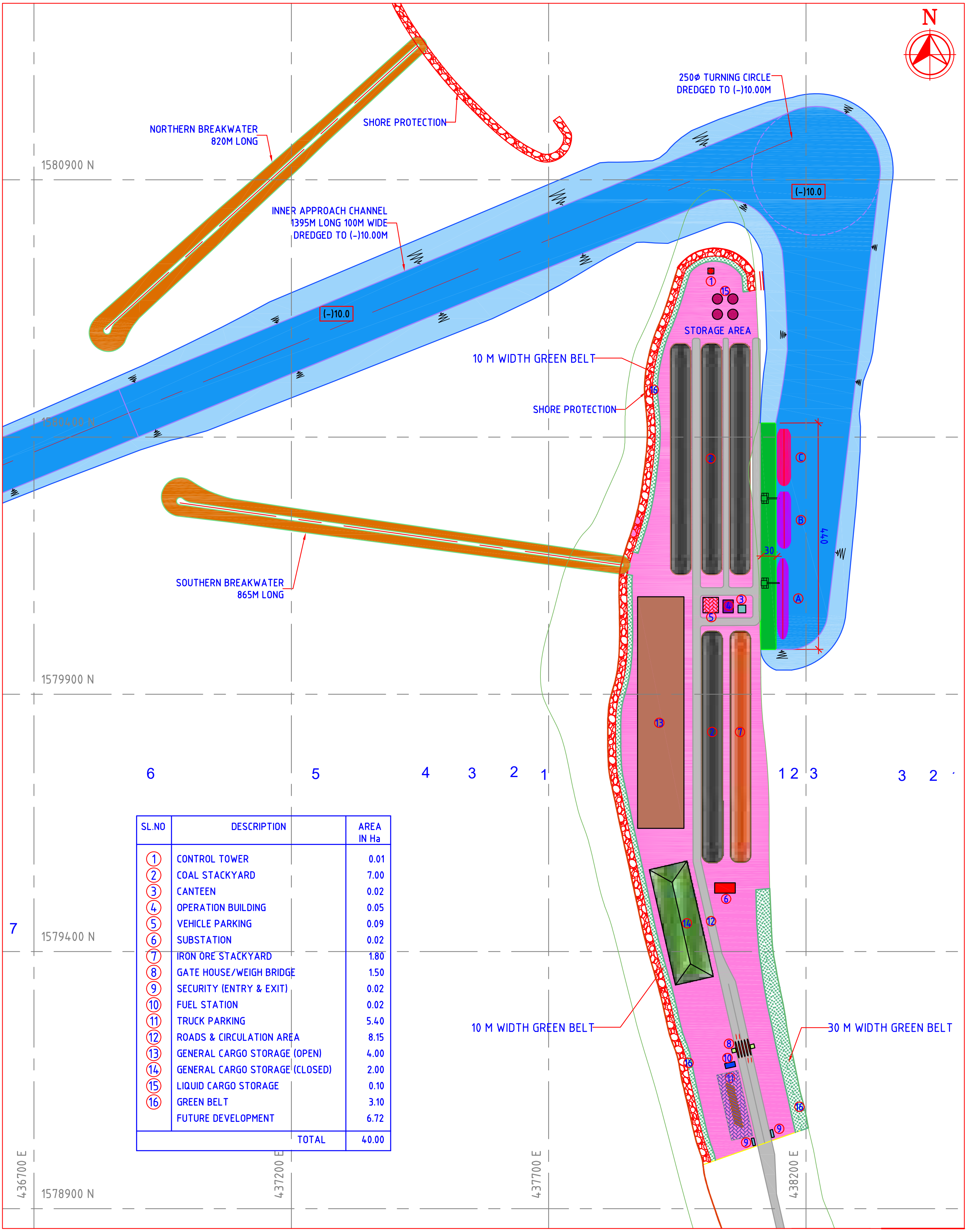
It is aimed at to achieve commissioning of the Barge/ vessel loading facility with in a period of 24 months from construction start / Financial Closure. The project implementation schedule is given as **Appendix I**.

2.11 Corporate Social Responsibility

As a part of Corporate Social Responsibility (CSR), HPPL proposed to take up following activities for improving the way of living of people of Kasarkod Tonka, Apsarkonda and other nearby villages.

- Providing better health services
- Providing better educational facilities for children of employees
- Creating job opportunities
- Facilitate self-employment through training and credit linkage
- Outsourcing opportunities to Self Help Groups (SHG)
- Providing protected water supply system to Kasarkod Tonka and Apsarkonda villages.
- Strengthening area Government hospitals by assisting them in procurement of essential medical equipments.
- Providing quality health care through regular medical camps.

FIGURES



SL.NO	DESCRIPTION	AREA IN Ha
1	CONTROL TOWER	0.01
2	COAL STACKYARD	7.00
3	CANTEEN	0.02
4	OPERATION BUILDING	0.05
5	VEHICLE PARKING	0.09
6	SUBSTATION	0.02
7	IRON ORE STACKYARD	1.80
8	GATE HOUSE/WEIGH BRIDGE	1.50
9	SECURITY (ENTRY & EXIT)	0.02
10	FUEL STATION	0.02
11	TRUCK PARKING	5.40
12	ROADS & CIRCULATION AREA	8.15
13	GENERAL CARGO STORAGE (OPEN)	4.00
14	GENERAL CARGO STORAGE (CLOSED)	2.00
15	LIQUID CARGO STORAGE	0.10
16	GREEN BELT	3.10
	FUTURE DEVELOPMENT	6.72
	TOTAL	40.00

Fig. 2: CRZ map (Note: Refer CRZ report for details)

Chapter 3
Analysis of Alternatives

3 Analysis of Alternatives

3.0 General

Environmental sustainability, Social, Engineering aspects and Economic viability are the criteria considered to study the various possible options of Barge/ vessel loading facility development and their advantages and disadvantages. Accordingly various possible layouts have been prepared utilising the results of traffic study, environmental aspects in the area, field surveys, model studies, and economic viability which enabled to short list the most promising alternatives.

3.1 Alternate Options

This section outlines the various alternatives considered for construction of the proposed facility. To study the possible options for development of Barge/ vessel loading facilities, various alternative layouts were prepared and reviewed. The following alternatives were analysed and evaluated.

- Alternative 1: Straight Channel with berth and Stockyard on Kasarkod side
- Alternative 2: Channel along the present river mouth, berth and Stockyard on Kasarkod side
- Alternative 3: Channel made after cutting open the Kasarkod spit with berth and Backup area on the Kasarkod side
- Alternative 4: Channel made after cutting open the Kasarkod spit with berth and Backup area on the Honnavar side

The features common to all alternatives are described here under:

All alternatives are planned to handle 2 vessel or 4 barges of 10000 DWT simultaneously. The total length of the berth is planned to be 440 m with a width 30 m. The approach channel is planned for a width of 100 m and dredged depth of (-) 10 m CD. The turning circle is planned for a diameter of 250 m and dredged depth of (-) 10 m CD.

The details of the alternative layouts are presented in following subsections:

3.1.1 Alternative 1: Straight Channel with berth and Stockyard on Kasarkod side

In this alternative the channel is aligned straight and is made by cutting open the Northern end of Kasarkod sand spit 75 m south of the present opening to provide better navigation in the turning circle. The berth is proposed south of the turning circle with the stockyard immediately behind the berth. Breakwater is proposed to prevent siltation in the channel. Southern breakwater of length 895 m and a Northern breakwater of length 580 m are proposed. Land area of about 3 Ha will be isolated due to cutting open the spit. The stockyard can be connected to the NH 17 by developing the road along the sand spit behind the fishery harbour. Alternative-1 Layout is presented in **FD0301**

3.1.2 Alternative 2: Channel along the present river mouth and berth and Stockyard on Kasarkod side

In this alternative the approach channel is aligned along the present channel which is being used by the fishing vessels. The channel is made by dredging the northernmost tip of Kasarkod sand spit. The berth is proposed south of the turning circle with the stockyard immediately behind the berth. Breakwater is proposed to prevent siltation in the channel. A Northern breakwater of length 820 m and a Southern Breakwater of length 865 m are proposed. The stockyard can be connected to the NH 17 by developing the road for about 4 km along the sand spit behind the fishery harbour. Alternative 2-Layout is presented in **FD0302**.

3.1.3 Alternative 3: Channel made after cut opening the Kasarkod spit with the berth and backup area on Kasarkod side

In this alternative the channel is made by cutting the Kasarkod spit just north of the proposed extended fishery wharf. The berth is proposed north of the turning circle with stockyard immediately behind the berth. Breakwater is proposed to prevent siltation in the channel. A northern breakwater of length 250 m and Southern breakwater of length 225 m is proposed. The stockyard can be connected to the NH 17 by developing a bridge connecting the Kasarkod and Honnavar road joining the NH 17 at Topoalgere. A road of about 1 km has to be developed after the bridge. Alternative-3 Layout is presented in **FD0303**.

3.1.4 Alternative 4: Channel made after cut opening the Kasarkod spit with berth and backup area on Honnavar side

In this alternative the channel is made by cutting open the Kasarkod spit just north of the proposed extended fishery wharf. The berth is proposed on the Honnavar Side of Sharavati River with the stockyard developed by reclaiming the area behind the berth. The stockyard can be connected to the NH 17 by developing road of about 2 km along the present commercial wharf in front of the port office and joining the NH 17 just before the Sharavati Bridge. Alternative-4 Layout is presented in **FD0304**.

A northern breakwater of length 250 m and Southern breakwater of length 225 m is proposed in this option.

3.2 Comparison of Layouts

Various alternatives discussed above are compared below:

Table 3-1 presents the comparison between the above presented layouts.

Table 3-1: Comparison of Layouts

S.No.	Description	Alternative 1	Alternative 2	Alternative 3	Alternative 4
1.	Location	Berth is located on the northern side of the Kasarkod spit	Berth is located on the northern side of the Kasarkod spit	Berth is located on the central part of the Kasarkod spit	Berth is located on Honnavar side

S.No.	Description	Alternative 1	Alternative 2	Alternative 3	Alternative 4
2.	Approach Channel	Channel is aligned East - West by cutting the Kasarkod Spit on the northern end. The Channel Length: 3740 m	Channel is aligned in the South West Direction. The Channel Length: 3675 m	Channel is aligned in the East - West Direction. Channel Length: 3550 m	Channel aligned in the West North West Direction. Channel Length: 3565 m
3.	Dredging	3.0M cum	3.9 M cum	3.5 M cum	2.8 M cum
4.	Breakwater	Northern: 580 m Southern: 895 m	Northern: 820 m Southern: 865 m	Northern: 250 m Southern: 225 m	Northern: 250 m Southern: 225 m
5.	Navigability	Straight Channel; Turning is comparatively easy	Channel connecting the turning circle is aligned and turning is comparatively easy	Straight Channel; Turning is comparatively easy	Straight Channel; Turning is comparatively easy
6.	Connectivity to NH 17	Road can be developed along the Sand spit behind the fishery wharf	Road can be developed along the Sand spit behind the fishery wharf	A connecting bridge has to be constructed to connect the Kasarkod and Honnavar side	Road can be developed along the commercial wharf on the Honnavar side in front of the port office
7.	Availability of Backup area	Good storage area of 44 Ha is available	Good storage area of 44 Ha is available	Good storage area of 44 Ha is available	Area needed for storage has to be reclaimed
8.	Additional cost	Nil	Nil	Total cost of the project is more as it needs a bridge and land acquisition for the road	Total cost of the project is more as it requires reclaiming of the stockyard and land acquisition for the road
9.	Social	Nil	Nil	Proposed Road alignment will pass through densely populated area	Area earmarked for development is in front of a densely populated area
10	Approx Civil cost* (` Crores)	303	450	285◊	276
11.	Future Development	Good potential for development into a major port	Good potential for development into a major port	It will continue as a lighterage port	It will continue as a lighterage port
12.	Ranking	II	I	IV	III

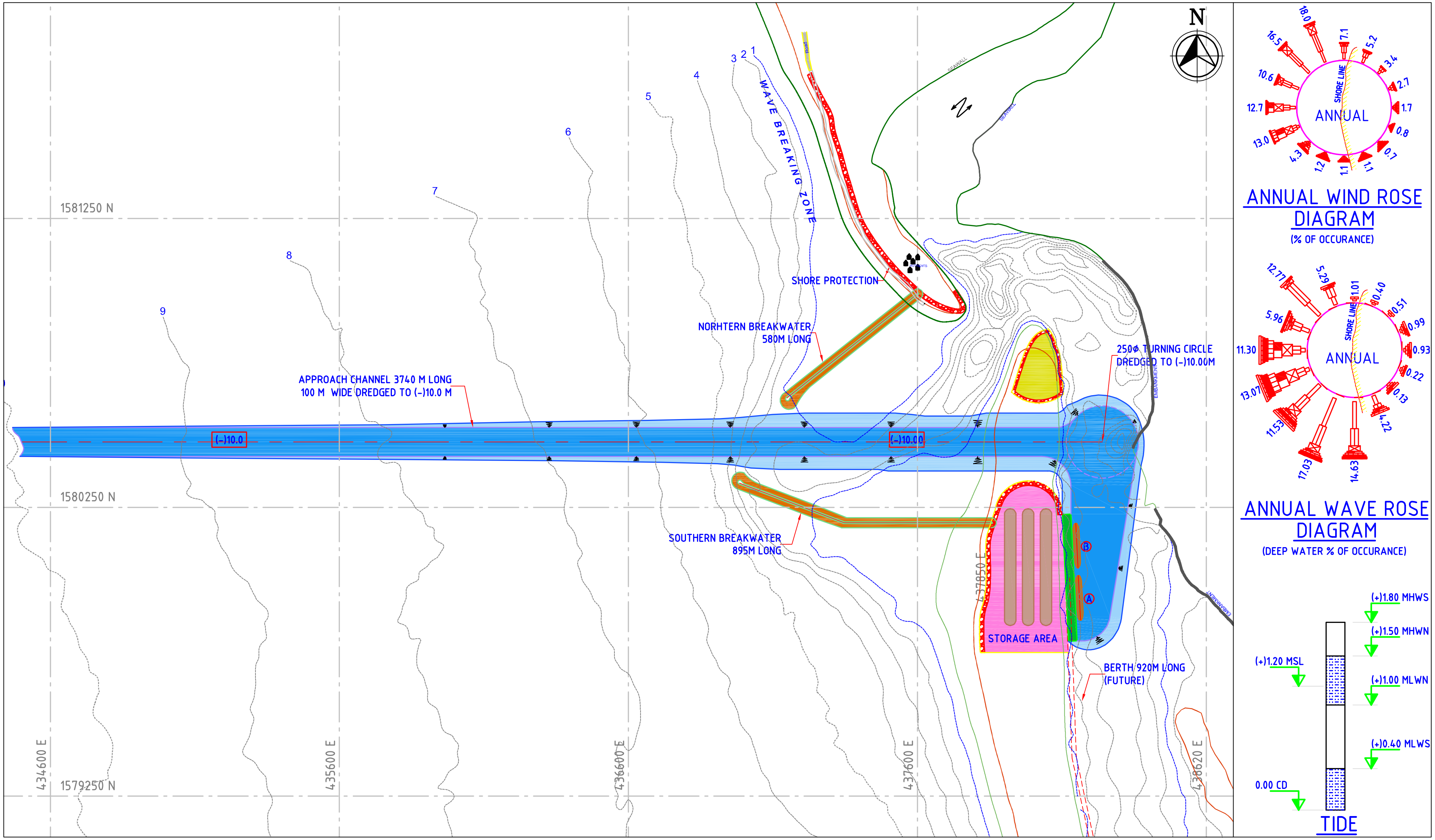
*) Cost of road way is not considered.

◊) Includes Cost of bridge connecting Kasarkod and Honnavar.

3.3 Selection of Best Layout

From the above comparison, Alternative 2 has been considered for further development as this alternative facilitates better connectivity easy operation and also good potential for future development.

FIGURES



NOTES :

1. ALL DIMENSIONS ARE IN METRES.
2. ALL LEVELS ARE IN METRES AND ARE WITH RESPECT TO CHART DATUM (C.D)
3. ALL COORDINATES ARE GIVEN IN METRES REFERRED TO UNIVERSAL TRANSVERSE MERCATOR (UTM) PROJECTION,SPHEROID (WGS 1984), ZONE 43 AS GIVEN BY INDOMER COASTAL HYDRAULICS (P) LTD.
4. BATHYMETRY & SHORE LINE DETAILS ARE BASED ON BATHYMETRY SURVEY CARRIED OUT BY INDOMER COASTAL HYDRAULICS (P) LTD.

DESCRIPTION	BERTH LENGTH	SHIP SIZE
COAL/IRON ORE - Ⓐ & Ⓑ	440	10,000 DWT

SCALE: 1:13000

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PROJECT: EIA FOR BARGE/VESSEL LOADING FACILITIES AT HONNAVAR, KARNATAKA

TITLE: ALTERNATIVE LAYOUT-1

L&T-RAMBØLL CONSULTING ENGINEERS LIMITED

REPORT NO: RP001

PROJECT NO: C1111304

DATE: 291111

MADE: BNK

FIGURE NO: FD0301

REV: 0

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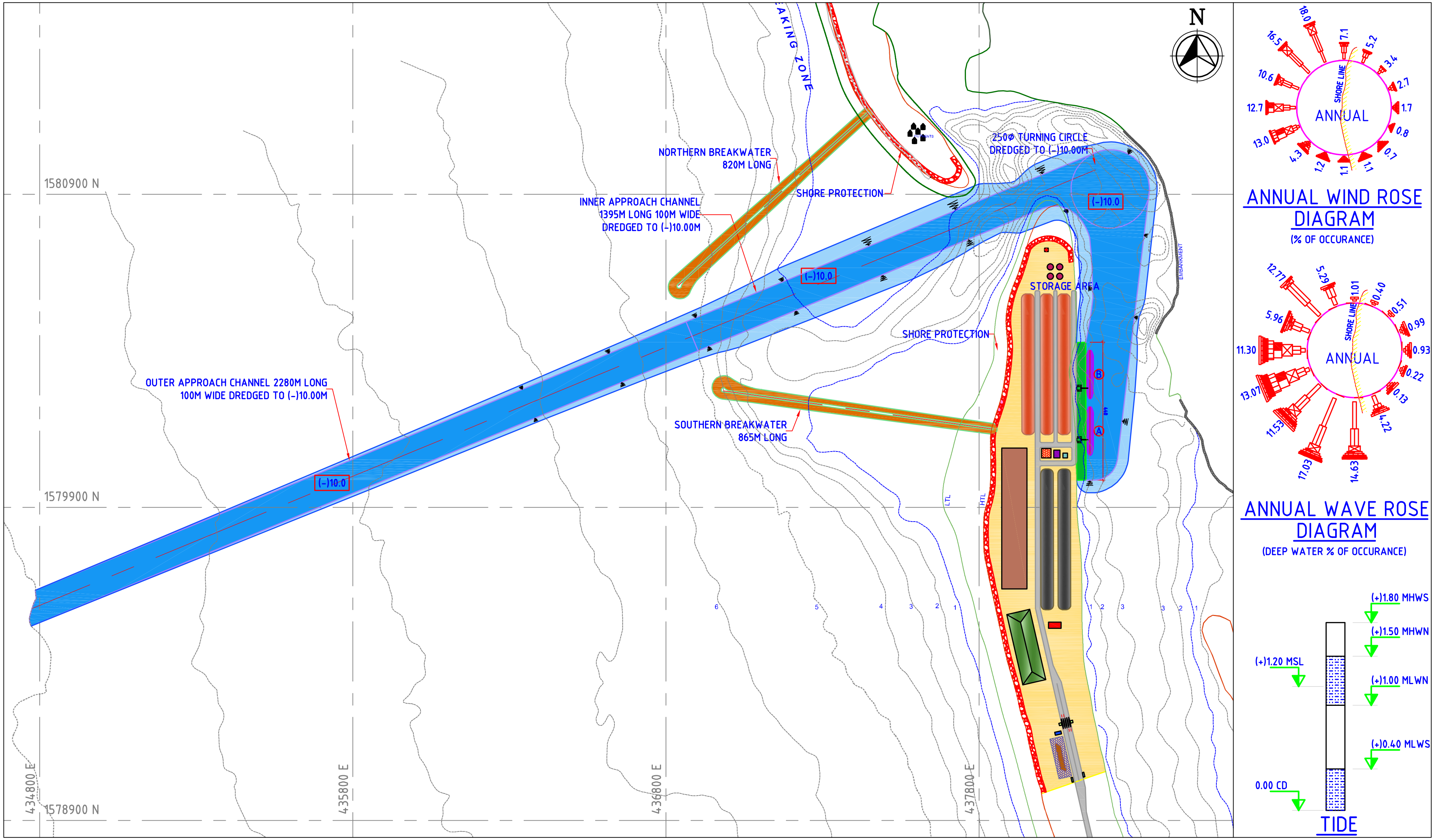
TBA



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4. BATHYMETRY & SHORE LINE DETAILS ARE BASED ON BATHYMETRY SURVEY CARRIED OUT BY INDOMER COASTAL HYDRAULICS (P) LTD.

DESCRIPTION	BERTH LENGTH (M)	VESSEL SIZE (M)
COAL/IRON ORE - Ⓐ & Ⓑ	440	10,000 DWT (156x21x8.8)

SCALE: 1:12000

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PROJECT: EIA FOR BARGE/VESSEL LOADING FACILITIES AT HONNAVAR, KARNATAKA

TITLE: ALTERNATIVE LAYOUT-2

L&T-RAMBØLL CONSULTING ENGINEERS LIMITED

REPORT NO: RP001
PROJECT NO: C1111304
DATE: 291111
MADE: BNK
FIGURE NO: FD0302
REV: 0

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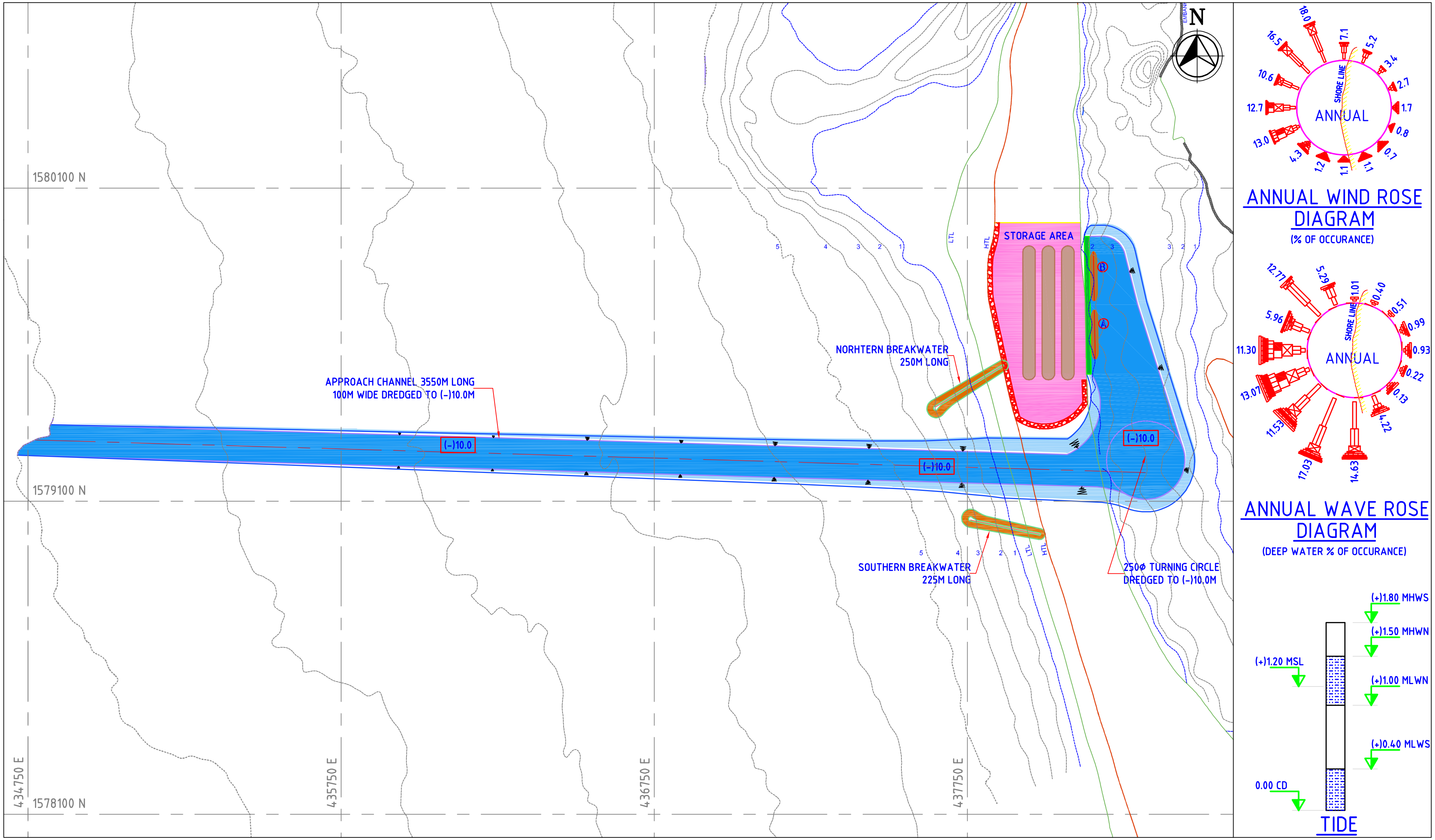

NOTES :

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4. BATHYMETRY & SHORE LINE DETAILS ARE BASED ON BATHYMETRY SURVEY CARRIED OUT BY INDOMER COASTAL HYDRAULICS (P) LTD.

DESCRIPTION	BERTH LENGTH (M)	VESSEL SIZE (M)
COAL/IRON ORE - Ⓐ & Ⓑ	440	10,000 DWT (156x21x8.8)

SCALE: 1:4000

PATH: REFER BOTTOM LEFT CORNER OF THE DRAWING

PROJECT: EIA FOR BARGE/VESSEL LOADING FACILITIES AT HONNAVAR, KARNATAKA

TITLE: ALTERNATIVE LAYOUT-3

L&T-RAMBØLL CONSULTING ENGINEERS LIMITED

REPORT NO: RP001
PROJECT NO: C1111304
DATE: 291111
MADE: BNK
FIGURE NO: FD0303
REV: 0

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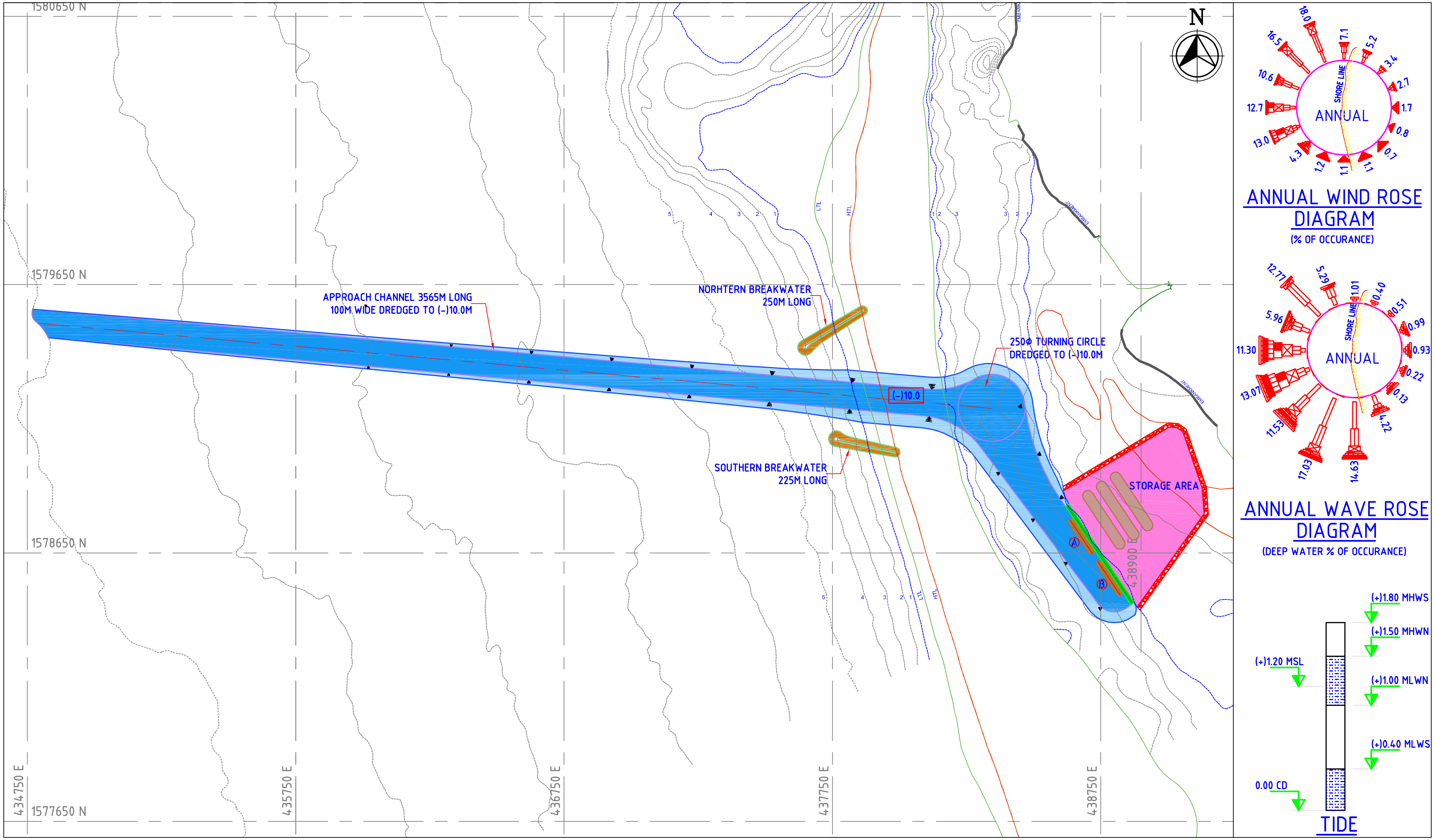
TBA



NOTES :

1. ALL DIMENSIONS ARE IN METRES.
2. ALL LEVELS ARE IN METRES AND ARE WITH RESPECT TO CHART DATUM (C.D)
3. ALL COORDINATES ARE GIVEN IN METRES REFERRED TO UNIVERSAL TRANSVERSE MERCATOR (UTM) PROJECTION,SPHEROID (WGS 1984), ZONE 43 AS GIVEN BY INDOMER COASTAL HYDRAULICS (P) LTD.
4. BATHYMETRY & SHORE LINE DETAILS ARE BASED ON BATHYMETRY SURVEY CARRIED OUT BY INDOMER COASTAL HYDRAULICS (P) LTD.

DESCRIPTION	BERTH LENGTH (M)	VESSEL SIZE (M)
COAL/IRON ORE - Ⓐ & Ⓑ	440	10,000 DWT (156x21x8.8)

SCALE: 1:5500

PATH: REFER BOTTOM LEFT CORNER OF THE DRAWING

PROJECT: EIA FOR BARGE/VESSEL LOADING FACILITIES AT HONNAVAR, KARNATAKA

TITLE: ALTRNATIVE LAYOUT-4

REPORT NO: RP001

PROJECT NO: C1111304

DATE: 291111

MADE: BNK

FIGURE NO: FD0304

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L&T-RAMBØLL CONSULTING ENGINEERS LIMITED

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Chapter 4
Description of Environment

4 Description of Environment

4.0 General

The baseline/existing environmental conditions in the study area/Project Influence Area (PIA) are established based on field surveys, investigations and review of data collected from various secondary sources. The baseline environmental studies have been conducted for one season (non monsoon season) covering the following terrestrial and marine environmental attributes.

Terrestrial Environmental Components	Marine Environmental Components
• Meteorology – Temperature – Humidity – Rainfall – Wind Speed & Direction – Secondary Data	• Marine Water Quality – Physico-Chemical Parameters
• Ambient Air Quality – PM_{10} – $PM_{2.5}$ – Sulphur Dioxide (SO_2) – Nitrogen Dioxide (NO_2) – Carbon Monoxide (CO) – Hydro carbons (HC) – Mercury (Hg) – Ozone (O_3)	• Sediment Quality – Physical Parameters – Chemical Parameters
• Ambient Noise Levels – Day equivalent noise levels – Night equivalent noise levels	• Biological Parameters – Plankton – Macrobenthos – Meiobenthos
• Inland Water Quality – Groundwater Quality – Surface Water Quality	•
• Soil Quality	
• Flora & Fauna (Ecology)	

4.1 Study Area

Project Influence Area/Study Area: As described in **Chapter 1**, an area within 10 km radius, with the barge/vessel loading facility site as boundary has been earmarked for the study as the PIA/**study area**. The **core area** is the project site. The study area is of 10 km radius for primary data generation.

Description of Project Influence Area: The proposed Honnavar Barge/vessel loading facility is located near the mouth of Sharavati River in Kasarkod Tonka Village, Uttara Kannada District, Karnataka. The land proposed to be developed for Barge/vessel loading facility is mostly between Low tide Line (LTL) and High tide Line (HTL) and partly beyond HTL and meets the Coastal Regulation Zone (CRZ) I (b), CRZ III & CRZ IV Classification.

Study Period: The baseline environmental data was generated for one season (12 Weeks).i.e., Summer Season 2011.

4.2 Land Environment

4.2.1 Land

Availability of required land for the Barge/ vessel loading activity: The proposed site of 98.84 acres (~44Ha) of land completely coastal sand. The rail/road corridor is proposed to be developed to connect the Konkan Railway network and NH 17 respectively.

4.2.2 Land Use – Land Cover Study Methodology

Methodology: The land use/land cover for the study area is prepared in the form of a map prepared by using satellite imageries of IRS – P6 LISS IV MX (RABI Season) procured from ***National Remote Sensing Centre (NRSC), Hyderabad***. The satellite imagery showing the 15 km radius PIA is shown as **Figure FD0401**. The satellite data is processed using ERDAS Imagine software supported with ground checks and ground truth verification. Area and distance calculations have been carried out using Geographical Information System (GIS) software after geo-referencing the interpreted data with the help of Survey of India (SoI) Toposheet (scale 1:25,000). Land use and Land Cover for the study area is given as **Figure FD0402**.

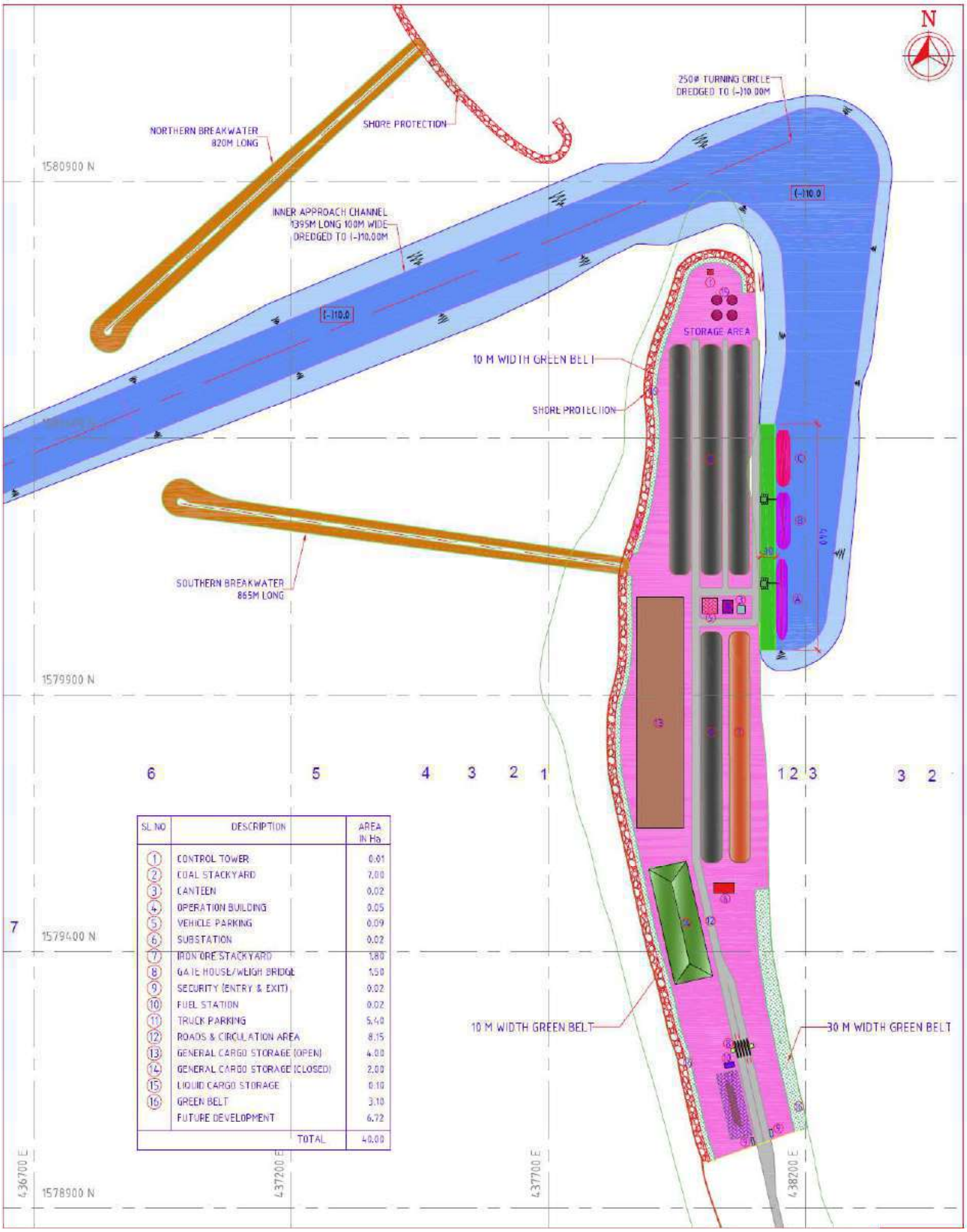
4.2.2.1 Land use Pattern in Project Site

The land use in the project site is presented in Table 4-1.land use pattern of the project influence area is presented in Table 4-2.

Table 4-1: Land Use in Project Site

S. No.	Land Use	Area (Ha)	%
1	Coastal sand	44	100
	TOTAL	**44**	**100**

The proposed land use of the project site is given in the below **Figure 4-1**.



SL NO	DESCRIPTION	AREA IN Ha
1	CONTROL TOWER	0.01
2	COAL STACKYARD	7.00
3	CANTEEN	0.02
4	OPERATION BUILDING	0.05
5	VEHICLE PARKING	0.09
6	SUBSTATION	0.02
7	IRON ORE STACKYARD	1.80
8	GATE HOUSE/WEIGH BRIDGE	1.50
9	SECURITY (ENTRY & EXIT)	0.02
10	FUEL STATION	0.02
11	TRUCK PARKING	5.40
12	ROADS & CIRCULATION AREA	8.15
13	GENERAL CARGO STORAGE (OPEN)	4.00
14	GENERAL CARGO STORAGE (CLOSED)	2.00
15	LIQUID CARGO STORAGE	0.10
16	GREEN BELT	3.10
	FUTURE DEVELOPMENT	6.72
	TOTAL	40.00

Figure 4-1: Proposed Land Use Pattern Map of Honnavar Barge/Vessel Loading Facility

4.2.2.2 Land use Pattern in and around Project Site

Table 4-2: Land Use Pattern in the Project Influence Area

S. No.	Land Use		Sq. km	Area (%)
	Description	Details		
1.	Built Up	Settlements	7.777	1.10
2.	Water bodies	Tank/River/etc.	43.127	6.10
		Sea	361.277	51.10
3	Forest	Dense forest	78.477	11.10
		Scrub forest	61.367	8.68
		Mangroves	10.605	1.50
4	Crop Land	Single crop	16.261	2.30
		Double crop	14.847	2.10
		Plantations	36.057	5.10
5	Waste Lands/Others	Land with scrub	18.382	2.60
		Land without scrub	14.847	2.10
		Costal sand	13.433	1.90
		Aquaculture	2.121	0.30
		Mud plat	1.414	0.20
		Others	24.038	3.40
		Total	**707.000**	**100.00**

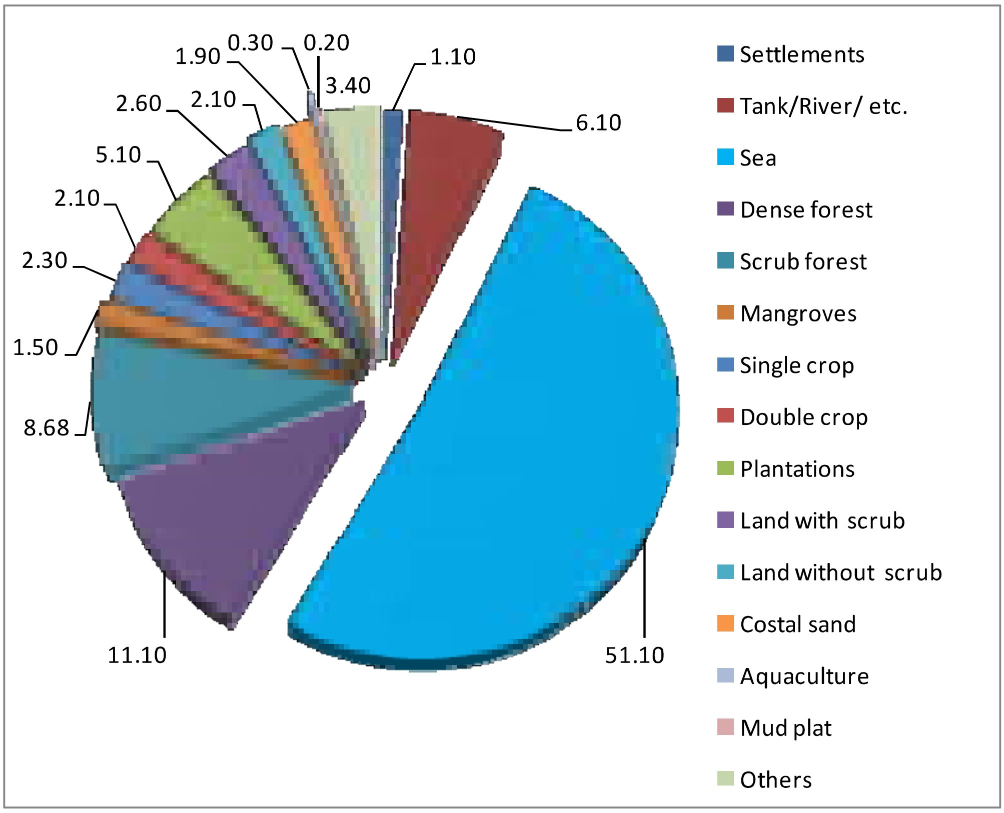


Figure 4-2: Land use Pattern in Project Influence Area

4.2.2.3 Environmentally/Ecologically Sensitive Areas

The environmental sensitive areas covering an aerial distance of 15 km from proposed barge/vessel loading facility boundary along with aerial distance from the boundary is given in Table 4-3.

Table 4-3: Environmentally Sensitive Areas within 15 km from Site Boundary

S. No.	Areas	Name/Identity	Aerial distance (within 15 km)
1	Areas protected under international conventions, national or local legislation for their ecological, landscape, cultural or other related value	Mangroves in Sharavati river	2.5 km, E
2	Areas which are important or sensitive for ecological reasons - Wetlands, watercourses or other water bodies, coastal zone, biospheres, mountains, forests	**River** Sharavati River	Proposed Barge/vessel loading facility near Sharavati river mouth
		Badgani River	~ 300 m, N
		Reserve Forest Reserve forest near Hebbankere	~ 14 km, NE
		Minor Forest There are minor forests with in the 15 km aerial distance.	~ 10 km, S
		Ecology Mangroves	~ 2.5 km, SE
3	Areas used by protected, important or sensitive species of flora or fauna for breeding, nesting, foraging, resting, over wintering, migration	**Reserve Forest** There is reserve forest near Hebbankere	~ 10 km , NE
4	Inland, coastal, marine or underground waters	Arabian sea	Adjoining West.
		Sharavati River	Proposed Project is near River mouth of Sharavati.
		Badgani river	~ 300 m, N
5	State, National boundaries	No	-
6	Routes or facilities used by the public for access to recreation or other tourist/pilgrim areas	NH 17	1 km, E
		NH 206	3.5 km, E
		Konkan railway line connecting Kerala and Maharashtra	1.5 km, E

S. No.	Areas	Name/Identity	Aerial distance (within 15 km)
7	Defence Installations	Nil	Nil
8	Densely populated or built-up area	Honnavar	1.5 km, E
		Karki	3.0 km, N
		Apsarkonda	5.0 km, S
		Manki	15.0 km, S
		Aroli	10. 0 km, E
		Arangandi	12.0 km, NE
		Navilgon	15.0 km, N
		Haldipur	7.0 km, N
9	Areas occupied by sensitive man-made land uses (hospitals, schools, places of worship, community facilities)	**Hospitals**	
		St. Ignatius Hospital, Honnavar	~ 1.5 km, E
		Sridevi Maternity Centre, Honnavar	
		Government Hospital, Honnavar	
		Sharada Nursing Home, Honnavar	
		Suvidha Hospital, Honnavar	
		Balkur Clinic, Honnavar	
		Educational Institutions	
		S.D.M. College of Management Studies, Honnavar	~ 1.5 km, E
		S.D.M. Arts, Science and Commerce College, Honnavar	
		St. Ignatius School of Nursing, Honnavar	
		St. Anthony's College for Physical Education, Honnavar	
		Government Industrial Training Institute, Honnavar	
		The New English School, Honnavar	
		St. Thomas School, Honnavar	
		Holy Rosary Convent School, Honnavar	
		Higher Elementary School (Brother School), Honnavar	
		St. Marathoma School, Honnavar	
		Government Kasba Primary School, Honnavar	
		NMS Higher Primary School, Honnavar	

S. No.	Areas	Name/Identity	Aerial distance (within 15 km)
10	Areas containing important, high quality or scarce resources, (ground water resources, surface resources, forestry, agriculture, fisheries, tourism, minerals)	Reserve forest	~ 14 km, NE
11	Areas already subjected to pollution or environmental damage. *(those where existing legal environmental standards are exceeded)*	Nil	Nil
12	Areas susceptible to natural hazard which could cause the project to present environmental problems, (*earthquakes, subsidence, landslides, erosion or extreme or adverse climatic conditions*)	The project falls in Seismic Zone III (Moderate risk). During the design stage the effects due to this natural disaster will be considered as per IS:1893 (part III) such as Zone factor 0.16 factor of safety will be considered.	-

4.2.3 Topography

The land proposed to be developed for Honnavar Barge/vessel Loading Facility is mostly between LTL and HTL. The project area is a typical coastal plain. The site exhibits flat terrain features with a gentle slope towards -west. The seashore in general is flat in this region.

Plate 4-1: Landscape of the Project Site

4.2.4 Geology

Geologically, the study area is underlain by potash rich granodiorite & granite soils are dominant in the study area. Near the mouth of the Honnavar Barge/vessel loading Facility River, saline soils are present.

The Geological map of Uttar Kannada district is provided in Figure 4-3.

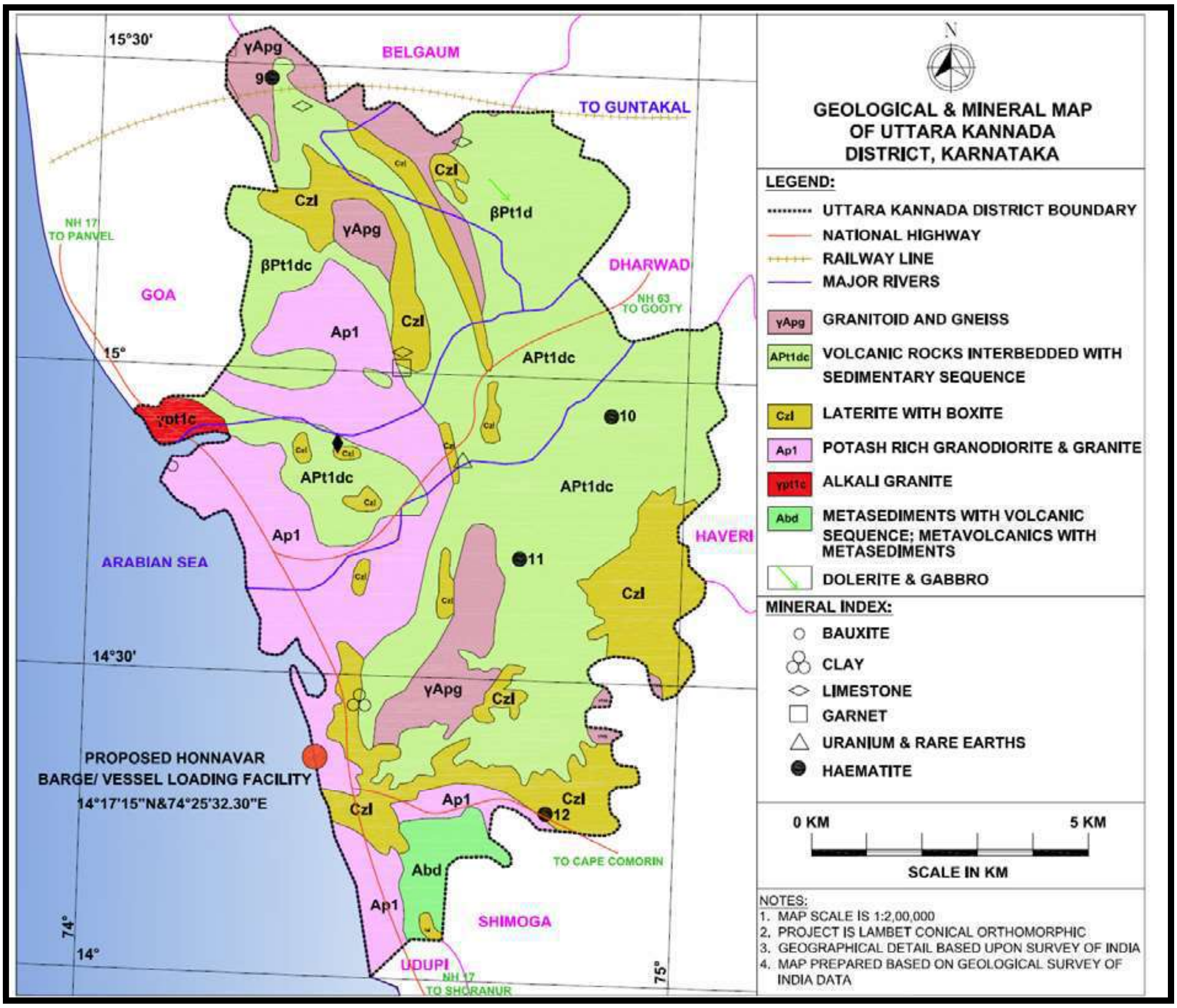


Figure 4-3: Geological Map of Honnavar Barge/vessel loading facility Region *(Source: District Planning Series Map)*

4.2.4.1 Hydrogeology

Uttara Kannada district consists of rock formations of Archaean complex characterised by a system of ridges and a plateau on the west. Laterites occur overlying the schist and granites, and alluvium along the rivers and lagoons of the coast.

Main aquifers in the study area are the weaker, weathered and fractured zones of metavolcanics, metasedimentaries, granites and gneisses, laterites, along with the alluvial patches found along the major stream courses.

Since, the hard rocks in the area do not posses the primary porosity, the secondary structures like joints, fissures and faults present in these formation acts as a porous media. It is generally constitute a 3% of volume of formation to facilitate to house the ground water. The ground water under atmospheric influence is the phreatic zone, which generally occurs with in the depth range of 3.00 to 30.00 mbgl .The fracture zones occur at various depth zones within the depth of 185.00mbgl are expected to be saturated with ground water. It is found that the water bearing characteristics of schistose rocks are more or less similar to that of gneisses and granites. But the weathered zones of schists may not yield as granites and gneisses, because of their compact and finegrained nature.

Alluvium occurs along the river banks in few to 14.00 metres thickness, holds the bank storage. and occurs as narrowstrip along the sea coast and the creeks occurs up to a depth of 50m. Ground water in the above aquifer material generally occurs under unconfined to semi-confined and confined conditions, in the shallower zones under phreatic condition and under semi-confined and confined condition in the deeper zones. The ground water is being exploited from within the depth range of 3.00 to 31.00mbgl through dugwells and 30.00 to 200.00mbgl through dugcum- bore wells and Bore wells. The hydrogeological map depicting all hydrogeological details of the area is presented as Figure-4-4.

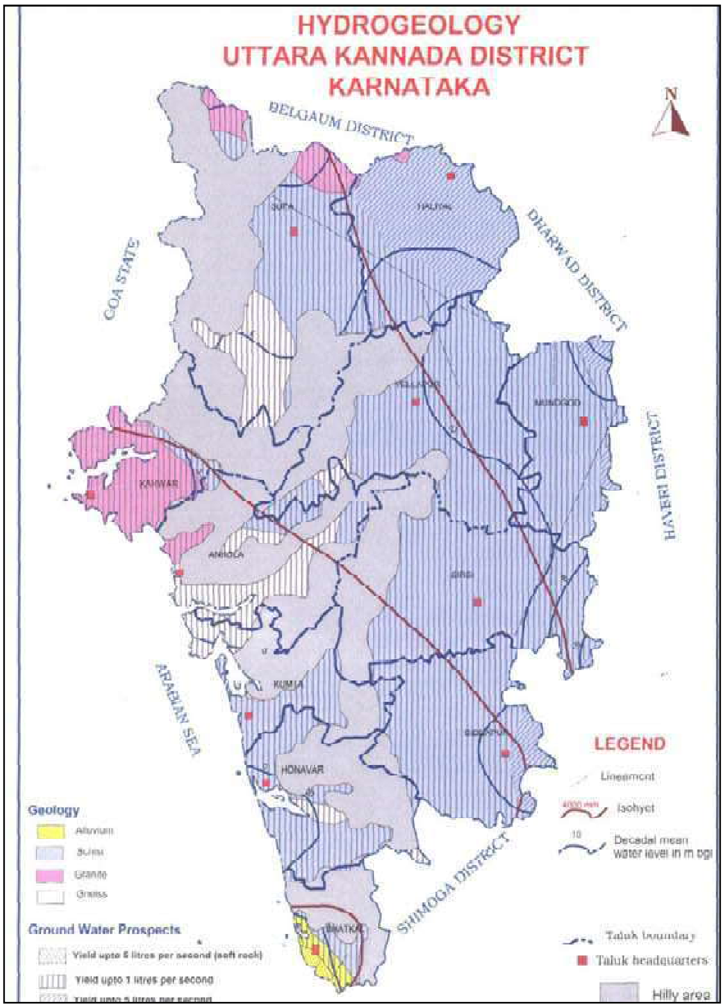


Figure 4-4: Hydrogeology Map of Uttara Kannada District

4.2.4.2 Seismicity

As per the IS: 1893 (Part 1) 2002 of Bureau of Indian Standards (BIS), the project area and study area fall in Zone III which is a moderate to low risk zone. The seismic zoning map of Karnataka region is shown in Figure 4-5.

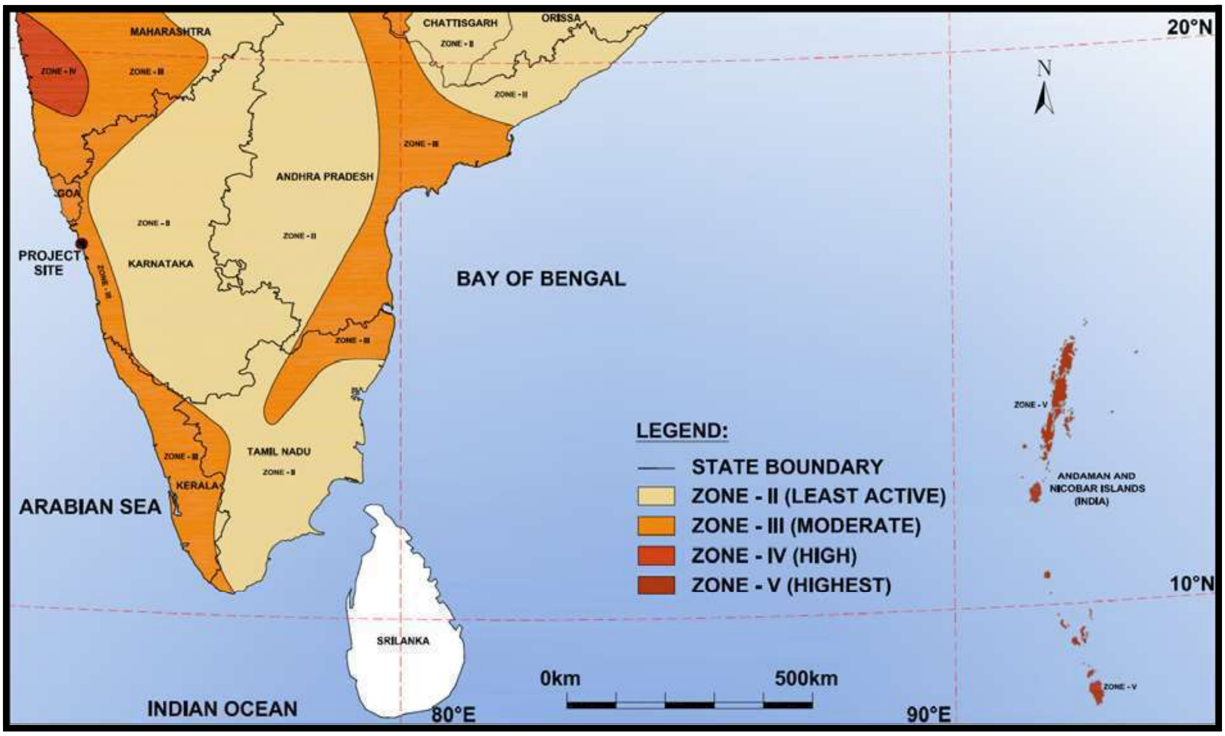


Figure 4-5: Seismic Zoning Map of Karnataka

4.2.5 Soil

Soil monitoring was carried out at Five (5) locations. Sampling locations within 10 km radius from the site are shown in **Figure FD0403**. The details of soil sampling locations are given in Table 4-4.

Table 4-4: Soil Sampling Locations

Station No.	Location	Distance (km) from Centre of Project Area	Azimuth Directions	Environmental Setting
S1	Proposed Site	--	--	--
S2	Honnavar	2.4	SE	Agriculture
S3	Kasarkod	2.5	S	Agriculture
S4	Karki	2.9	N	Agriculture
S5	Apsarkonda	6.2	S	Agriculture

4.2.5.1 Results and Discussion

Soil analysis was carried as per IS: 2720 and results are given in **Appendix B**. Inferences on soil quality are provided.

- Soil types are sandy (S1, S3, S4 and S5) and sandy clay (S2)
- pH of soils ranged between 6.62 (S4) and 7.86 (S2) indicating slightly acidic to alkaline in nature
- Electrical Conductivity varied between 88 µmhos/cm (S3) and 112 µmhos/cm (S2)
- Phosphorus as P varied between 12 mg/100 gm (S4) and 26 mg/100 gm (S2)
- Potassium (K) varied between 32 mg/100 gm (S4) and 92 mg/100 gm (S2)
- Sodium Absorption Ratio varied between 1.82 (S3) and 2.12 (S1)

- Infiltration Rate ranged between 52mm/hr (S2 & S5) and 58mm/hr (S1 & S4)
- Water Holding Capacity varied between 6.1 % (S4) and 9.3 % (S2)
- Porosity varied between 32 v/v % (S2) and 38 % v/v (S4)
- Zinc (Zn) varied between 0.49 mg/kg (S4) and 0.92 mg/kg (S2)
- Iron (Fe) varied between 0.36 mg/kg (S1) and 0.84 mg/kg (S2)
- Lead (Pb) is less than 0.02 mg/kg at all locations
- Nickel (Ni) is less than 0.02 mg/kg at all locations.

4.3 Water Environment

The baseline status of water quality has been assessed through identification of water resources and appropriate sampling locations for surface and groundwater in the study area. The samples were collected once during study period. Water samples collected were analysed for physical, chemical and bacteriological parameters. Standard methods prescribed for sampling and analysis were adopted. Inland water quality results are presented in **Appendix C** and inferences are provided.

4.3.1 Groundwater

Total *three (3)* groundwater monitoring locations were identified for assessment in different villages around the project site based on the usage of groundwater by the settlements/ villages in the study area.

Water sample analysis with respect to physico-chemical, nutrient, demand and bacteriological parameters having relevance to public health and aesthetic significance are selected to assess the water quality status with special attention. Standard methods prescribed for groundwater sampling and analysis were adopted.

Descriptions of sampling locations are given in Table 4-5. Sampling locations within 10 km radius from the proposed site are shown in **Figure FD0404**.

Table 4-5: Description of Groundwater Sampling Locations

Station No.	Location	Distance (km) from Centre of Project Area	Azimuth Directions	Source	Environmental Setting
GW1	Honnavar	2.4	N	Bore Well Water	Drinking, Bathing & Toilets
GW2	Kasarkod	2.5	S	Bore Well Water	Drinking, Bathing& Toilets
GW3	Karki	2.9	N	Bore Well Water	Drinking, Bathing& Toilets

Results and Discussion on Groundwater Quality

- pH is slightly acidic in nature and ranged between 6.68 (GW1) & 6.84 (GW3)
- Electrical Conductivity (EC) varied between 118 μS/cm (GW2) & 146 μS/cm (GW3)
- Total dissolved solids ranged between 74 mg/l (GW2) & 92 mg/l (GW3)
- Total alkalinity (as $CaCO_3$) varied between 30 mg/l (GW1) & 40 mg/l (GW2 & GW3)
- Total hardness (as $CaCO_3$) ranged between 40 mg/l (GW1 & GW2) & 48 mg/l (GW3)

- Calcium (Ca)is 12.8 mg/l at all locations
- Chlorides (as Cl^-) ranged between 7.1 mg/l (GW1) and 14.2 mg/l (GW2 & GW3)
- Fluorides as (F^-) at all locations is 0.1 mg/l
- Sulphates as (SO_4) ranged between 6.7 mg/l (GW2) & 10.6 mg/l (GW1)
- Nitrates as (NO_3) value ranged between 1.3 mg/l (GW1 & GW2) & 1.9 mg/l (GW3)
- Zinc as (Zn) is less than 0.02 mg/l at all locations
- Cadmium as (Cd) is less than 0.01 mg/l at all locations
- Arsenic as (As) is less than 0.001 mg/l at all locations
- Cyanides as (CN) and chromium as (Cr^{+6}) is <0.05 mg/l at all locations
- Mercury as (Hg) is <0.002 mg/l at all locations
- Total Coliforms and Faecal Coliforms were absent in all the monitored locations.

4.3.2 Surface Water

Total *three (3)* surface water monitoring locations were identified for assessment in different villages around the project site based on the usage of surface water by the settlements/villages in the study area.

Water sample analysis with respect to physico-chemical, nutrient, demand and bacteriological parameters having relevance to public health and aesthetic significance are selected to assess the water quality status with special attention. Standard methods prescribed for surface sampling and analysis were adopted.

Descriptions of sampling locations are given in Table 4-6. Sampling locations within the PIA of 10 km radius from the site are shown in **Figure FD0404**.

Table 4-6: Description of Surface Water Sampling Locations within the PIA

Station No.	Location	Distance from Centre of Project Area	Azimuth Direction
SW1	Sharavati River at Honnavar	2.4	SE
SW2	Badgani River at Pavinkurve	4.0	N
SW3	Sharavati River at Nagare	6.0	SE

Results and Discussion on Surface Water Quality

- pH is slightly alkaline in nature and ranged between 6.96 (SW3) & 7.64 (SW2)
- Electrical Conductivity (EC) varied between 48 μS/cm (SW3) & 8668 μS/cm (SW2)
- Total dissolved solids ranged between 26mg/l (SW3) & 5456 mg/l (SW2
- Total alkalinity (as $CaCO_3$) varied between 10 mg/l (SW3) & 50 mg/l (SW2)
- Total hardness (as $CaCO_3$) ranged between 12mg/l (SW3) & 1040 mg/l (SW2)
- Calcium (Ca) ranged between 3.2 mg/l (SW3) & 312 mg/l (SW2)
- Chlorides (as Cl^-) ranged between 7.1 mg/l (SW3) & 2982 mg/l (SW2)
- Fluorides as (F^-) at all locations is <0.1 mg/l (SW3) & 1.60 (SW2)
- Nitrates value ranged between 0.04 mg/l (SW3) & 15.2 mg/l (SW2)
- Zinc as (Zn) is less than 0.012 mg/l (SW1) & 0.22 (SW2)
- Cadmium as (Cd) is less than 0.01 mg/l at all locations
- Selenium as (Se) is less than 0.01 mg/l at all locations
- Arsenic as (As) is less than 0.001 mg/l at all locations
- Cyanides as (CN) is less than 0.02 mg/l at all locations
- Chromium as (Cr^{+6}) ranged between less than 0.01 mg/l (SW3) & 0.03 mg/l (SW2)

- Mercury as (Hg) is less than 0.0002 mg/l at SW1 & SW3 & 0.0004 mg/l (SW2)
- Total Coli forms ranged between 1 MPN/100 (SW3) & 32 MPN/100 (SW2)
- Faecal Coliforms were absent in SW3 & 12 MPN/100 (SW2)

4.3.2.1 Observation

It is inferred that all the parameters for groundwater are within the limits specified as per Drinking Water Quality Standards (IS:10500, 1991) as per Guidelines for Water Quality Management – CPCB 2008.

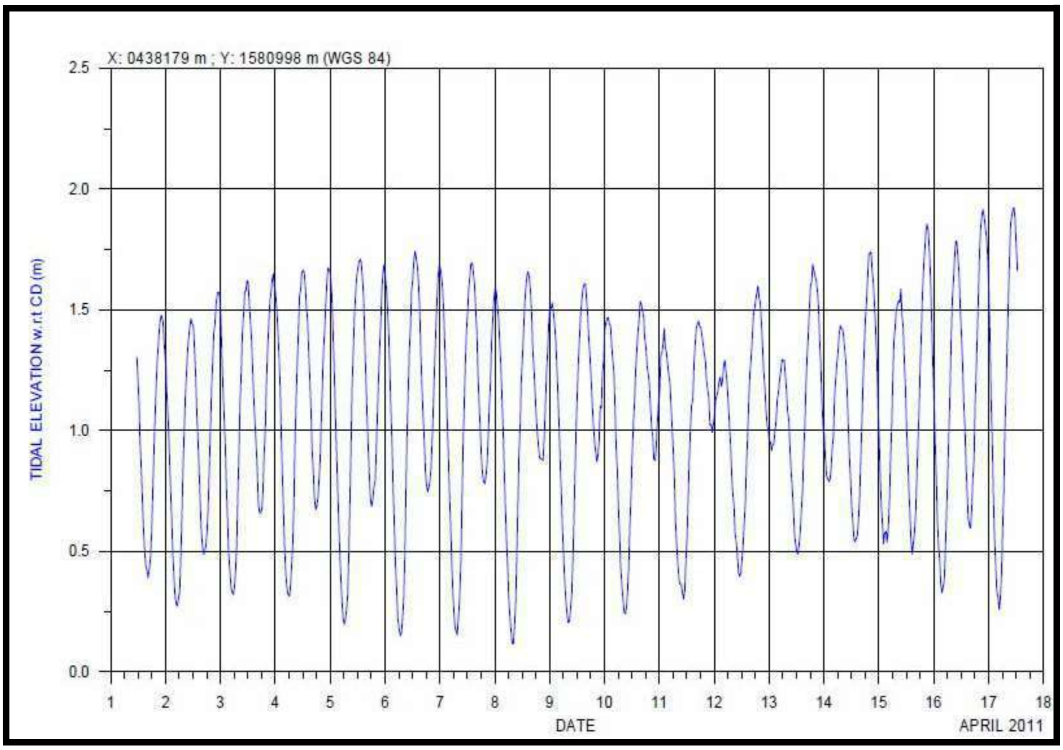
4.4 Marine Environment

4.4.1 Coastal Hydrology/ Geomorphology

4.4.1.1 Tides

Tide measurements were carried at two locations namely stations (stns) T1 and T2. At stn. T1, the measurement was carried out using Aanderaa Wave and Tide recorder (WTR 9) for a period of 16 days from 02.04.11 to 17.04.11 at 30 min interval. At stn. T2, the tide measurement was carried out manually with tide staff fixed on the jetty for a period of 16 days from 02.04.11 to 17.04.11 at 15 minute interval. The various design tide levels with respect to Chart Datum for Honnavar barge/loading as presented in Naval Hydrographic Chart (No. 216) are given below:

Mean High water Spring	:	1.8 m
Mean High Water Neap	:	1.5 m
Mean Sea Level	:	1.2 m
Mean Low Water Neap	:	1.0 m
Mean Low Water Spring	:	0.4 m



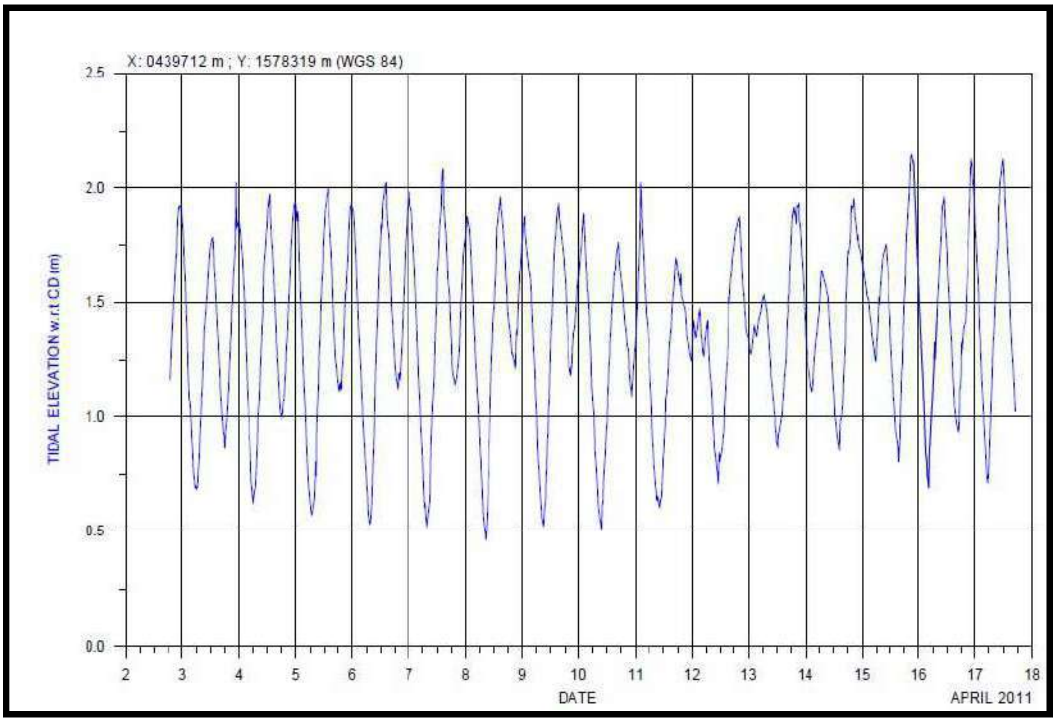


Figure 4-6: Tidal Variation in the Honnavar Barge/vessel Loading Facility

4.4.1.2 Waves

Wave measurements were carried using a Datawell Wave Rider Buoy DWRG4 for a period of 16 days at one location. The wave measurement was recorded at 30 min interval.

The variation of significant wave height, maximum wave height, zero crossing period and predominant wave direction is shown in Figs. 4-7 to 4-10. During the measurement period the significant wave height varied between 0.32 m to 1.02 m. The maximum wave height recorded was 1.67 m. The zero crossing wave periods varied between 3 to 10 seconds. The predominant wave direction during the measurement period mostly remained around 230º.

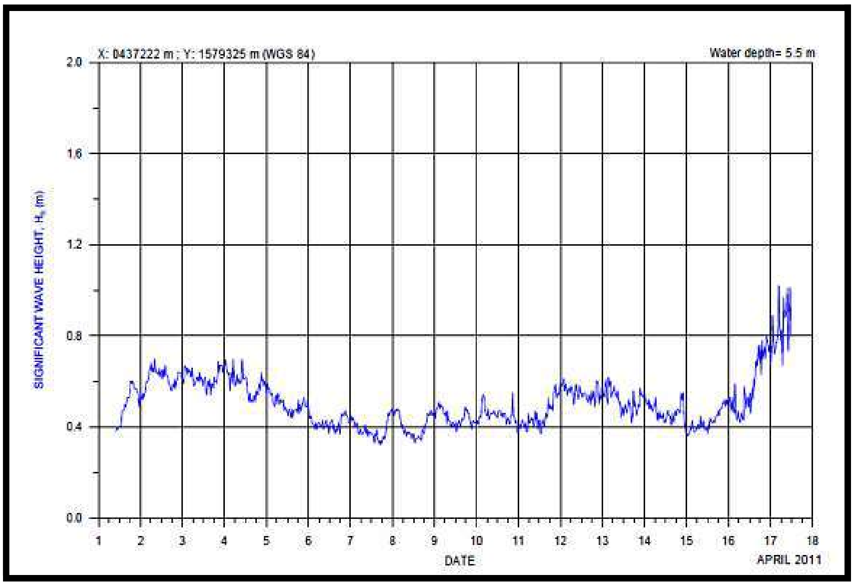


Figure 4-7: Variation of Significant Wave Height

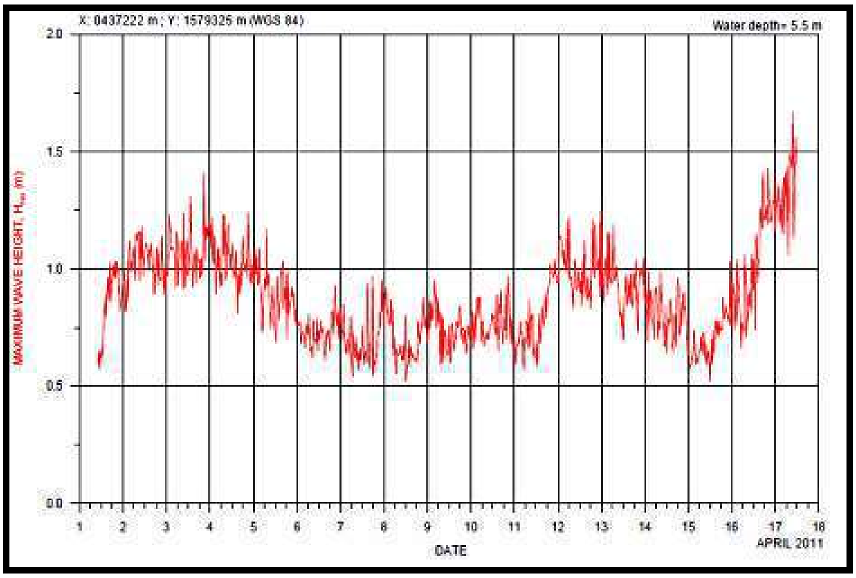


Figure 4-8: Variation of Maximum Wave height

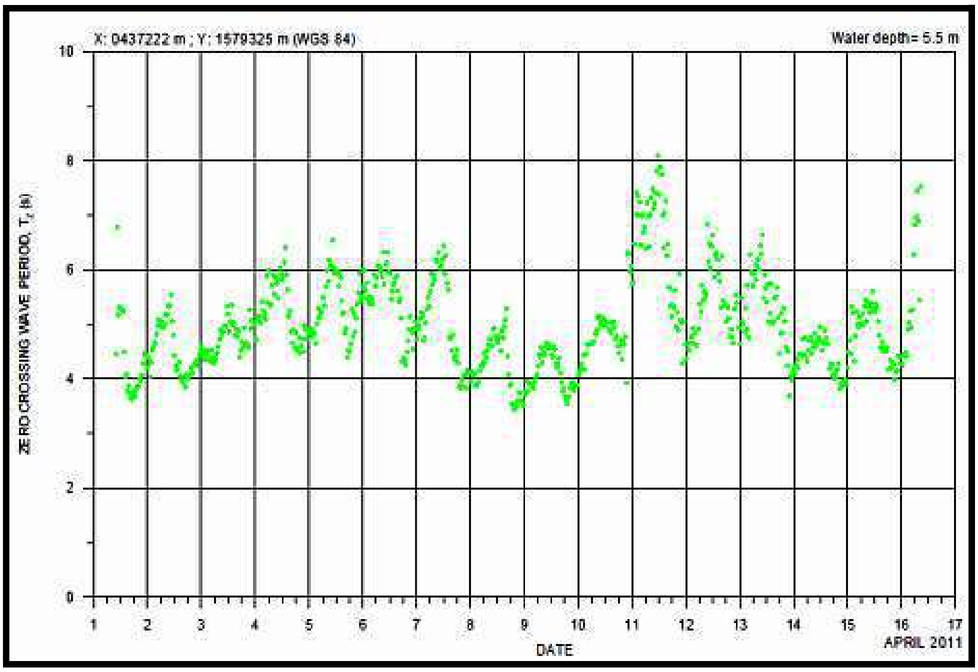


Figure 4-9: Variation of Zero Crossing Wave Height

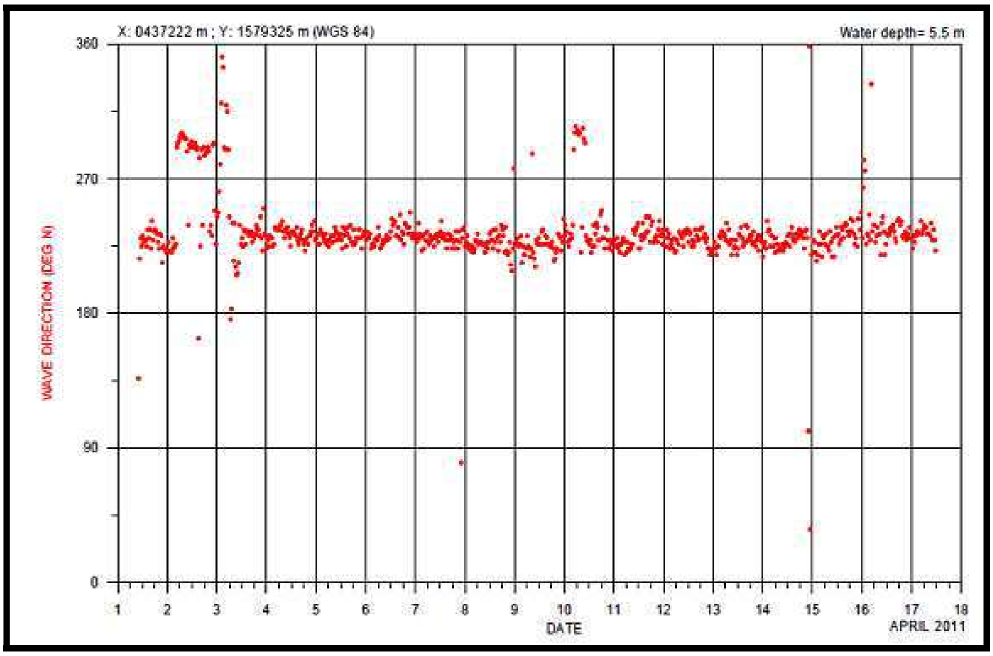


Figure 4-10: Variation of Wave Direction

4.4.1.3 Littoral Drift

The littoral drift along the West Coast of India takes place in South–North direction in general and the net drift direction is directed towards South. The direction of sediment transport varies depending on the local shoreline orientation. The configuration of shoreline between the coastal stretch of Sharavati River and Badgani River is aligned along WSW; further the coastline aligns itself in North South direction to the Honnavar Barge/vessel loading facility at river mouth. The coastline north of river Sharavati is aligned in ENE direction which gradually orients itself southward.

The result of the shoreline change studies carried out by Department of Meteorology and Oceanography, Andhra University, Vishakhapatnam indicates the direction of sediment is towards north.

The littoral sand transport studies conducted through MIKE 21 (ST) model gave information on sand transport rates along the coastal stretch and near the tidal inlet.

For case-I (without breakwater) the rates of sediment transport for deep water waves from S and SSW are much less (< 200 m^3/yr/m) along the entire coastal stretch. However slightly higher values (about 400 m^3/yr/m) are noticed on the seaward side of the entrance where shoals are present. The bed level changes indicate deposition at the mouth and to the south of the inlet. For SW and SSW waves during monsoon season high values of sand transport (> 2000 m^3/yr/m) are noticed along the entire coastal stretch due to high and steep waves during this season. The bed level changes indicate significant deposition (0.005 m/day) both to the south and north of the entrance channel. During non-monsoon season, when W and WNW waves prevail the sediment transport as well as the bed level changes are not significant.

For case-II (with breakwaters) during monsoon season when SW and WSW waves prevail the sediment transport is significant (>2000) to the north as well as to the south of breakwater. Bed level changes indicate deposition to the northern and southern coastline in general; but there is also erosion just to the north of northern breakwater, some deposition is observed inside the breakwaters zone just at the mouth of the entrance channel, which must be cleared periodically in maintenance dredging.

Model studies indicate an annual deposition of about 10,300 m^3/yr in the dredged channel. Again, during non-monsoon months there is no significant deposition. On the whole the sand transport model studies indicate depositional trend near the mouth of the channel as well as to the north of the channel for case I. But for case II, the depositional trend in the channel has somewhat decreased due to breakwaters while some erosional trend is noticed towards the northern shores.

The predominant direction of alongshore sediment transport is towards north due to S, SSW and SW waves and the net transport of sediment is around 0.6×10^6 m^3 directed towards north.

4.4.1.4 Currents

Variations of current speed and direction were measured at three locations using Aanderaa RCM 9 self recording current meter for a period of 16 days at 20 minute interval.

The variations of current speed and direction at stns. C1, C2 and C3 are shown in Figs. 4-11 4-12 and 4-13 respectively.

Stn. C1 (Open Sea): The maximum current speed at surface reached upto 0.34 m/s. The current direction was inconsistent but predominantly showed towards south.

Stn. C2 (River-south): The maximum current speed at surface reached upto 1.23 m/s. The current direction was towards south during flood tide and towards north during ebb tide. The current direction varied between 350° and 10° during ebb tide and 170° and 190° during flood tide.

Stn. C3 (River-north): The current speed reached up to 0.81 m/s. The current direction showed a formation of gyre showing almost a unidirectional flow towards 240°.

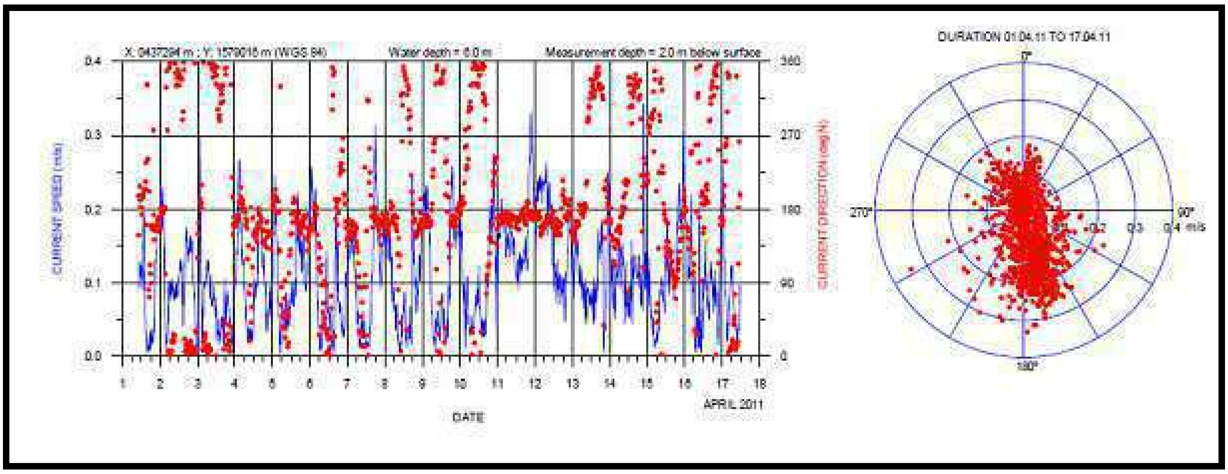


Figure 4-11: Variation of Current Speed and Direction at Stn. C1 (Open Sea)

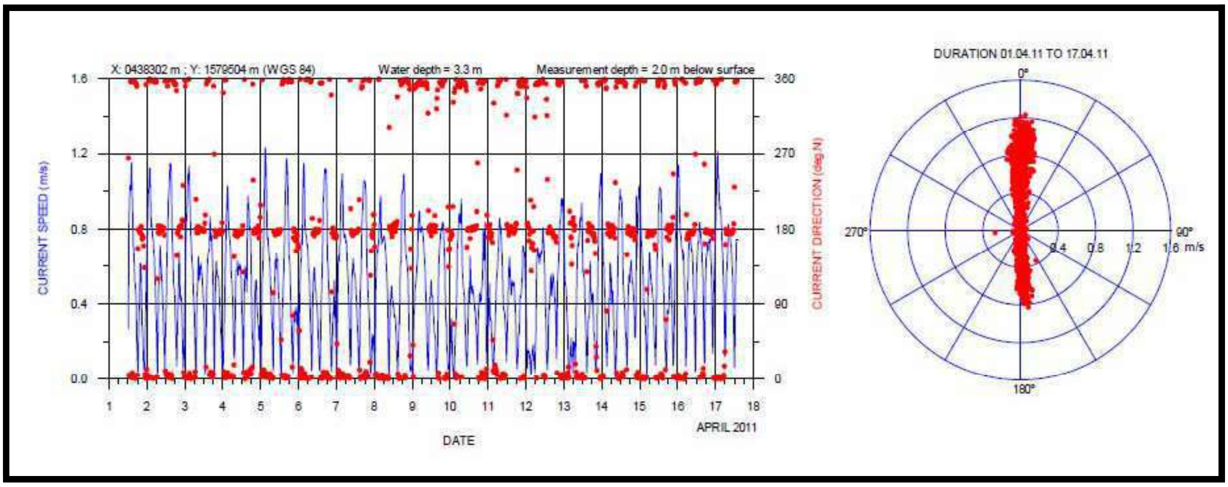


Figure 4-12: Variation of Current Speed and Direction at Stn. C2 (River South)

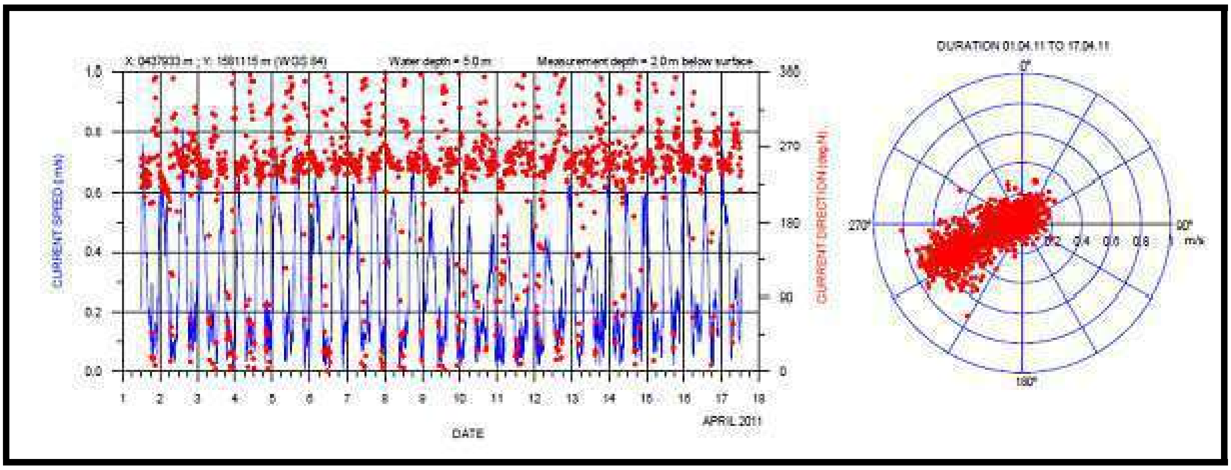


Figure 4-13: Variation of Current Speed and Direction at Stn. C3 (River North)

4.4.1.5 Seabed Bathymetry

The bathymetric survey was carried out for 3.5 km along the shoreline and 3.5 km into the sea. From the analysis of the survey data it is observed that the contours run parallel to each other in the project area. Bathymetry of the study area exhibits a gentle bed slope of 1:180 up to 5 m contours beyond which it flattens to 1:350. The 10 m water depth occurs at a distance of approximately 3350 m from the coast.

The bathymetry survey carried out on the river side of the project site illustrates that the river bed is shallow and there are few deeper portions depending on the current. A maximum river depth of 3-4 m is observed, otherwise the whole of the bed seems to be very shallow and few islands in the river course. Mouth/estuary of the river also seems very shallow with maximum water depth of 2-3 m in the river mouth. Large area of shallow depth of 0.7 m is observed on either side of the river mouth which is mainly due to the deposition of the sediments brought by the river.

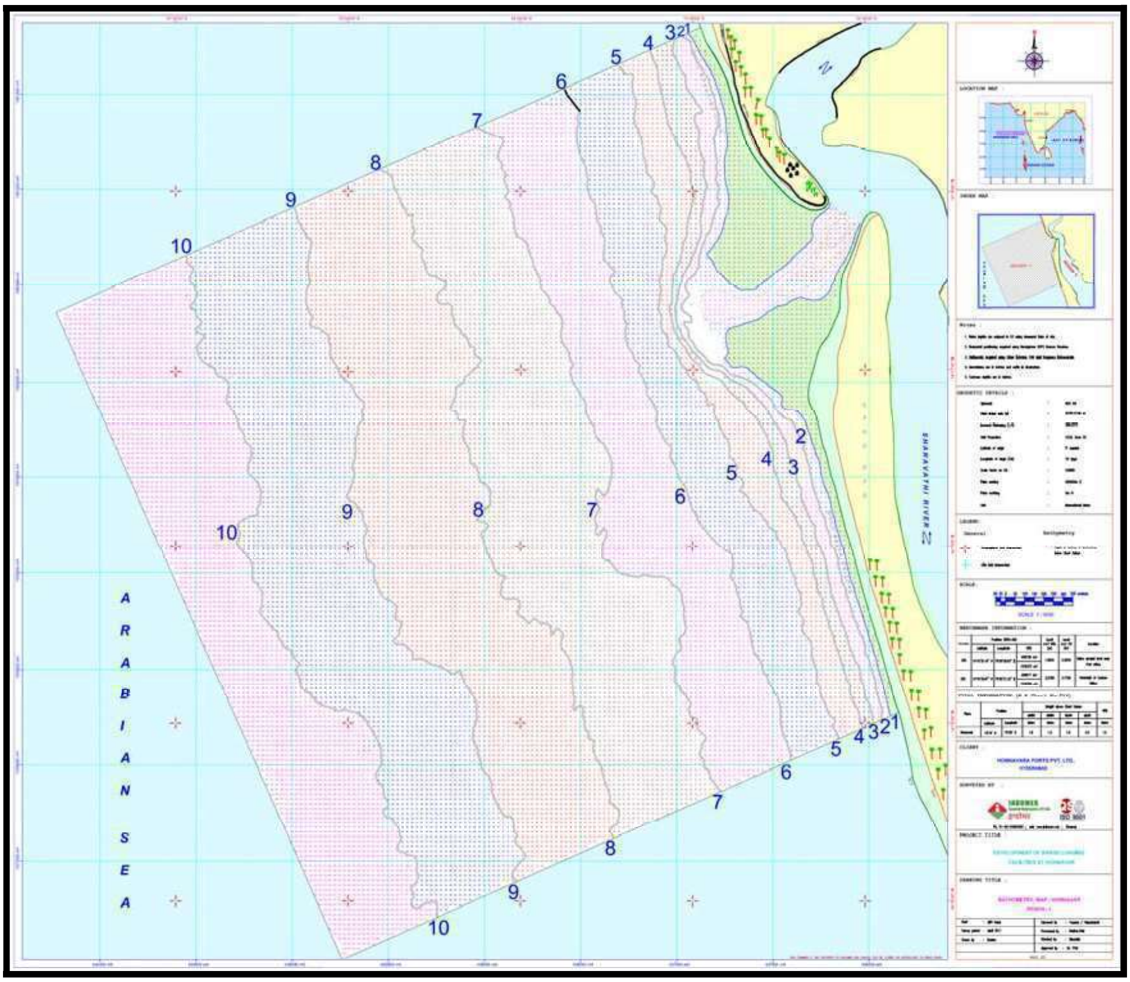


Figure 4-14: Combined Chart Open Sea and River Mouth

4.4.2 Bed Sediment Contamination/Bed Sediment Quality

Sediment samples were collected from nine locations. There are four sampling locations (HMSL-1, 2, 4, and 6) selected at <5 m depth; four sampling locations (HMSL-3, 5, 7, 8) between 5 m and 9 m depth HMSL-9 is located at a depth of 15 m. A map showing the marine sampling locations is given in **Figure FD0405**. The Coordinates of the sampling locations are given in the Table 4-7.

Table 4-7: Marine Sampling Locations

S. No.	Location Code	Latitude	Longitude
1.	HMSL-1	14°17’42.28” N	74°25’34.63” E
2.	HMSL-2	14°17’49.89” N	74°25’12.81” E
3.	HMSL-3	14°17’34.84” N	74°24’40.74” E
4.	HMSL-4	14°16’54.45” N	74°25’21.96” E
5.	HMSL-5	14°17’01.82” N	74°24’35.91” E
6.	HMSL-6	14°18’19.84” N	74°24’54.74” E
7.	HMSL-7	14°17’56.50” N	74°24’10.28” E
8.	HMSL-8	14°18’38.77” N	74°24’02.81” E

S. No.	Location Code	Latitude	Longitude
9.	HMSL-9	14°16’35.01” N	74°21’59.75” E

Among the stations, HMSL-1 is located in the river mouth, HMSL-2, 4, 6 were situated near the shore, HMSL-3, 5, 7, 8 were situated away from shore and HMSL-9 in open sea.

4.4.2.1 Physical Parameters

The sediment composition is from sandy to silty in nature. The percentage of sand ranged between 98.29% at HMSL-1 during low tide and 19.52% at HMSL-2 during low tide. The silt content varied between 46.06% at HMSL-7 during low tide and 1.27% at HMSL-1 during low tide. The percentage of clay ranged between 54.66% at HMSL-2 during low tide and 0.42% at HMSL-1 during high tide. The variations in sediment quality are given in Table 4-8.

Oil and grease levels ranged from 9 µg/g at HMSL-8 during low tide & HMSL-9 during high tide to 831 µg/g at HMSL-1 during high tide. The details of the sediment composition and Oil and Grease are given in Table 4-8 and Figure 4-15.

Table 4-8: Sediment Composition

Location Code	Sand (%)	Silt (%)	Clay (%)	Oil and Grease (µg/g)
HMSL-1-HT	98.22	1.35	0.42	831
HMSL-1-LT	98.29	1.27	0.44	137
HMSL-2-HT	19.63	26.26	54.12	29
HMSL-2-LT	19.52	25.81	54.66	49
HMSL-3-HT	21.14	27.83	51.02	27
HMSL-3-LT	22.11	26.22	51.68	19
HMSL-4-HT	71.30	26.32	2.38	79
HMSL-4-LT	75.15	23.48	1.37	35
HMSL-5-HT	24.79	22.63	52.58	21
HMSL-5-LT	23.75	24.18	52.07	53
HMSL-6-HT	29.58	31.78	38.64	27
HMSL-6-LT	29.30	31.09	39.61	11
HMSL-7-HT	41.26	45.23	13.51	17
HMSL-7-LT	41.79	46.06	12.15	13
HMSL-8-HT	76.05	21.52	2.42	23
HMSL-8-LT	78.50	19.65	1.85	9
HMSL-9-HT	28.28	31.15	40.57	9
HMSL-9-LT	30.26	28.58	41.16	13

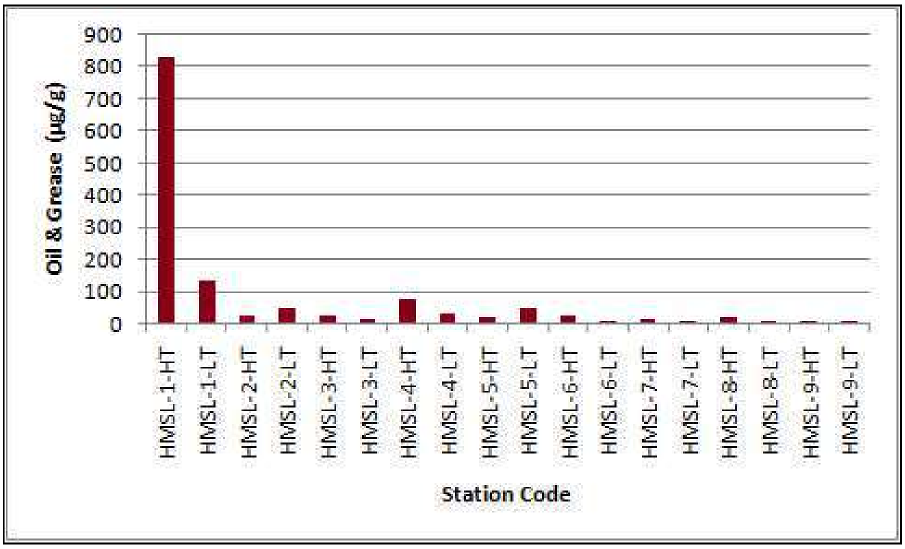


Figure 4-15: Variations in Oil and Grease Levels (Sediment)

4.4.2.2 Chemical Parameters: Heavy Metal Concentration & Total Organic Carbon

The concentrations of cadmium in sediment ranged between 1.38 µg/g at HMSL-8 during low tide and 0.40 µg/g at HMSL-6 during high tide. The Copper varied between 61.04 µg/g at HMSL-5 during low tide and 0.80 µg/g at HMSL-6 during high tide. The concentrations of Lead varied between 22.84 µg/g at HMSL-5 during low tide and 10.88 µg/g at HMSL-2 during high tide. Iron varied between 22860 µg/g at HMSL5- during high tide and 1132.28 µg/g at HMSL-6 during high tide and the zinc concentration varied between 66.40 µg/g at HMSL-5 during high tide and 12.92 µg/g at HMSL-8 during low tide. The concentration of mercury varied between 0.006 and 0.028 µg/g. The total organic carbon in all the sampling locations varied between 7.611 mg/g at HMSL-5 during low tide and 1.125 mg/g at HMSL-1 during high tide. The concentrations of heavy metals and Total Organic Carbon are given in Table 4-9.

Table 4-9: Heavy Metals & Total Organic Carbon Levels In Sediment

Location Code	Parameters (µg/g)						
	Cd	Cu	Fe	Pb	Zn	Hg	Total Organic Carbon (mg/g)
HMSL-1-HT	1.08	12.00	1459.2	14.48	17.92	0.024	1.125
HMSL-1-LT	0.84	8.04	1978.0	13.48	13.08	0.028	1.815
HMSL-2-HT	0.79	27.28	15880.0	10.88	35.76	0.016	5.196
HMSL-2-LT	0.76	35.20	17500.0	13.80	44.64	0.015	3.747
HMSL-3-HT	0.85	36.16	18664.0	15.64	48.88	0.012	6.576
HMSL-3-LT	0.92	32.96	19436.0	16.68	44.24	0.006	6.507
HMSL-4-HT	0.80	32.16	18400.0	15.00	40.48	0.012	7.197
HMSL-4-LT	1.04	25.32	5576.0	17.96	13.04	0.008	1.746
HMSL-5-HT	1.12	56.52	22860.0	22.48	66.40	0.014	7.266
HMSL-5-LT	1.10	61.04	22368.0	22.84	65.72	0.011	7.611
HMSL-6-HT	0.40	0.80	1132.28	14.48	42.35	0.013	2.919
HMSL-6-LT	1.04	31.28	16396.0	12.88	39.36	0.012	6.783
HMSL-7-HT	0.75	21.04	9480.0	17.68	18.64	0.010	2.367
HMSL-7-LT	0.81	11.96	2068.0	14.60	16.28	0.014	1.539

Location Code	Parameters (µg/g)						
	Cd	Cu	Fe	Pb	Zn	Hg	Total Organic Carbon (mg/g)
HMSL-8-HT	1.12	7.16	1828.8	13.88	15.96	0.012	1.746
HMSL-8-LT	1.38	16.24	2986.4	16.00	12.92	0.016	2.367
HMSL-9-HT	1.15	47.04	18628.0	19.08	52.20	0.018	7.611
HMSL-9-LT	0.95	42.60	18216.0	17.60	58.04	0.014	6.645

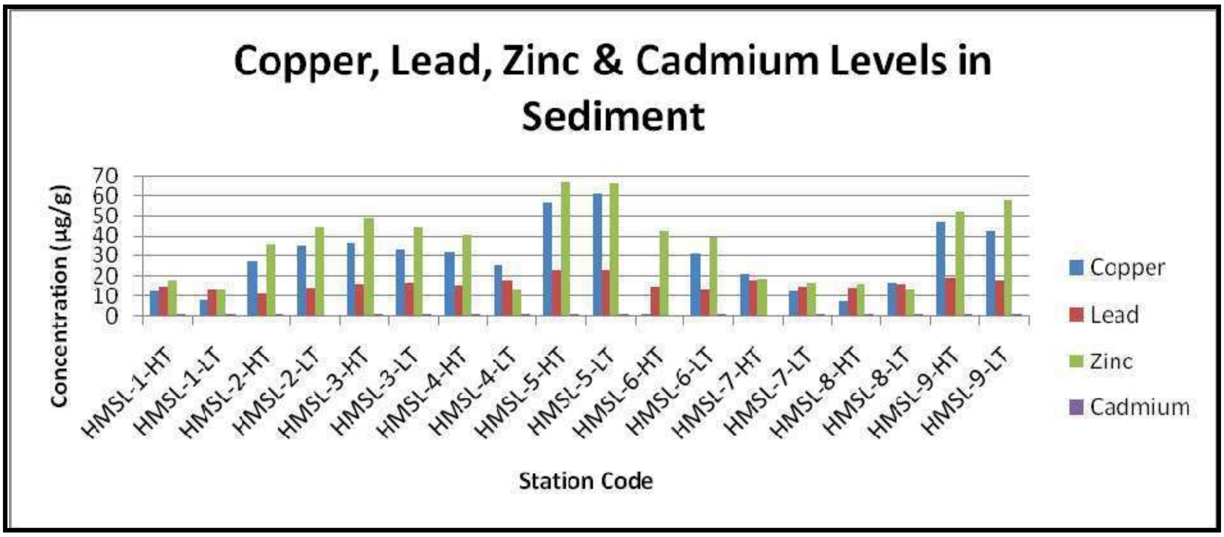


Figure 4-16: Variation of Copper, Cadmium Zinc & Lead in Sediment

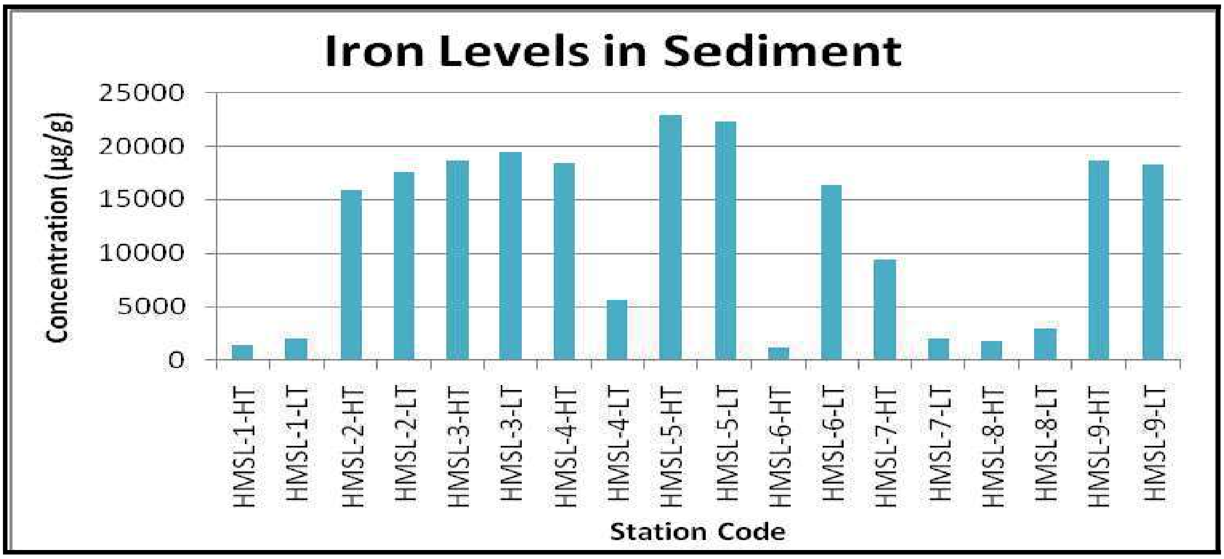


Figure 4-17: Variation of Iron concentration in Sediment

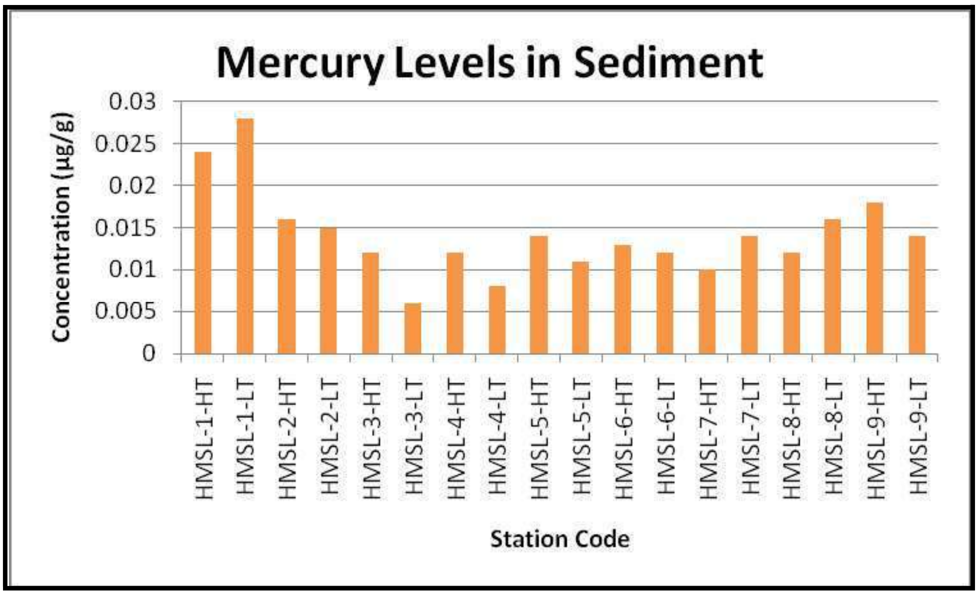


Figure 4-18: Variation of Mercury concentration in Sediment

4.4.2.3 Microbial Population

The indicator and pathogenic bacteria isolated from sediment samples collected from the marine monitoring locations are described below.

Escherichia Coli (EC)

The *E.coli* population varied between $28x10^2$ CFU/mg at HMSL-2 during high tide and 10×10^2 CFU/mg at HMSL-7 during high tide and HMSL-9 during low tide.

Faecal Coliform (FC)

The Faecal Coliform population ranged between 36×10^2 CFU/mg at HMSL-1 during high tide and $20x10^2$ CFU/mg at HMSL-4 during low tide.

Pseudomonas Aeurginosa (PA)

The *Pseudomonas aeurginosa* population ranged between 24×10^3 CFU/mg at HMSL-5 during high tide and 10×10^2 CFU/mg at HMSL-9 during high tide.

Proteus-Klebsiella (PK)

The *Proteus Klebsiella* population ranged between 24×10^2 CFU/mg at HMSL-3 during high tide and 10×10^2 CFU/mg at HMSL-1, HMSL-5 & HMSL-7 during low tide.

Streptococcus Faecalis (SF)

The *Streptococcus Faecalis* population ranged between 25×10^1 CFU/mg at HMSL-1 during low tide and 10 CFU/ml at HMSL-5 during low tide.

Shigella (SH)

The *Shigella* population observed ranged between 24 x 10^2 CFU/mg and 10 x 10^2 CFU/mg. The minimum concentration was observed at HMSL-2 and HMSL-7 during low tide. The maximum concentration was observed at HMSL-4 & HMSL-6 during high tide.

Salmonella (S)

The Salmonella population ranged between 17 x 10^3 CFU at HMSL-6 during high tide and 80 CFU/mg at HMSL-9 during low tide.

Total Coliform (TC)

The Total Coliform population ranged between 19 x 10^4 CFU/mg at HMSL-2 during high tide and 10 x 10^4 CFU/mg at HMSL-1 and HMSL-3 during high tide and also at HMSL-9 during low tide.

Total Viable Count -Total Heterotrophic Bacteria (TVC)

Total Viable Count ranged between 34 x 10^5 CFU/mg at HMSL-2 during high tide and 12 x 10^5 CFU/mg at HMSL-7 during low tide.

Vibrio Cholera (VC)

The *Vibrio Cholera* population ranged between 25 x 10^2 CFU/mg at HMSL-4 during high tide and 23 CFU/mg at HMSL-9 during low tide.

Vibrio Parahaemolyticus (VP)

The *Vibrio Parahaemolyticus* population observed in sediment samples ranged between 28 x 10^2 CFU/mg at HMSL-4 during high tide and 18 CFU/mg at HMSL-9 during low tide.

The details of microbial population at each location are given in the **Appendix D**.

4.4.2.4 Benthos

Macrobenthos:

Overall macrobenthos was, represented by taxonomic groups' viz., Polychaetes, Bivalves, Amphipods, Gastropods, and Isopods. Around 44 species of macrobenthos was recorded. Minimum Density (625 Nos/m^2) was observed at HMSL-2 during high tide. Maximum density (875 Nos./m^2) was observed at HMSL-5 during high tide. The summary of macrobenthos population is given in the Table 4-10 and the variation in macrobenthos population is graphically shown in Figure 4-19. The details of macrobenthos population are given in the **Appendix D**.

Table 4-10: Summary of Macrobenthos Population

Location Code	Macro Benthos ($Nos./m^2$)
HMSL-1-HT	650
HMSL-1-LT	775
HMSL-2-HT	625
HMSL-2-LT	825
HMSL-3-HT	725
HMSL-3-LT	800
HMSL-4-HT	725
HMSL-4-LT	800
HMSL-5-HT	875
HMSL-5-LT	500
HMSL-6-HT	825
HMSL-6-LT	650
HMSL-7-HT	675
HMSL-7-LT	750
HMSL-8-HT	650
HMSL-8-LT	850
HMSL-9-HT	675
HMSL-9-LT	700

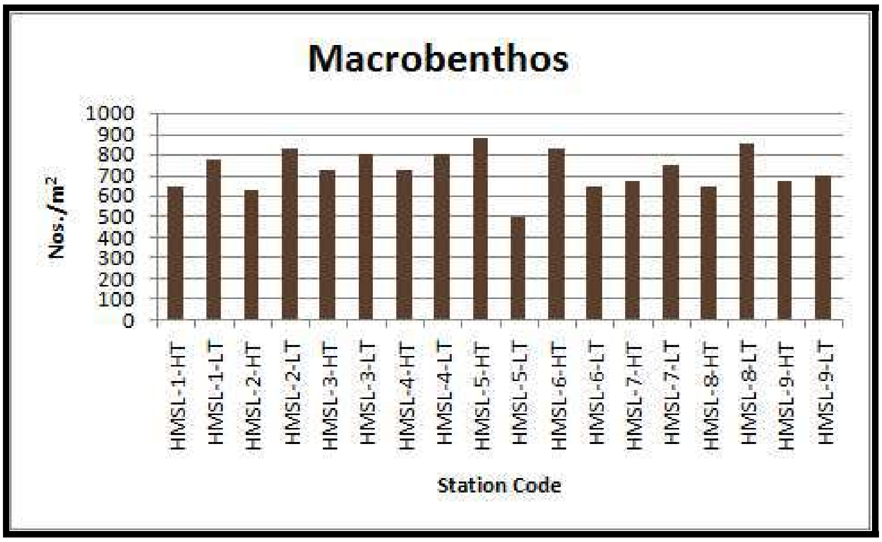


Figure 4-19: Variations in Population Density of Macrobenthos

Meiobenthos:

Overall meiobenthos was, represented by taxonomic group's viz., Nematodes, Foraminiferans, Gastrotricha, Cumacea, Oligochates, Harpacticoids, Ostrocodes, Archiannelid, Tanaidacea and Rotifera were encountered during the study. Around 81 species were recorded. The meiobenthos density was ranged between 416 nos/10cm^2 at HMSL-6 during low tide and 256 nos/10cm^2 at HMSL-1 during high tide. The Summary of meiobenthos population is given in the Table 4-11 and the variation in meiobenthos population is graphically shown in Figure 4-20. The details of meiobenthos population are given in the **Appendix D**.

Table 4-11: Summary of Meiobenthos Population

Location Code	Meio Benthos (Nos/10cm^2)
HMSL-1-HT	256
HMSL-1-LT	347
HMSL-2-HT	283
HMSL-2-LT	386
HMSL-3-HT	299
HMSL-3-LT	387
HMSL-4-HT	325
HMSL-4-LT	411
HMSL-5-HT	281
HMSL-5-LT	373
HMSL-6-HT	303
HMSL-6-LT	416
HMSL-7-HT	298
HMSL-7-LT	392
HMSL-8-HT	278
HMSL-8-LT	357
HMSL-9-HT	260
HMSL-9-LT	369

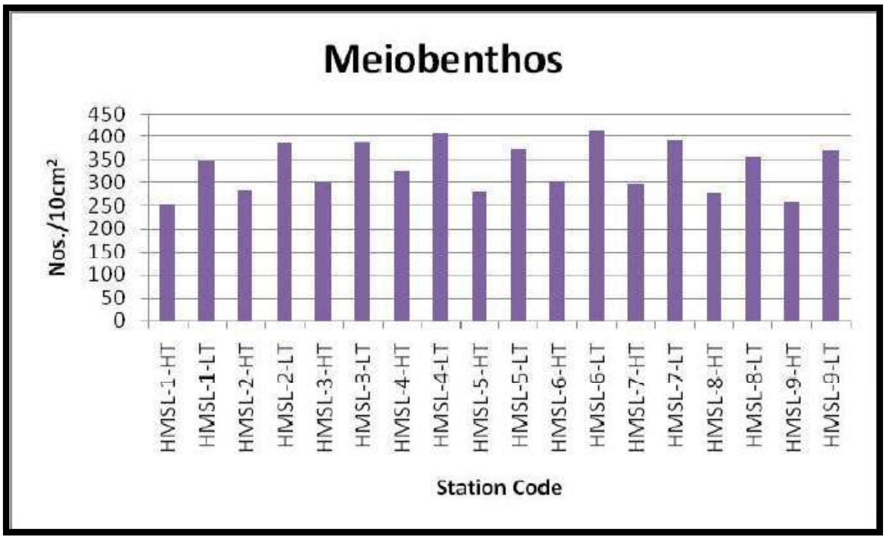


Figure 4-20: Variations in Population Density of Meiobenthos

4.4.3 Sea/Harbour Water Quality

The primary objective of this investigation was to establish baseline data on seawater quality, sediment quality and marine ecology prior to the development of Honnavar barge/ vessel loading facility. Methodologies used for the study are therefore clearly aimed at obtaining information on the environmental conditions according to EIA governed protocols defined in standard manuals and reference material (e.g. UNESCO, 1978; Parsons et al., 1984; Standard Methods of the American Public Health Association APHA, 1989, 1998; Grasshoff et al., 1999).

Temperatures, Salinity, Transparency, DO, BOD, Nitrate, Nitrite, Ammonia, Total Nitrogen, Total Phosphorous and Inorganic Phosphate were monitored. All parameters were estimated by using following standard methods. Biological variables have also been studied and this includes planktons (both Phyto and Zooplankton), productivity and benthos (macro & meio). Sediment samples were also collected and analyzed for various parameters including heavy metals.

The following sections present the sampling locations and results for the above mentioned parameters monitored.

4.4.3.1 Physico-Chemical Parameters

The details regarding physical parameters for all monitoring locations are given in Table 4-12.

Table 4-12: Physical Parameters

Location Code	Temp. (°C)	Salinity (‰)	pH	TSS (mg/l)	Turbidity (NTU)	DO (mg/l)	BOD (mg/l)
HMSL-1-HT	29.0	26	7.4	28.0	10	5.658	0.464
HMSL-1-LT	30.5	21	7.2	33.6	12	5.222	0.960
HMSL-2-HT	29.0	32	8.2	29.0	8	5.947	1.216
HMSL-2-LT	30.0	34	8.1	24.0	9	5.593	0.960
HMSL-3-HT	29.0	31	8.1	65.0	7	5.189	1.104
HMSL-3-LT	31.0	30	8.0	81.4	7	5.462	1.168
HMSL-4-HT	30.0	32	8.0	68.6	9	5.801	0.400
HMSL-4-LT	31.0	31	8.0	51.0	8	5.004	0.544
HMSL-5-HT	31.0	33	8.2	62.6	4	5.642	1.472
HMSL-5-LT	30.0	33	8.2	75.4	5	5.220	1.200
HMSL-6-HT	29.0	33	8.2	72.2	3	5.852	1.072
HMSL-6-LT	30.0	30	8.0	86.0	3	5.769	0.928
HMSL-7-HT	29.0	31	8.1	54.4	5	5.820	1.264
HMSL-7-LT	30.0	30	8.0	44.2	6	5.092	1.376
HMSL-8-HT	29.0	25	7.5	32.4	8	6.205	1.040
HMSL-8-LT	30.0	24	7.3	45.6	8	6.624	1.168
HMSL-9-HT	31.0	28	7.7	44.2	7	6.866	0.720
HMSL-9-LT	31.0	28	7.7	32.2	9	6.545	1.216

Temperature (°C): The water temperature ranged from 29.0°C to 31.0°C. The variation of temperature at all the monitoring locations is shown in Figure 4-21.

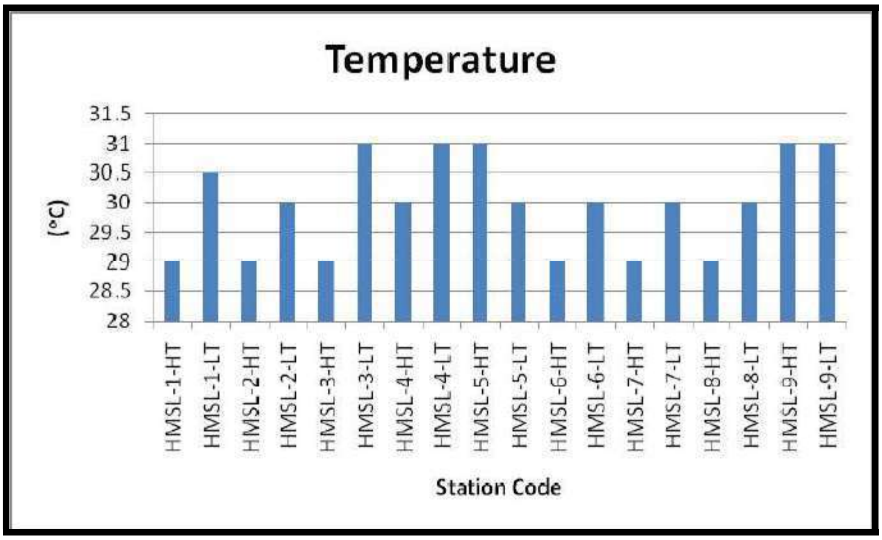


Figure 4-21: Variations in Temperature

Salinity (ppt): The major variable in the coastal environment is salinity. Usually there is a continuous gradient between shore line area and deep waters, the minimum and maximum salinity observed were 21 and 34 (ppt) respectively. The variation of salinity at all the monitoring locations is shown in Figure 4-22.

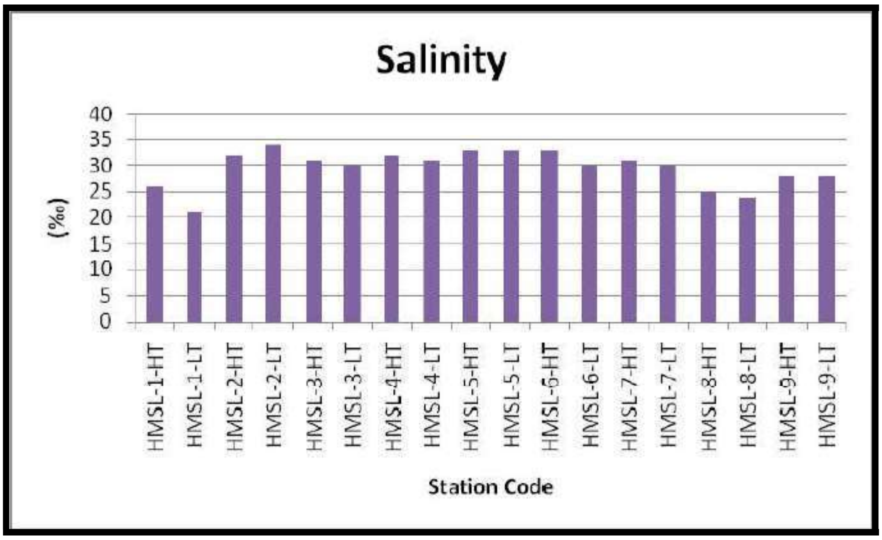


Figure 4-22: Variations in Salinity

pH: The pH value of water in the present study remained alkaline at all stations. It ranged between 7.2 and 8.2. The variation of pH at all the monitoring locations is shown in Figure 4-23.

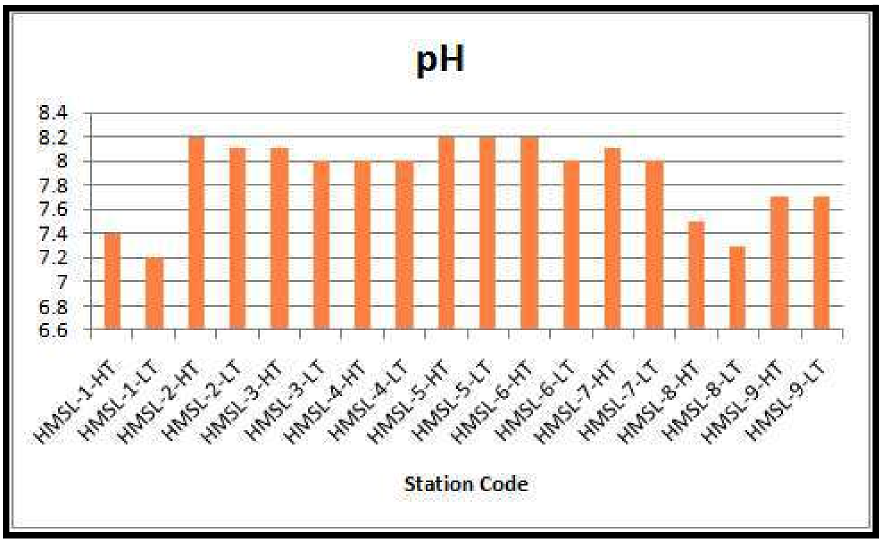


Figure 4-23: Variations in pH

Turbidity: The turbidity varied from 3 to 12 Nephlometric Turbidity Unit (NTU). The minimum turbidity was recorded at HMSL-6 during high & low tide. The maximum turbidity was recorded at HMSL-1 during low tide. The variation of turbidity at all the monitoring locations is shown in Figure 4-24.

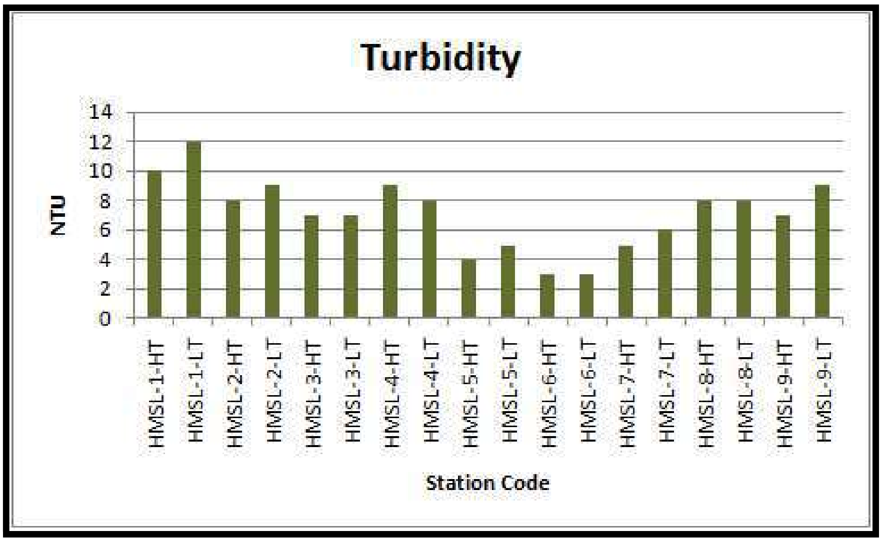


Figure 4-24: Variations of Turbidity Levels

Total Suspended Solids: The Total suspended Solids varied from 24 to 86 mg/l. The minimum level was recorded in HMSL-2 during low tide and the maximum level was recorded at HMSL-6 during low tide. The variation of Total Suspended Solids at all the monitoring locations is shown in Figure 4-25.

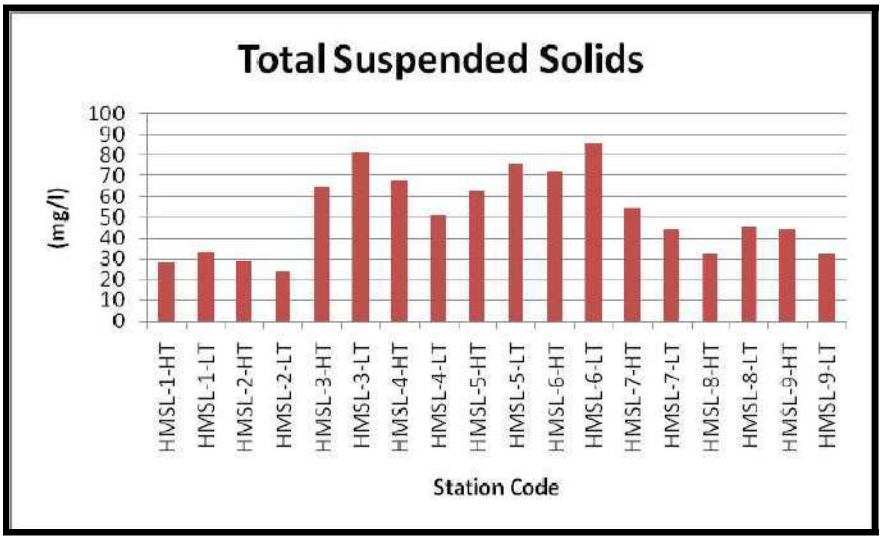


Figure 4-25: Variations in Total Suspended Solids

Oil & Grease levels The oil & grease levels varied from 0.145 µg/ to 0.810 µg/l. The minimum level was recorded in HMSL-4 during low tide and the maximum level was recorded at HMSL-6 during high tide. The variation of Oil and Grease at all the monitoring locations is shown in Table 4-13 & Figure 4-26.

Table 4-13: Oil & Grease Levels in Water

Location Code	Variations in Oil & Grease Levels
HMSL-1-HT	0.655
HMSL-1-LT	0.315
HMSL-2-HT	0.420
HMSL-2-LT	0.250
HMSL-3-HT	0.325
HMSL-3-LT	0.290
HMSL-4-HT	0.175
HMSL-4-LT	0.145
HMSL-5-HT	0.430
HMSL-5-LT	0.470
HMSL-6-HT	0.810
HMSL-6-LT	0.155
HMSL-7-HT	0.280
HMSL-7-LT	0.375
HMSL-8-HT	0.365
HMSL-8-LT	0.355
HMSL-9-HT	0.275

Location Code	Variations in Oil & Grease Levels
HMSL-9-LT	0.315

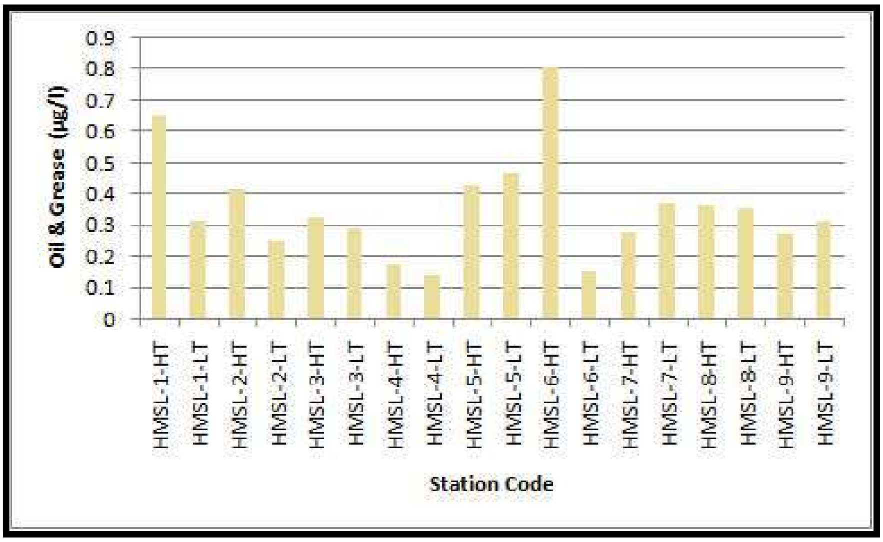


Figure 4-26: Variations in Oil and Grease Levels (Water)

Dissolved Oxygen (mg/l): The Dissolved Oxygen (DO) varied between 5.004 mg/l to 6.866 mg/l. The minimum value was observed at HMSL-4 during low tide and the maximum was recorded at HMSL-9 during high tide. The variation of DO at all the monitoring locations is shown in Figure 4-27.

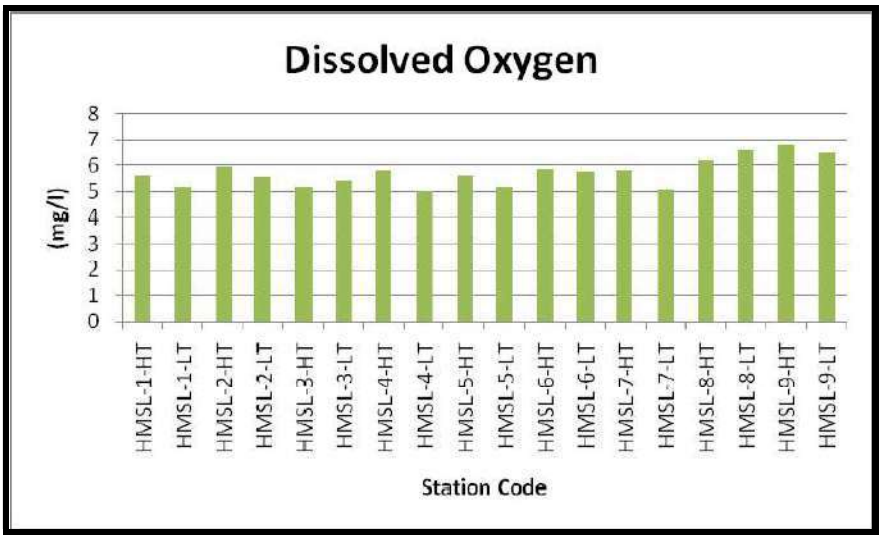


Figure 4-27: Variations in Dissolved Oxygen Levels

Biological Oxygen Demand (mg/l): The Biological Oxygen Demand (BOD) varied between 0.40 mg/l to 1.472 mg/l. The minimum value was observed at HMSL-4 during high tide and the maximum was recorded at HMSL-5 during high tide. The variation of BOD at all the monitoring locations is shown in Figure 4-28.

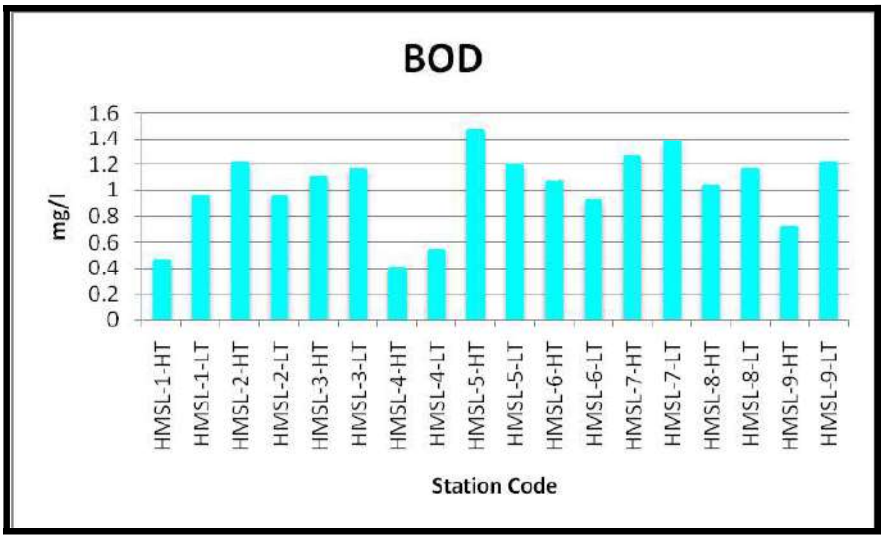


Figure 4-28: Variations in Biological Oxygen Demand

4.4.3.2 Nutrients

The details regarding nutrients for all monitoring locations are given in Table 4-14.

Table 4-14: Nutrients in Water

Location Code	Parameters (µmol/l)						
	NO_2	NO_3	NH_4	TN	IP	TP	SiO_4
HMSL-1-HT	0.345	7.230	0.971	22.950	1.019	1.562	32.204
HMSL-1-LT	0.517	8.435	1.079	25.634	0.831	1.151	32.225
HMSL-2-HT	0.249	10.802	0.648	26.171	0.944	1.069	15.422
HMSL-2-LT	0.268	7.875	0.722	19.729	0.906	1.110	21.499
HMSL-3-HT	0.383	8.177	0.681	21.205	0.755	1.028	25.742
HMSL-3-LT	0.268	8.865	0.664	26.574	0.944	1.274	20.683
HMSL-4-HT	0.326	10.113	0.374	24.695	0.680	1.069	21.590
HMSL-4-LT	0.192	7.832	0.415	25.768	1.019	1.192	18.074
HMSL-5-HT	0.284	8.865	0.174	25.097	0.982	1.110	17.801
HMSL-5-LT	0.555	7.789	0.689	23.218	1.284	1.397	19.888
HMSL-6-HT	0.230	6.756	0.166	26.574	0.982	1.110	15.037
HMSL-6-LT	0.134	8.392	0.257	27.245	0.793	1.069	18.314
HMSL-7-HT	0.115	10.974	0.648	20.534	0.755	1.151	12.607
HMSL-7-LT	0.153	7.875	0.739	17.850	1.284	1.644	13.132
HMSL-8-HT	0.172	8.435	0.432	21.205	1.548	1.726	35.966
HMSL-8-LT	0.149	9.296	0.448	24.560	0.944	1.480	30.299
HMSL-9-HT	0.345	8.005	0.623	25.231	0.906	1.028	37.983
HMSL-9-LT	0.230	8.865	0.988	26.708	1.359	1.767	41.702

Ammonium Ion: The ammonical nitrogen concentration varied from 0.166 to 1.079 µmol/l. The minimum level of ammonical nitrogen recorded at HMSL-6 during high tide, whereas the maximum level was recorded at HMSL-1 during low tide. The variation of ammonical nitrogen at all the monitoring locations is shown in Figure 4-29.

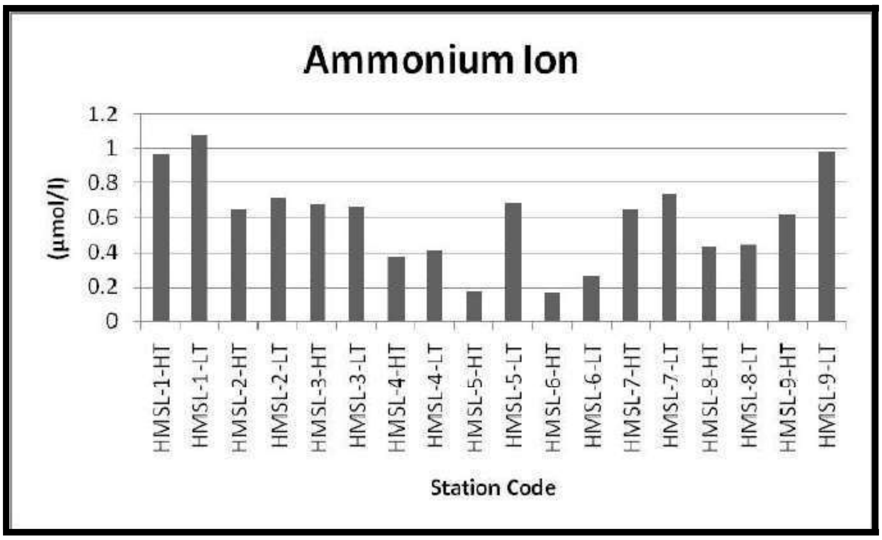


Figure 4-29: Variations in Ammonium Ion Levels

Nitrite: The nitrite concentration varied from 0.115 to 0.555 μmol/l. The minimum level of nitrite was observed at HMSL-7 during high tide whereas the maximum level of was observed at HMSL-5 during low tide. The variation of nitrite at all the monitoring locations is shown in Figure 4-30.

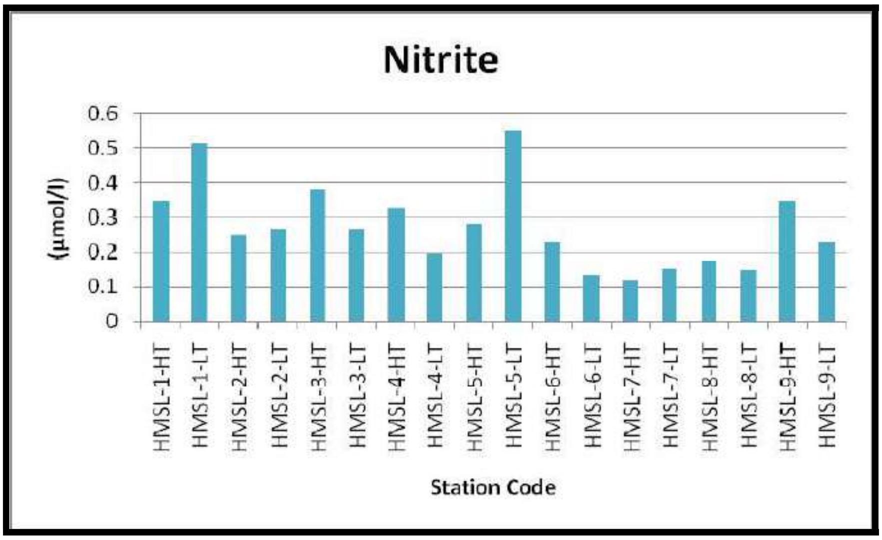


Figure 4-30: Variations in Nitrite Levels

Nitrate: The nitrate concentration ranged between 6.756 to 10.974 μmol/l. The minimum level of nitrate observed at HMSL-6 during high tide, whereas the maximum level of nitrate observed at HMSL-7 during high tide. Nitrate levels at all the monitoring locations are shown in Figure 4-31.

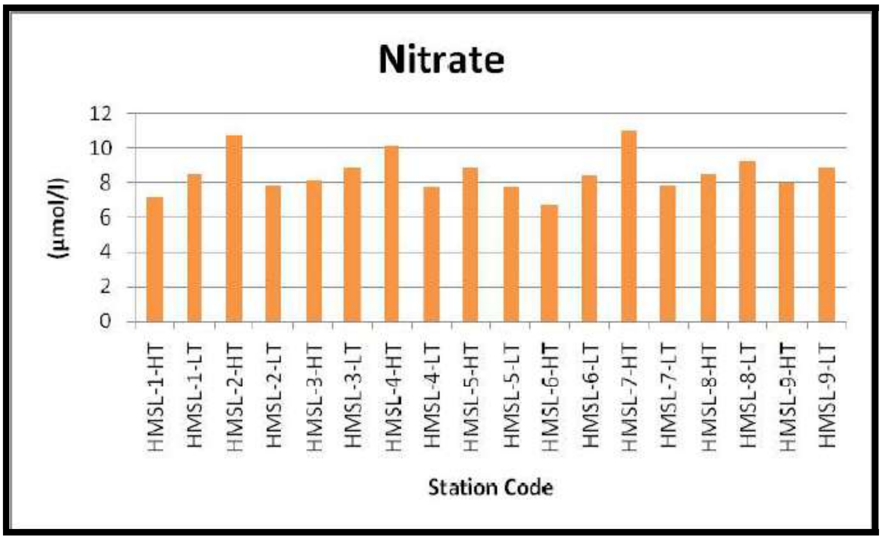


Figure 4-31: Variations in Nitrate Levels

Total Nitrogen: The Total Nitrogen concentration varied from 17.85 to 27.245 µmol/l. The minimum level of Total Nitrogen observed at HMSL-7 during low tide, whereas the maximum level was recorded at HMSL-6 during low tide. Total Nitrogen levels at all the monitoring locations are shown in Figure 4-32.

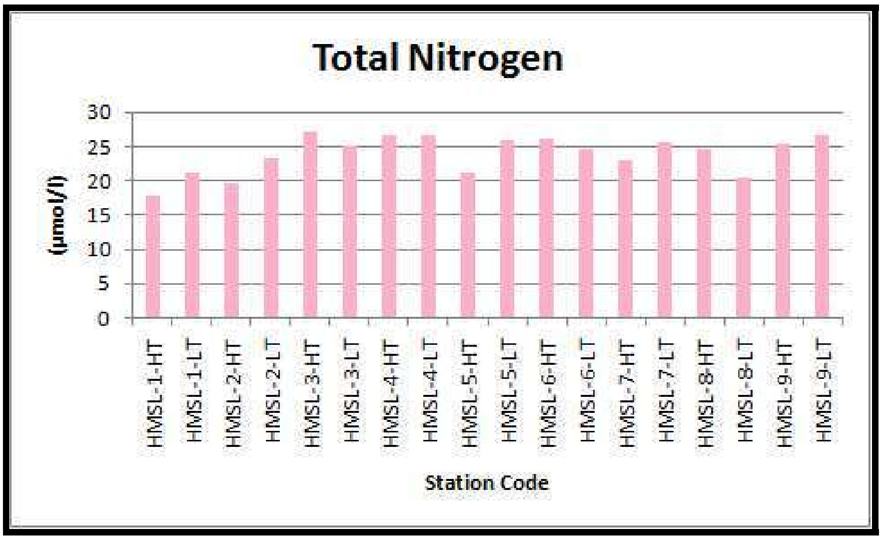


Figure 4-32: Variations in Nitrogen Levels

Inorganic Phosphate: The inorganic phosphate concentrations in the sampling stations were fluctuated between 0.680 and 1.548 µmol/l. The lower level of inorganic phosphate was recorded at HMSL-4 during high tide and the maximum level was recorded at HMSL-8 during high tide. Inorganic phosphate levels at all the monitoring locations are shown in Figure 4-33.

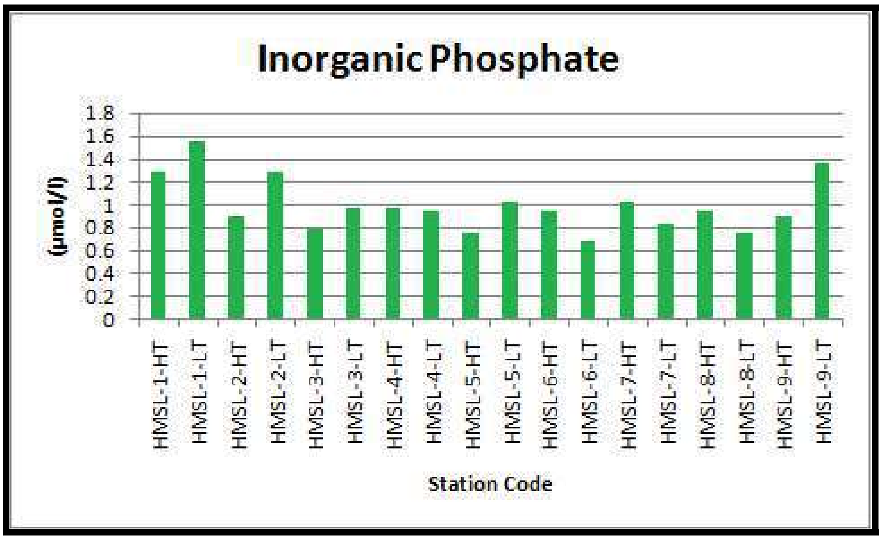


Figure 4-33: Variations in Inorganic Phosphate Levels

Total Phosphorus: The total phosphorus concentration varied from 1.028 to 1.767 µmol/l. The minimum level was recorded at HMSL-3 and HMSL-9 during both high tide the maximum level was recorded at HMSL-9 during low tide. Total Phosphorus levels at all the monitoring locations are shown in Figure 4-34.

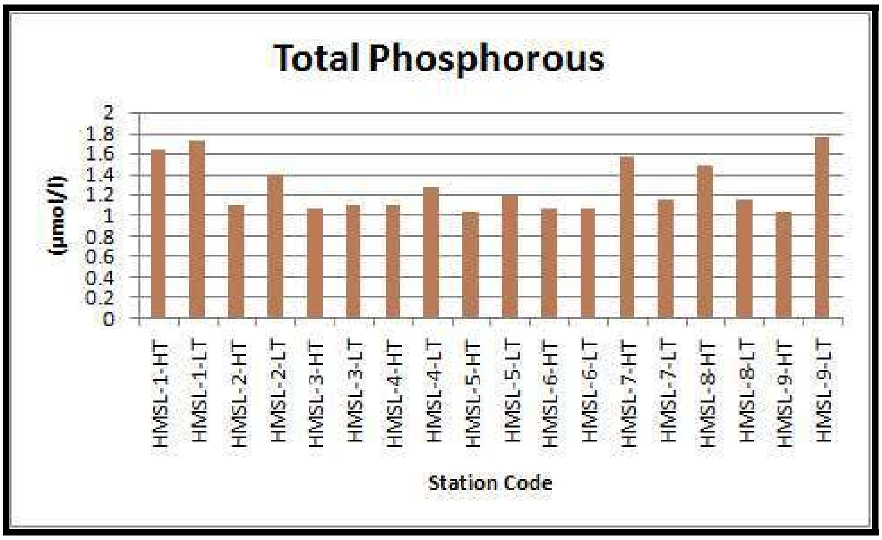


Figure 4-34: Variations in Total Phosphorous Levels

Silicate: The silicate level was ranged from 12.607 to 41.702 µmol/l. The maximum level was recorded at HMSL-9 during low tide and the minimum level was recorded at HMSL-7 during high tide. Silicate levels at all the monitoring locations are shown in Figure 4-35.

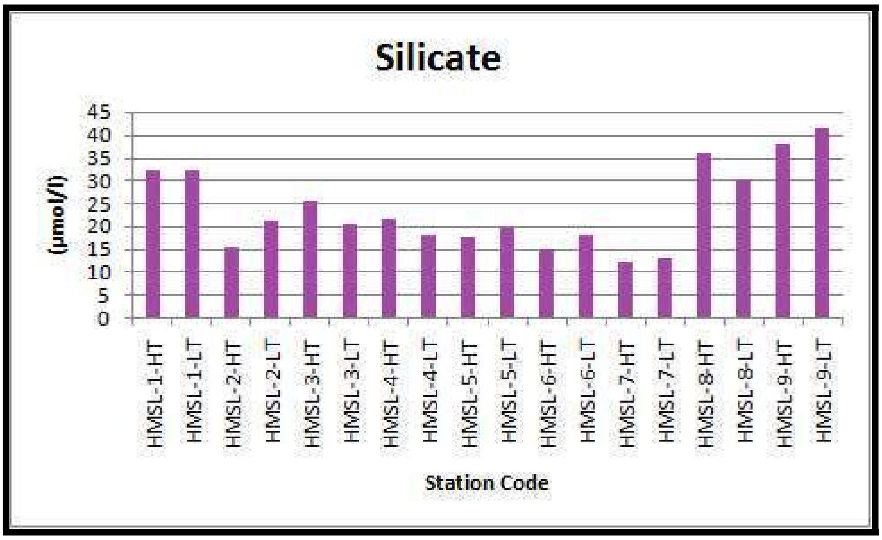


Figure 4-35: Variations in Silicate Levels

Heavy Metals:

In water samples the fluctuations of heavy metal such as Cadmium (Cd), Copper (Cu), Iron (Fe), lead (Pb), Zinc (Zn), and Mercury (Hg) have been examined. The results of heavy metal concentrations in the sampling locations are given in Table 4-15.

Table 4-15: Heavy Metal Concentrations (µg/l) in Seawater

S. No.	Location Code	Parameters (µg/l)					
		Cd	Cu	Fe	Pb	Zn	Hg
1	HMSL-1-HT	1.24	18.12	59.65	16.72	31.88	0.012
2	HMSL -1-LT	1.08	12.06	97.82	15.22	34.62	0.024
3	HMSL -2-HT	1.15	40.92	90.24	16.32	55.64	0.048
4	HMSL -2-LT	1.14	52.82	75.62	20.73	62.96	0.042
5	HMSL -3-HT	0.98	54.24	98.24	23.46	63.32	0.024
6	HMSL -3-LT	1.38	49.44	94.12	25.02	66.36	0.012
7	HMSL-4-HT	1.25	48.24	84.69	22.52	60.72	0.008
8	HMSL-4-LT	1.56	37.98	55.76	11.94	73.56	0.006
9	HMSL-5-HT	1.68	44.78	82.64	33.72	59.63	0.018
10	HMSL-5-LT	0.94	41.56	95.63	34.26	58.58	0.006
11	HMSL-6-HT	0.6	49.23	63.22	22.22	56.25	0.010
12	HMSL-6-LT	1.56	46.92	91.25	19.32	53.04	0.018
13	HMSL-7-HT	1.35	31.56	94.81	11.52	46.96	0.024
14	HMSL-7-LT	0.63	17.94	20.68	16.95	45.42	0.012
15	HMSL-8-HT	0.83	10.74	18.28	15.82	59.94	0.036
16	HMSL-8-LT	1.39	24.36	29.864	19.23	54.38	0.028
17	HMSL-9-HT	1.26	30.56	86.28	28.62	51.32	0.042
18	HMSL-9-LT	1.55	33.91	82.16	26.42	68.06	0.054

Cadmium (Cd): The values ranged from 0.60 µg/l at HMSL-6 (HT) to 1.68 µg/l at HMSL-5 (HT).

Copper (Cu): The values ranged from 10.74 µg/l at HMSL-8 (HT) to 54.24 µg/l HMSL-3 (HT).

Lead (Pb): The values ranged from 34.26 µg/l at HMSL-5 (LT) to 11.52µg/l at HMSL-7 (HT).

Zinc (Zn): The values ranged from 73.56 µg/l at HMSL-4 (LT) to 31.88 µg/l at HMSL-1 (HT). The variation of Cadmium, Copper, Lead and Zinc at all the monitoring locations is shown in Figure 4-36.

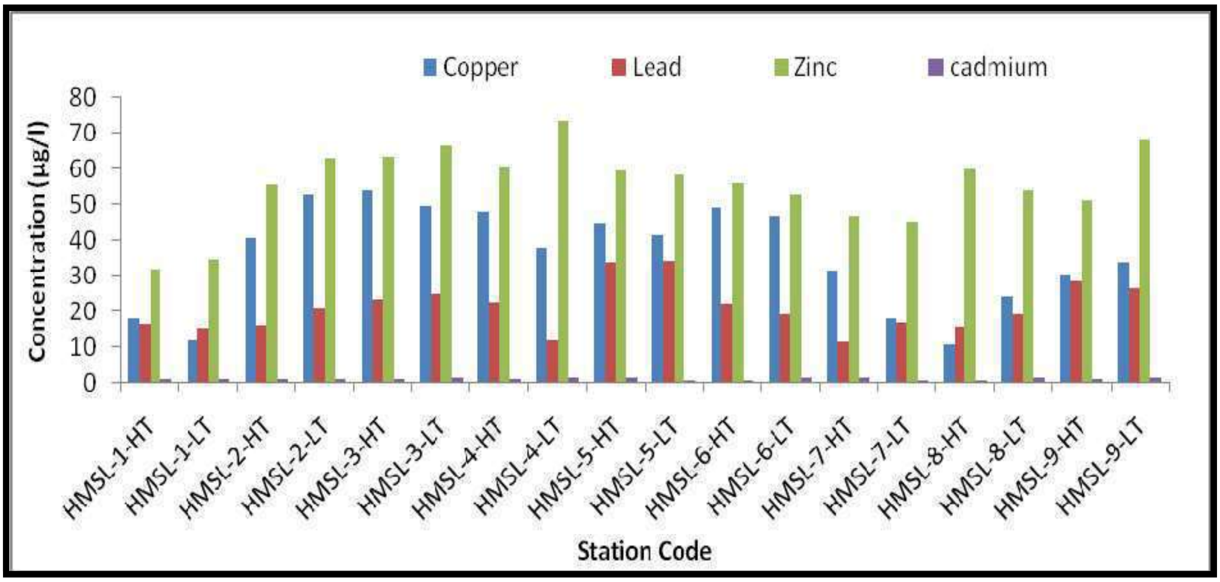


Figure 4-36: Variations in Cadmium, Copper,Zinc and Lead

Iron (Fe): The values ranged from 18.28 µg/l at HMSL-8 (HT) to 98.24 µg/l HMSL-3 (HT). The variation of iron at all the monitoring locations is shown in Figure 4-37.

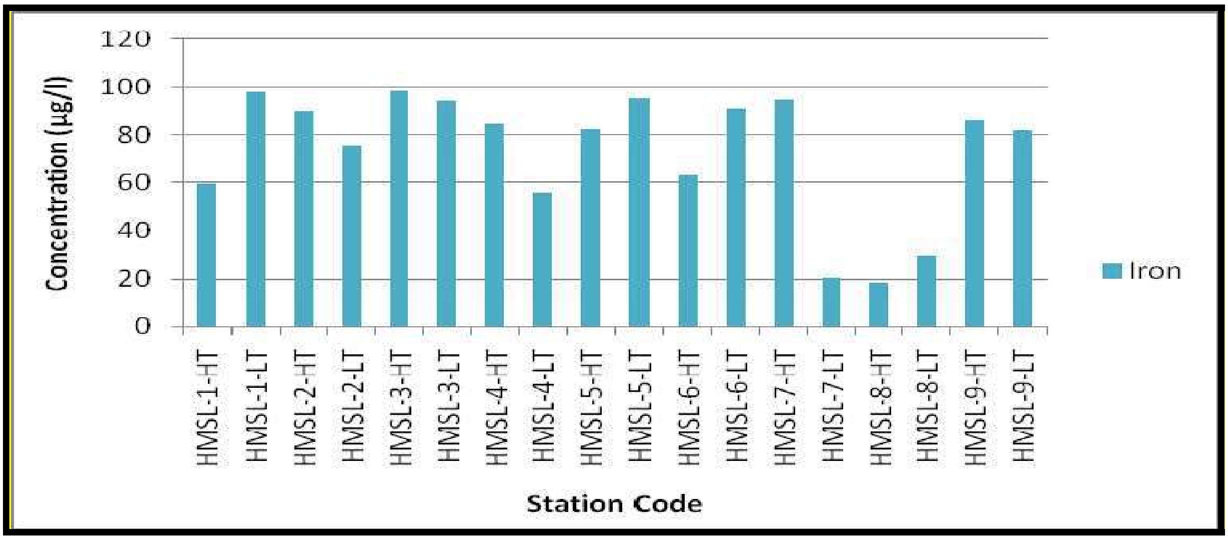


Figure 4-37: Variations in Iron Concentration

Mercury (Hg): The values ranged from 0.006 µg/l at HMSL-4 & HMSL-5 during low tide to 0.054 µg/l at HMSL- 9 during low tide. The variation of mercury at all the monitoring locations is shown in Figure 4-38.

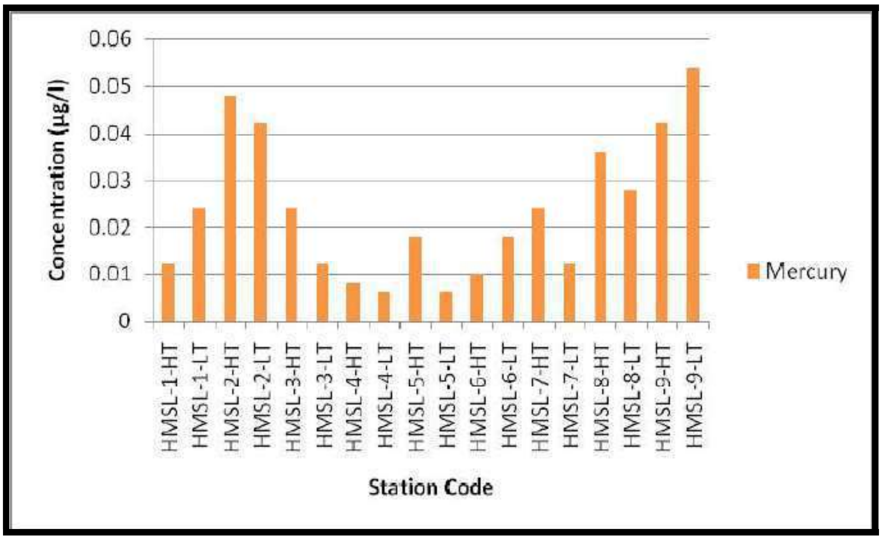


Figure 4-38: Variations in Mercury Concentration

4.5 Biological Environment

4.5.1 Marine/Coastal Ecology

The details of the various biological parameters monitored and the range of values observed are given in the paragraphs below.

4.5.1.1 Phytoplankton

Surface phytoplankton samples were collected from all nine locations. The population density of phytoplankton ranged between 1064 Nos/L at HMSL-1 during low tide to 4139 Nos/L at HMSL-3 during high tide. Around 61 species of phytoplankton were recorded from the study area.

The Number of species of Phytoplankton are given in the Table 4-16 and graphically shown in Figure 4-39.

Table 4-16: Number of Species at Each Sampling Location

Location Code	Phytoplankton Density (Nos./l)
HMSL-1-HT	2150
HMSL-1-LT	1064
HMSL-2-HT	2051
HMSL-2-LT	1290
HMSL-3-HT	4139
HMSL-3-LT	2506
HMSL-4-HT	2905
HMSL-4-LT	2477
HMSL-5-HT	2820

Location Code	Phytoplankton Density (Nos./l)
HMSL-5-LT	1660
HMSL-6-HT	3290
HMSL-6-LT	2860
HMSL-7-HT	2388
HMSL-7-LT	1884
HMSL-8-HT	3232
HMSL-8-LT	2898
HMSL-9-HT	3693
HMSL-9-LT	3022

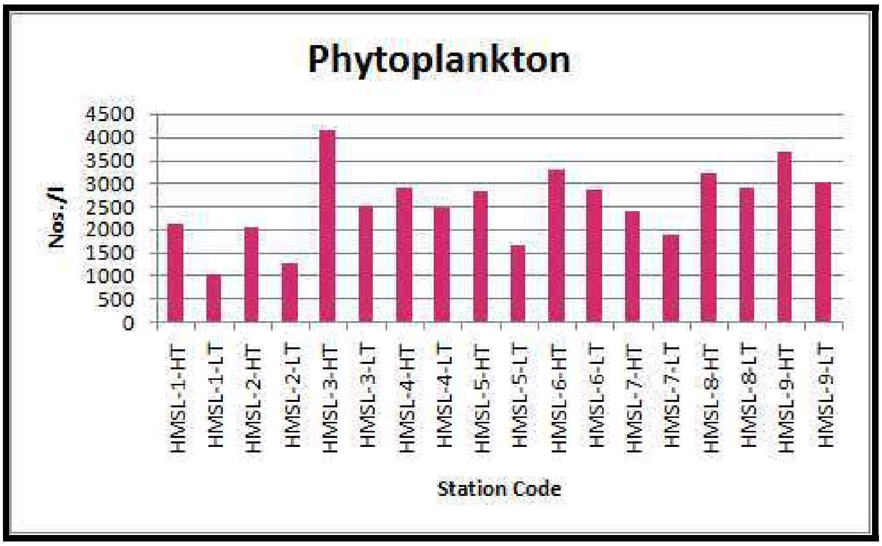


Figure 4-39: Variations in Phytoplankton Density

The details regarding phytoplankton abundance for all monitoring locations are given in **Appendix D**.

Primary ProductivityPrimary Productivity ranged between 46.86 mg C/m^3/hr at HMSL-3 during high tide and 98.80 mg C/m^3/hr at HMSL-4 during low tide.

Chlorophyll-a

Chlorophyll-a ranged between 0.324 mg/m^3 at HMSL-1 during low tide and 1.691 mg/m^3 at HMSL-3 during high tide.

Phaeopigment

Phaeopigment ranged between 0.025 mg/m^3 at HMSL-1 during low tide and 0.874 mg/m^3 at HMSL-3 during high tide.

Total Biomass

Total Biomass varied between 10.46 mg/100 m^3 at HMSL-5 during low tide and 54.08 mg/100 m^3 at HMSL-7 during high tide. Detailed results for the above parameters are given in Table 4-17.

Table 4-17: Primary Productivity, Chlorophyll-a, Phaeopigment, Total Biomass

S. No.	Location Code	Primary Productivity (mg C/m^3/hr)	Chlorophyll a (mg/m^3)	Phaeopigment (mg/m^3)	Total Biomass (ml/100 m^3)
1	HMSL-1-HT	54.94	0.723	0.062	20.73
2	HMSL-1-LT	69.48	0.324	0.025	11.23
3	HMSL-2-HT	80.58	0.821	0.492	33.16
4	HMSL-2-LT	71.01	0.414	0.231	14.22
5	HMSL-3-HT	98.8	1.691	0.874	20.56
6	HMSL-3-LT	87.26	0.749	0.492	13.37
7	HMSL-4-HT	74.34	0.720	0.623	27.95
8	HMSL-4-LT	46.86	0.560	0.430	20.96
9	HMSL-5-HT	66.25	0.623	0.452	14.10
10	HMSL-5-LT	80.83	0.947	0.623	10.46
11	HMSL-6-HT	90.5	1.218	0.512	28.10
12	HMSL-6-LT	75.95	0.676	0.400	17.27
13	HMSL-7-HT	74.74	0.946	0.312	54.08
14	HMSL-7-LT	83.82	0.745	0.623	42.34
15	HMSL-8-HT	91.81	0.614	0.241	32.32
16	HMSL-8-LT	66.26	0.413	0.230	21.21
17	HMSL-9-HT	98.65	1.077	0.600	38.22
18	HMSL-9-LT	81.27	1.589	0.623	36.33

4.5.1.2 Zooplankton

Zooplankton abundance varied from a minimum of 2826 cells/m^3 at HMSL-5 (LT) to 8112 Nos/m^3 at HMSL-7 (HT). Around 42 species of zooplankton were recorded from the study area.

The Number of species of Zooplankton are given in the Table 4-18 and graphically shown in Figure 4-40.

Table 4-18: Number of Species at Each Sampling Location

Location Code	Zooplankton Density (Nos./m^3)
HMSL-1-HT	4144
HMSL-1-LT	2920
HMSL-2-HT	6301
HMSL-2-LT	3553
HMSL-3-HT	4320
HMSL-3-LT	3477
HMSL-4-HT	5590
HMSL-4-LT	4193

Location Code	Zooplankton Density (Nos./m^3)
HMSL-5-HT	3381
HMSL-5-LT	2826
HMSL-6-HT	5059
HMSL-6-LT	3974
HMSL-7-HT	8112
HMSL-7-LT	6777
HMSL-8-HT	5494
HMSL-8-LT	4458
HMSL-9-HT	6880
HMSL-9-LT	5813

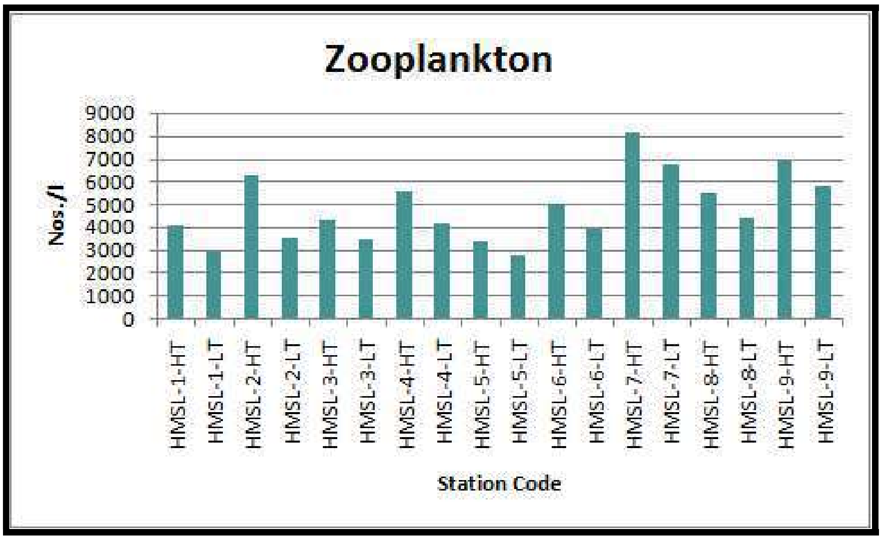


Figure 4-40: Variations in Zooplankton Density

The details regarding zooplankton abundance for all monitoring locations are given in **Appendix D**.

4.5.1.3 Finfish eggs density

Finfish eggs density varied from a minimum of 73 Nos./m^3 at HMSL-8 (LT) to 110 Nos./m^3 at HMSL-8 (HT).

4.5.1.4 Finfish Larvae density

The recorded Finfish larvae density varied from a minimum of 1 Nos./m^3 to 3 Nos./m^3 .

4.5.1.5 Microbial Population

The indicator and pathogenic bacteria isolated from water samples collected from the marine monitoring locations are described below and the details are given below & **Appendix D**.

Escherichia Coli (EC)

The *E.coli* population varied between 10 x 10^1 CFU/ml at HMSL-3 and HMSL-7 during low tide and 28 x 10^1 CFU/ml at HMSL-8 during high tide.

Faecal Coliform (FC)

The Faecal Coliform population ranged between 30 CFU/ml at HMSL- 9 during low tide and 39 x 10^1 CFU/ml at HMSL-5 during high tide.

Pseudomonas Aeurginosa (PA)

The PA population ranged between 70 CFU/ml at HMSL-9 during low tide and 20 x 10^2 CFU/ml at HMSL-5 during high tide.

Proteus-Klebsiella (PK)

The PK population ranged between 11 x 10^1 CFU/ml at HMSL-9 during low tide and 23 x 10^2 CFU/ml at HMSL-8 during high tide.

Streptococcus Faecalis (SF)

The SF population ranged between 10 CFU/ml at HMSL-3 during low tide and 28 CFU/ml at HMSL-4 during high tide.

Shigella (SH)

The SH population observed ranged between 21x10^3 CFU/ml and 90 CFU/ml. The minimum concentration was observed at HMSL-9 during low tide. The maximum concentration was observed at HMSL-6 during high tide.

Salmonella (S)

The Salmonella population ranged between 10 CFU at HMSL-1 during low tide and 22 x 10^1 CFU/ml at HMSL-5 (HT).

Total Coliform (TC)

The Total Coliform population ranged between 11 x 10^2 CFU/ml at HMSL-1 during low tide and 50 x 10^3 CFU/ml at HMSL-5 during low tide.

Total Viable Count -Total Heterotrophic Bacteria (TVC)

TVC observed in water samples ranged between 36 x 10^4 CFU/ml at HMSL-8 during high tide and 10 x 10^4 CFU/ml at HMSL-5 during low tide.

Vibrio Cholera (VC)

The VC population ranged between 10 CFU/ml at HMSL-8 during low tide and 22 x 10^1 CFU/ml at HMSL-3 during high tide.

Vibrio Parahaemolyticus (VP)

The VP population observed in water samples ranged between 5 CFU/ml at HMSL-9 during low tide and 20 x 10^1 CFU/ml at HMSL-6 during high tide. The details regarding Microbial population all monitoring locations are given in **Appendix D**.

4.5.2 Fisheries

The most common species landed at Honnavar is the Indian Mackerel (*Rastrelliger kanagurta*). Its peak season is from June to July, and fished using gillnets. Seer Fish season is from the 15th of August till the end of September. Anchovies (*Engraulidae*) and Sardines (*Sardinella sp.)* are available throughout the year. *Limited* fishing activity in the Sharavati River is observed with Traditional Boats using Trap Nets and Traditional nets. A list of fishes either trapped or caught by local fishermen from the waters of the study area is given in Table-4-19.

Table 4-19: List of Fish Reported from the Study Area.

S. No.	Scientific Names	S. No.	Scientific Names
1	*Epinephelus diacanthus*	25	*Rhinobatos granulatus*
2	*Grammoplites suppositus*	26	*Pristipomoides filamentosus*
3	*Priacanthus hamrur*	27	*Pampus argenteus*
4	*Scomberomorus commerson*	28	*Parastromateus niger*
5	*Scomberomorus guttatus*	29	*Rachycentron canadum*
6	*Euthynnus affinis*	30	*Kowala coval*
7	*Thunnus tonggol*	31	*Dussumieria acuta*
8	*Auxis thazard*	32	*Chirocentrus dorab*
9	*Sphyraena jello*	33	*Stolephorus commersonii*
10	*Sphyraena obtusata*	34	*Stolephorus devisi*
11	*Sphyrna lewini*	35	*Thryssa mystax*
12	*Rhizoprinodon acutus*	36	*Leiognathus bindus*
13	*Scoliodon laticaudus*	37	*Secutor insidiator*
14	*Carcharhinus limbatus*	38	*Saurida tumbil*
15	*Trichiurus lepturus*	39	*Pseudorhombus arsius*
16	*Sardinella longiceps*	40	*Pseudorhombus natelensis*
17	*Rastrelliger kanagurta*	41	*Cynoglossus macrostomus*
18	*Megalaspis cordyla*	42	*Metapenaeus monoceros*
19	*Decapterus russelli*	43	*Portunus pelagicus*
20	*Caranx kalla*	44	*Portunus sanguinolentus*
21	*Scomberoides tol*	45	*Oratosquilla nepa*
22	*Lactarius lactarius*	46	*Sepia aculeata*
23	*Nemipterus japonicus*	47	*Loligo duvauceli*
24	*Nemipterus mesoprion*	48	*Rastrelliger karnagurta*

4.5.3 Flora and Fauna in the Area

A detailed study on flora and fauna was carried out at various locations within the study area. Study methodology and status of flora and fauna in the study area are discussed.

4.5.3.1 General Description of the Study Area

The project area falls towards southern side of the Sharavati river mouth. The coastal zone of the region is populated with a coconut clad villages. The hill chains of the Western Ghats, which run in the north-south direction, parallel to the coast, form the backbone of the district.

This section is concerned with the development of the proposed barge/vessel loading facility site of HPPL. Methodology of the Flora & Fauna Study

Flora and fauna studies were conducted to assess the list of plant and animal species and their habitat in and around the port site. The area meant for the establishment of the barge/vessel loading facility is described as the ***Core Area*** while the area surrounding the core area up to a radius of 10 km is described as the ***Project Influence Area***.

4.5.3.2 Status of Flora & Vegetation

Core Area: The land identified for barge/vessel loading facility (core area) is coastal sand. No major vegetation is observed. The proposed project site is mostly barren and the only vegetation found here are a few grasses, occasional cacti and a few stretches of *Ipomoea pes-caprae.* This type of vegetation is quite common along the Indian Coast. There are no forests or plantations within the core area.



Plate 4-2: Vegetation in Core Area

Project Influence Area: In the project influence area consists of dense forests (78.477 sq. Km) of, scrub forests (61.3676 sq. km). Mangroves occupy about 10.605 Sq. km as per the land use survey. Paddy is most widely grown during the rainy season. Agricultural land (which includes plantations) about 67.165 sq. km comprising about 9.5% of the PIA. Among the other crops, Areca nut, cocoa, nutmeg, chickoo, vanilla, and black pepper are common but limited to small size plots. *Coconut (Cocos nucifera)* is widely grown in PIA. Among the other cultivated trees, Areca nut, Cashew nut, and Mango are important.

4.5.3.3 Forest and Mangrove vegetation and flora of the PIA

There is a dense patch of Mangroves more than 2.5 km towards SE in the Sharavati River. There is a reserve forest near Hebbankere around 10 km, NE and several minor forests around 10 km south aerial distance.

According to published sources*[1]., a total of 268 species of plants have been recorded in the Uttara Kannada district. This includes 14 species of liana, 35 species of climber, 33 species

of herb, 59 species of shrub, 4 species of palm, 2 species of grass, 5 species of orchid and 116 species of tree. Among them two species are listed as critically endangered viz. *Semicarpus kathlekanensis, Vateria indica*, and five species as endangered viz. *Chenomorpha fragrans, Dipterocarpus indicus, Dysoxylum malabaricum, Nothapodytes nimmoniana, Persea macrantha*, and about 16 species as vulnerable A detailed list of all the flora of the project area is given in **Appendix E**.

Plate 4-3: Mangroves near Sharavati River

Plate 4-4: Forest Vegetation in Project Impacted Area

4.5.3.4 Non forest and non mangrove vegetation and flora of the PIA

Paddy is the main crop and it is grown as rain fed crop during the rainy season. Other crops include Banana, Betel leaves, Sugar cane, Jute and vegetables, especially brinjal. These crops are very rare and occupy small and isolated areas. Coconut (*Cocos nucifera*), Areca nut (*Areca catechu*), Cashew nut (*Anacardium occidentale*).

[1] H. N. Kumara, Vijay Mohan Raj & K. Santhosh, Indian Institute of Science, & Karnataka Forest Department

4.5.3.5 Status of Terrestrial Fauna

As far as the core area is concerned, there is no fauna that belongs to the REET (Rare Endemic Endangered and Threatened) category. Only a few black kites (*Milvus migrans*) had been seen.

Since it was not possible to cover all the existing fauna in the Project impacted area common check lists have been prepared based mainly on authentic secondary data and also on the basis of direct observation, indirect or circumstantial evidence such as foot prints, feathers, skin, hair, hooves etc. The list of terrestrial fauna found in the study area is provided in **Appendix E**. The lion tailed macaque (*Macaca silenus*) and Grey Langur (Semnopithecus *entellus*.) are reported in the Uttara Kannada district. These primates belong to the Endangered and Near Threatened categories of IUCN (International Union for Conservation of Nature). There were Signboards indicating the presence of the Indian bison *(Bibos gaurus)*.

Migratory birds and the REET category birds had not been observed during the field visit. However, from the secondary data collected from the forest Department, Malabar Grey Hornbill (*Ocyceros griseus*) although not endangered, is endemic to the study area. The Painted stork (*Mycteria leucocephala*), the black headed ibis (*Threskiornis melanocephalus)* had been reported in the study area*. These are* classified as Near Threatened as per IUCN Standards. Commonly observed birds include Paddy field Egrets, Mynas and Kingfishers. Similarly, the Reptiles of the study area are represented by common species of widespread occurrence. There are no Crocodiles and Sea turtles.

Plate 4-5: Fauna reported in Uttara Kannada District

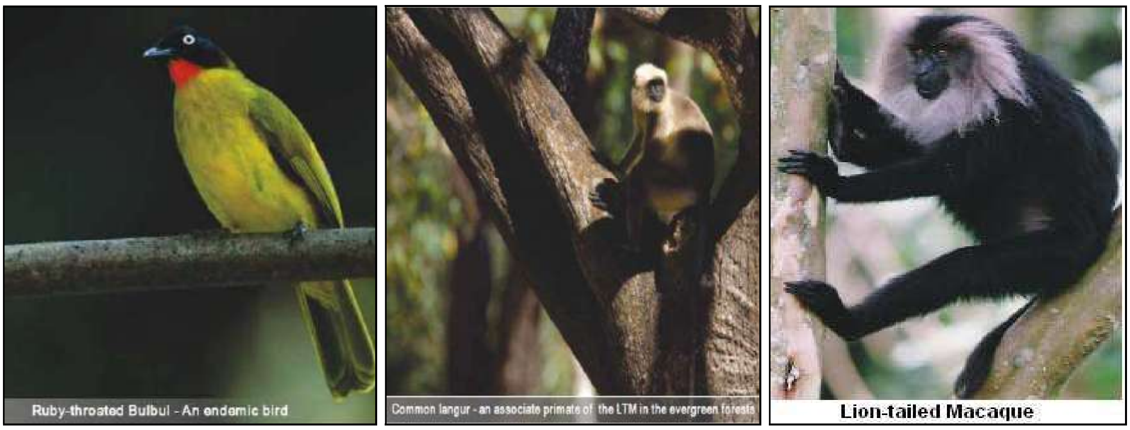


Plate 4-6: Endemic Fauna reported in Uttara Kannada District

4.5.3.6 Aquatic flora and fauna of the PIA/study area

There are no perennial reservoirs either in the core or project affected area. But a good deal of aquatic ecosystem diversity represented by the marine (Arabian Sea), estuarine (around the Sharavati river mouth and banks), occasional lotic (streams) and a few scattered lentic (ponds and marshes) ecosystems could be noticed.

4.6 Air Environment

4.6.1 Meteorological Data from Nearest Meteorological Station (Honnavar)

The nearest Indian Meteorological Department (IMD) station located to project site is Honnavar. The climatological data for Honnavar (14°17' N and 74°27' E), published by the IMD, based on daily observations at 08:30 and 17:30 hour IST for a 30 year period, is presented in the following sections. The monthly variations of the relevant meteorological parameters are presented in Table 4-20.

Table 4-20: Climatological Summary – Honnavar Region (1951-1980)

Month	Temp (°C)		Rainfall (mm)		Relative Humidity (%)		Station Level Pressure hPa		Mean Wind Speed (km/h)	Predominant Wind Directions (From)*	
	Daily Max.	Daily Min.	Total	No. of days	08:30	17:30	08:30	17:30		08:30	17:30
Jan	31.9	20.0	0.6	0.1	70	58	1010.7	1007.2	6.2	E,NE	W,NW
Feb	31.5	20.5	0.0	0.0	75	63	1010.0	1006.5	6.7	E,NE	W,NW
Mar	32.2	22.9	1.1	0.1	80	65	1009.1	1005.6	6.9	E,NE	W,NW
Apr	32.9	25.2	17.0	1.0	78	67	1007.5	1004.1	7.2	E,NE	W,NW
May	32.5	25.8	171.9	5.7	79	70	1005.8	1003.0	8.4	E, W	W,NW
Jun	29.5	23.9	1016.1	23.9	90	84	1004.8	1002.9	9.2	E, W	W,SW, S
Jul	28.2	23.4	1196.0	28.7	92	88	1004.8	1003.3	9.4	W, E	W,SW
Aug	28.3	23.5	702.7	25.0	92	86	1005.7	1003.8	8.4	W, E	W,SW
Sep	29.1	23.2	363.1	15.4	91	82	1007.0	1004.4	5.9	E, S,W	W, S
Oct	30.9	23.3	171.1	8.0	86	77	1008.0	1005.1	5.7	E,NE	W,S
Nov	32.6	22.2	58.6	2.7	72	64	1009.3	1006.1	5.9	E,NE	W,NW
Dec	32.8	21.2	17.1	0.6	64	57	1010.5	1006.9	7.0	E,NE	W,NW

**Predominant wind in decreasing order (Source: IMD Climatological Data for Honnavar Region)*

As per the above climatological table the following are the observations were drawn from the period of 1951-1980.

- The daily maximum temperature is 32.9°C and the daily minimum temperature is 20.0°C.
- Maximum and minimum relative humidity of 92% and 64% were recorded at 08:30 hours in the months of July, August and December. Maximum and minimum relative humidity of 88% and 57% were recorded at 17:30 hours in the months of July and December.
- The Maximum rainfall observed is 1196.0 mm during July month and no rainfall was recorded in February month. Annual total rainfall was 3753.3 mm.

- Annual Mean wind speed is 7.2 km/h.

4.6.2 Meteorological Scenario during Study Period

Site-specific meteorological data was generated during Pre monsoon season. Automatic weather station was installed to record the meteorological parameters during the study period. Meteorological parameters recorded include temperature, wind speed, wind direction, relative humidity and rainfall.

Temperature: Maximum and minimum temperatures observed during the study period are 33.22°C and 21.72°C respectively.

Humidity and Rainfall: Maximum and minimum relative humidity recorded in the study period is 96.2% and 43.5% respectively. Total rainfall recorded during study period is 14.99 mm.

4.6.3 History of cyclones

Although cyclones affect the entire coast of India, the East Coast is more prone compared to the West Coast. An analysis of the frequencies of cyclones on the East and West coasts of India during 1891-2000 show that nearly 308 cyclones (out of which 103 were severe) affected the East Coast. During the same period 48 tropical cyclones crossed the West Coast, of which 24 were severe cyclonic storms. Out of the cyclones that develop in the Bay of Bengal, over 58 percent approach and cross the east coast in October and November. Only 25 percent of the cyclones that develop over the Arabian Sea approach the west coast. In the pre-monsoon season, corresponding figures are 25 percent over the Arabian Sea and 30 percent over the Bay of Bengal. Cyclone map of the Karnataka state is given in the Figure 4-41

Table 4-21 History of cyclones in west coast during 1891-2001

WEST COAST		
State	**Station Coastal Districts**	**No. of Cyclonic storms**
Kerala (3)	Malappuram Kozikode Kannur	1 1 1
Karnataka (2)	Dakshina Kannada ***Uttar Kannada***	1 1
Maharastra(13)	Sindhu durg Ratnagiri Mumbai ,Thane	3 3 3,4
Goa (2)	Goa	2
Gujarat (28)	Surat kaira Bhavnagar Amroli Junngarh	1 1 4 4 7

	Jamnagar Kutch	6 5

(Source: National Cyclone Risk Mitigation Project(NCRMP))

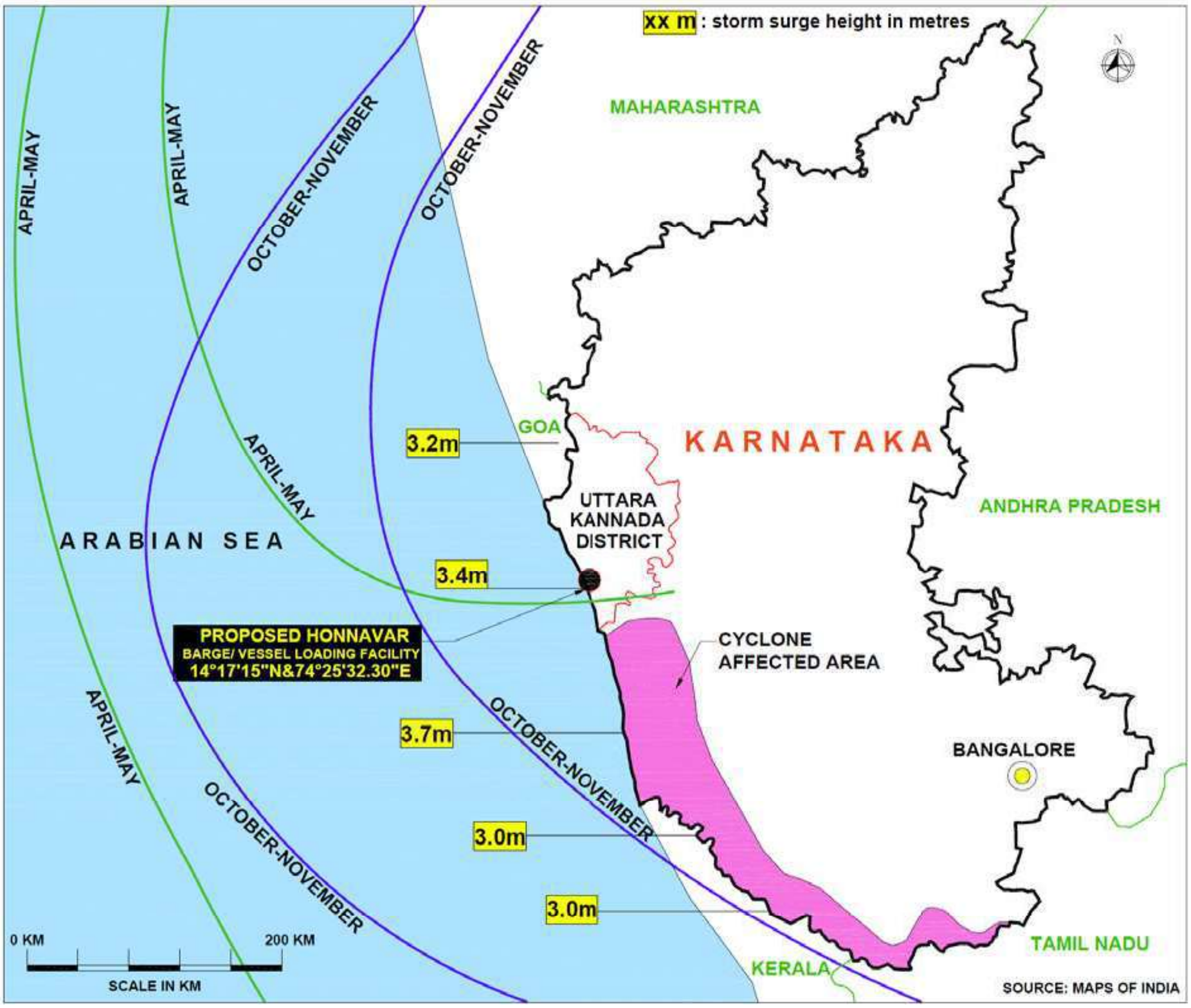


Figure 4-41 Cyclone map of Karnataka coast

4.6.4 Ambient Air Quality

The monitoring locations were selected based on the following:

- Topography/Terrain
- Meteorological conditions
- Minimum two locations in upwind direction
- More sites in downwind side/ impact zone
- Residential and sensitive areas within the study area
- Representatives of regional background air quality/pollution levels and
    - Representation of likely impacted areas

4.6.4.1 Ambient Air Quality Monitoring Stations

To evaluate the baseline air quality of the study area, Six *(6)* monitoring locations have been identified. The details of the locations are given in Table 4-21. Sampling locations within 10 km radius from the proposed site are shown in **Figure FD0406**.

Table 4-22: Ambient Air Quality Monitoring Locations

Station No.	Location	Distance (km) from Project Area	Azimuth Directions	Environmental Setting
A1	Honnavar	2.4	N	Residential Area
A2	Kasarkod	2.5	S	Residential Area
A3	Karki	2.9	N	Residential Area
A4	Ramthirth	3.0	E	Residential Area
A5	Kulkod	4.3	E	Residential Area
A6	Hosad	7.4	SE	Residential Area

4.6.4.2 Ambient Air Quality Monitoring Techniques and Frequency

The techniques used for ambient air quality monitoring and its minimum detectable levels are given in **Appendix F**.

Ambient air quality was monitored twice a week for complete one season. PM_{10}, $PM_{2.5}$, SO_2, NO_2, Hg and were monitored on 24 hourly basis and O_3, CO, HC were monitored on an eight hourly basis. Sampling was carried out as per Central Pollution Control Board (CPCB) monitoring guidelines.

4.6.4.3 Results

The maximum, minimum and mean values of PM_{10}, $PM_{2.5}$, SO_2, NO_2, CO and O_3 are given in **Appendix F**. The variations of PM_{10} and $PM_{2.5}$ are presented in the Figure 4-42.

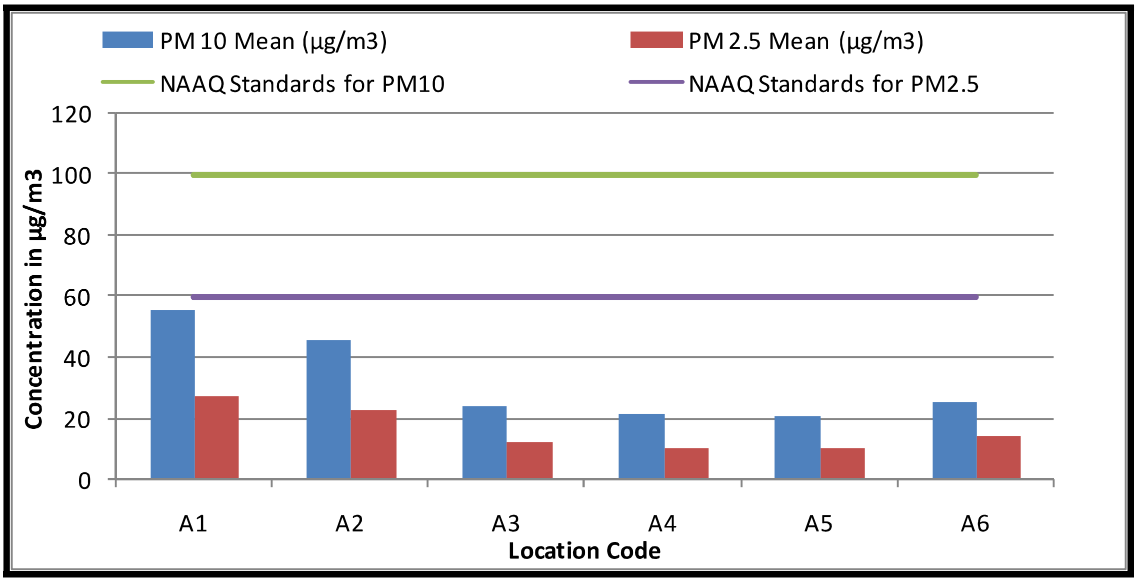


Figure 4-42: Ambient PM_{10} and $PM_{2.5}$ Levels

The variations of SO_2 and NO_2 levels at all the locations are presented in the Figure 4-43.

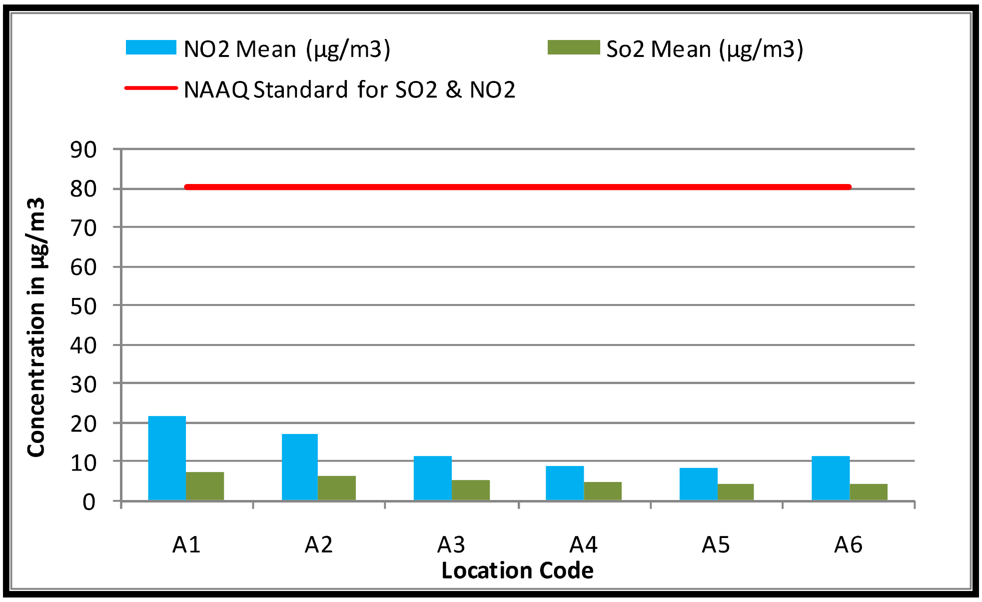


Figure 4-43: Ambient SO_2 and NO_2 Levels

4.6.4.4 Observations

- Maximum concentrations of PM_{10}, $PM_{2.5}$, SO_2 and NO_2 are well within the National Ambient Air Quality Standards during the study period.
- Maximum concentration of PM_{10} ranged between 23.6 µg/m^{3}at Ramthirth and 65.6 µg/m^3 at Honnavar.
- Maximum concentration of $PM_{2.5}$ ranged between 11.6 µg/m^3 at Ramthirth and 35.4 µg/m^3 at Honnavar.
- Maximum concentration of SO_2 ranged between 4.6 µg/m^3 at Kulkod & Hosad and 8.2 µg/m^3 at Honnavar.
- Maximum concentration of NO_2 ranged between 8.6 µg/m^3 at Kulkod and 23.8 µg/m^3 at Honnavar.
- The CO concentration at all locations was observed less than 1.0 ppm.
- Maximum Concentration of Ozone (O_3) ranged between 1.3 µg/m^3 at Karki and 4.1 µg/m^{3}at Honnavar
- Hydro Carbons and Mercury is found to be Below Detectable Limit at all the locations.

4.6.4.5 Inference

The maximum concentrations of PM_{10} and $PM_{2.5,}$ SO_2, NO_2 and O_3 observed at Honnavar during the study period. CO and Hydrocarbons are found to be <1.0 and Below Detectable Limit at all the locations. However, all concentrations are within the NAAQ standards.

4.7 Noise

Baseline ambient noise quality has been established by monitoring noise levels at *Six (6)* locations. The noise monitoring locations in the study area were selected after giving due consideration to the various land use categories. The land use categories include commercial, residential, rural and sensitive areas. Sampling locations within 10 km radius from the barge/vessel loading facility site are shown in **Figure FD0407**. The details of the same are given in Table 4-22. Noise levels were recorded on an hourly basis for one complete day at each location using pre- calibrated noise levels.

Table 4-23: Noise Monitoring Locations

Station No.	Location	Environmental Setting	L_{dn}	L_d	CPCB Standard L_d	L_n	CPCB Standard L_n
N1	Honnavar	Residential Area	47.7	48.9	55	38.8	45
N2	Kasarkod	Residential Area	46.1	47.3	55	37.1	45
N3	Karki	Residential Area	45.1	46.3	55	36.2	45
N4	Ramtirth	Residential Area	43.3	44.4	55	36.0	45
N5	Kulkod	Residential Area	43.5	44.6	55	36.0	45
N6	Hosad	Residential Area	41.4	42.4	55	35.7	45

4.7.1 Results and Discussion

Based on the recorded hourly noise levels at each monitoring location, the day equivalent (L_d) and night equivalent (L_n) were calculated,

L_d: Average noise levels between 6:00 hours to 22.00 hours.
L_n: Average noise levels between 22:00 hours to 6.00 hours.

The Day-Night (L_{dn}) equivalent noise levels were calculated using the US Environmental Protection Agency formula:

$L_{dn} = 10 \text{ Log } [0.0416 \{16 (10^{Ld/10}) + 8 (10^{Ln+10/10})\}]$

The comparison of day equivalent noise levels (L_d) and night equivalent noise levels (L_n) with the respective CPCB stipulated noise standards for various land use categories are shown in the Figure 4-44.

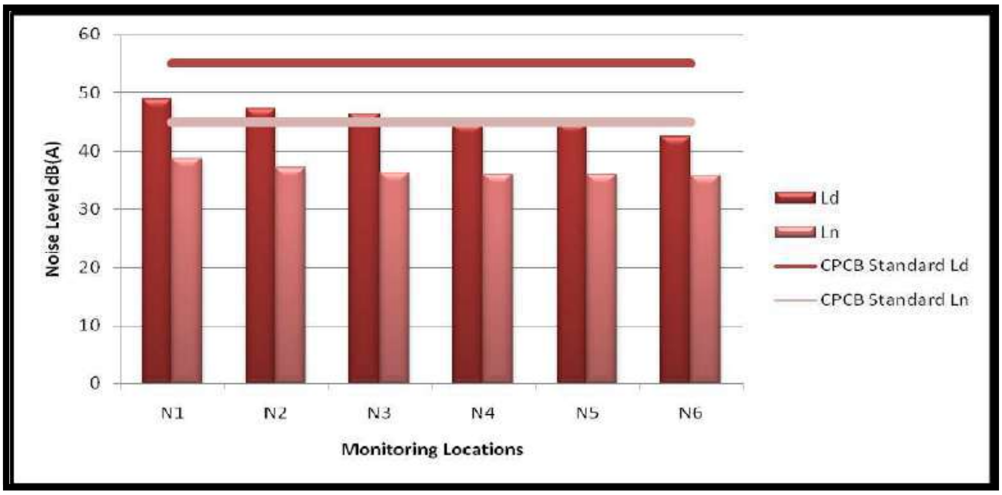


Figure 4-44: Comparison of L_d & L_n with CPCB Standards

4.7.2 Observations

It is observed that day and night time equivalent noise levels at all locations are within CPCB standards for Industrial, residential and silent zones.

- Day equivalent noise levels (L_d) ranged between 42.4 to 48.9 dB(A) in residential zone
- Night equivalent noise levels (L_n) ranged between 35.7 to 38.8 dB(A) in residential zone

4.8 Socio-Economic and Occupational Health Environment

The socio-economic profile of the project influence area was established through compilation of secondary data and 2001 census data for assessing the project influence area profile. The project influence area falls under Uttara Kannada District. Their brief socio-economic data is described in this section.

4.8.1 Population Characteristics

The Honnavar Taluk has a total population of 32808 persons. Further details regarding the socio economic status of villages and settlements in the project influenced area is given as **Appendix G**.

4.8.2 Medical Facilities

The details of community health centres and primary health centres in project influence area are provided in Table 4-23.

Table 4-24: Medical Facilities in PIA

S. No.	Name of the Hospital	Distance from Site (km)
1	St. Ignatius Hospital	2.4
2	Sridevi Maternity Centre	0.5
3	Government Hospital	1.2
4	Sharada Nursing Home	2.7
5	Suvidha Hospital	1.8
6	Balkur Clinic	1.0

4.8.3 Educational Facilities

Details of educational facilities available in the project influence area are given in Table 4-24.

Table 4-25: Educational Facilities in PIA

S.No.	Educational Institution	Distance from Site (km)
1	S.D.M. College of Management Studies, Honnavar	2.2
2	S.D.M. Arts, Science and Commerce College, Honnavar	2.2
3	St. Ignatius School of Nursing, Honnavar	2.4
4	St. Anthony's College for Physical Education, Honnavar	2.0
5	Government Industrial Training Institute, Honnavar	2.8
6	The New English School, Honnavar	0.9

S.No.	Educational Institution	Distance from Site (km)
7	St. Thomas School, Honnavar	0.6
8	Holy Rosary Convent School, Honnavar	2.2
9	Higher Elementary School (Brother School), Honnavar	0.9
10	Marthoma School, Honnavar	1.0
11	Government Kasba Primary School, Honnavar	2.3
12	NMS Higher Primary School, Honnavar	0.6

Further details regarding the socio-economic status of villages and settlements in the project influenced area is given as **Appendix G**.

4.8.4 Details of Fishing Villages and Fish Landing Centres

There are no major fishing zones in the study area. The fish landing centres and fishing settlements in the study area are Honnavar 1.0 km SE and Manki, 11 km SE. The numbers and types of boats and nets in Honnavar harbour is presented in Table 4-25. The population details of Honnavar and Manki are presented in the Table 4-26 and the fish catch statistics are present in Table 4-27.

Table 4-26: Numbers & Types of Boats and Nets in Honnavar Fishing Harbour

Types	Numbers
Purse Sienes	14
Trawlers	85
Gillnet	162
Traditional (including small boats)	645
Total	**906**

(Source: Fisheries department)

Table 4-27: Population details of Fishing Settlements in Honnavar Taluk

Name of the Fish Landing Centre	No. of Fishing settlements	No of Families	Fishermen Population				No.of People engaged in Fisheries		
			Male	Female	Children	Total	Male	Female	Total
Honnavar	16	2555	3063	3076	5709	11848	3342	2939	6281
Manki	6	672	1168	1123	2556	4847	1081	883	1964
Total	22	3227	4231	4199	8265	16695	4423	3822	8245

(Source: Uttarakanada.nic.in)

Table 4-28: (Annual Fish Catch Statistics April 2010 – March 2011)

Period	Total Weight (kg)	Net Worth (in Lakh rupees)
Apr-10	2425.75	404.41
May-10	592.57	124.28
Jun-10	56.29	13.76
Jul-10	21.57	6.44
Aug-10	349.97	122.85

Sep-10	614.07	187.4
Oct-10	1353.94	260.78
Nov-10	2257.34	314.8
Dec-10	2821.88	458.05
Jan-11	4623.62	974.96
Feb-11	1725.03	327.77
Mar-11	1530.36	424.77
Total	**18372.4**	**3620.27**

(Source: Fisheries department)

4.9 Existing Solid and Liquid Waste Disposal Facilities

There are eight chemical industries, 17 engineering industries and 45 other industries in Uttara Kanada district. No common environmental infrastructures such as solid and liquid waste disposal facilities available nearer to the proposed barge/ vessel loading site. Negligible quantity of solid and liquid waste generation is envisaged due to the proposed development. The municipal solid waste will be disposed in to the Municipal solid waste disposal site after obtaining necessary approvals.

4.10 Public Utilities

Water Supply: During construction and operational phase, water requirements will be met through Sharavati River where the river water quality meets the requirement of potable use. The water from the river will be collected and treated before pumping into an Overhead Tank (OHT) for storage purpose. From the OHT, the water will be distributed to the barge/vessel loading facility under gravity.

Power Supply: Power requirement during the construction phase will be met through DG set. Operation phase power requirement will be met from the substation located at Honnavar.

Road: The Barge/vessel loading facility site is well connected with NH 17 & NH 63.

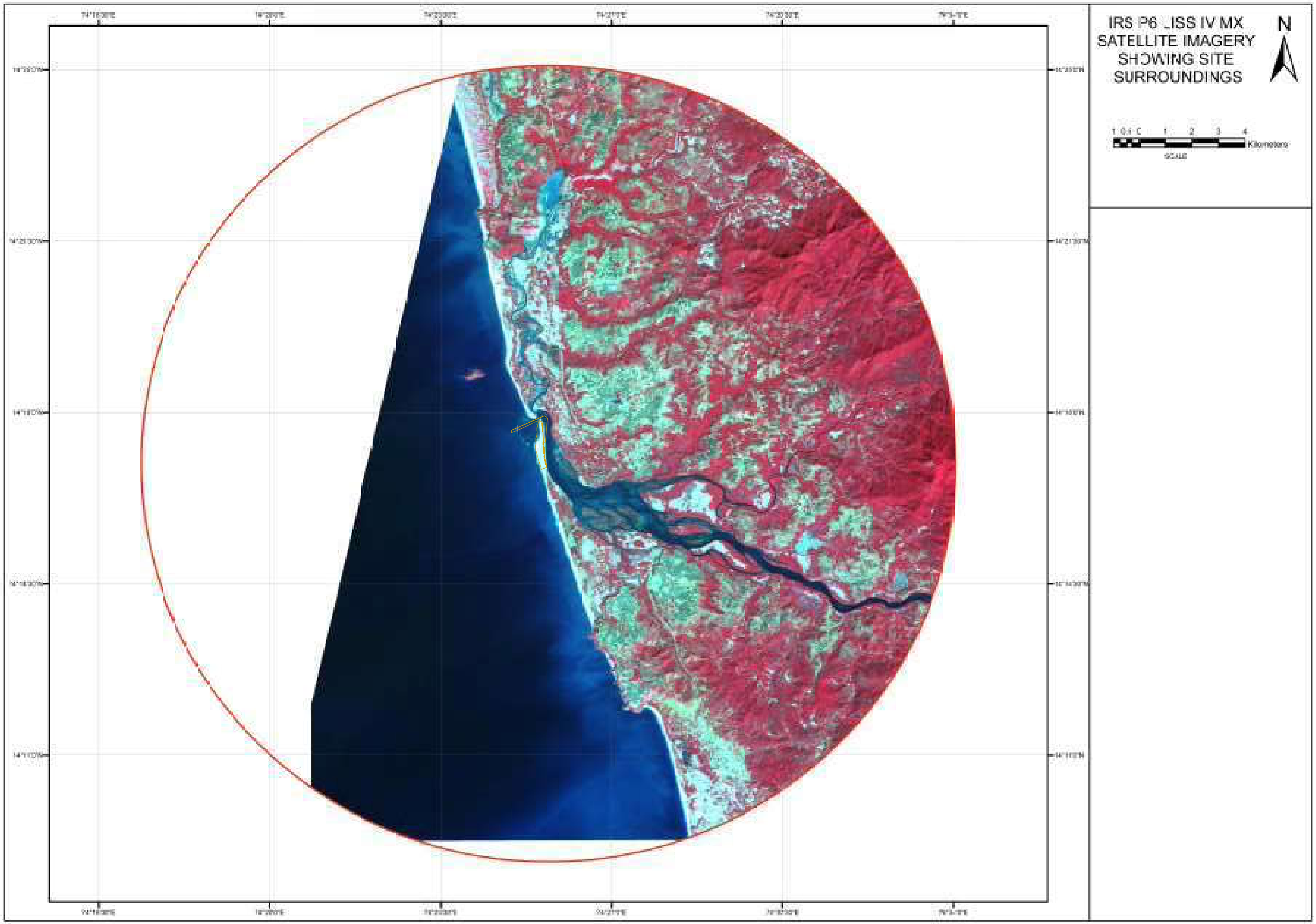
Railway: The Konkan railway is running close to the proposed barge/vessel loading facility.

Air: Goa and Mangalore Airports is located 180 km (N) and 170 km (S) respectively from the Barge/vessel loading facility area.

4.11 Archaeological Monuments

There are no listed monuments in the project study area as per Archaeological Survey of India (ASI).

FIGURES



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TITLE: SATELLITE IMAGERY - 10 KM RADIUS	DATE: 07.11.2011
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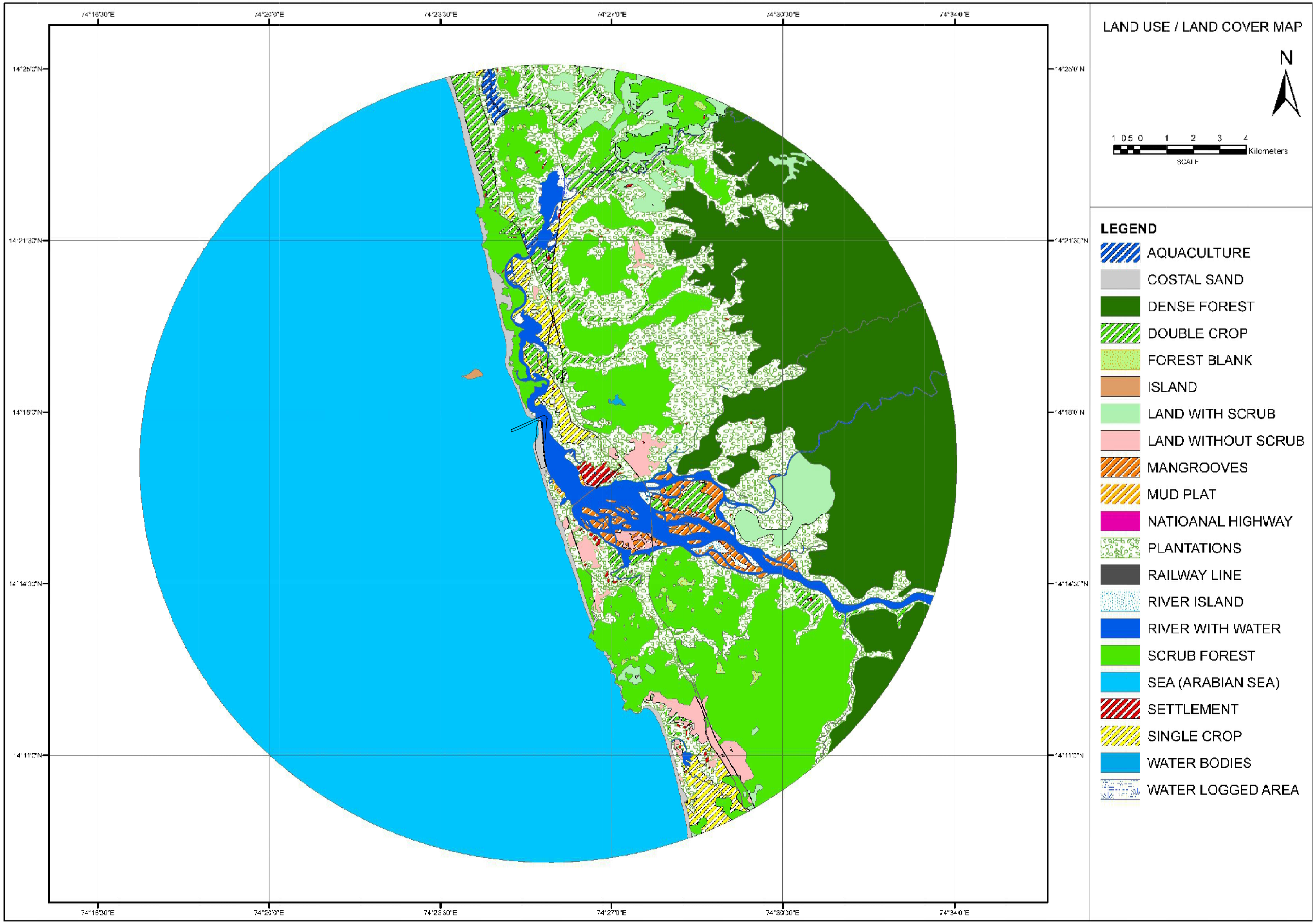

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PROJECT NO: C1111304

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DATE: 07.11.2011

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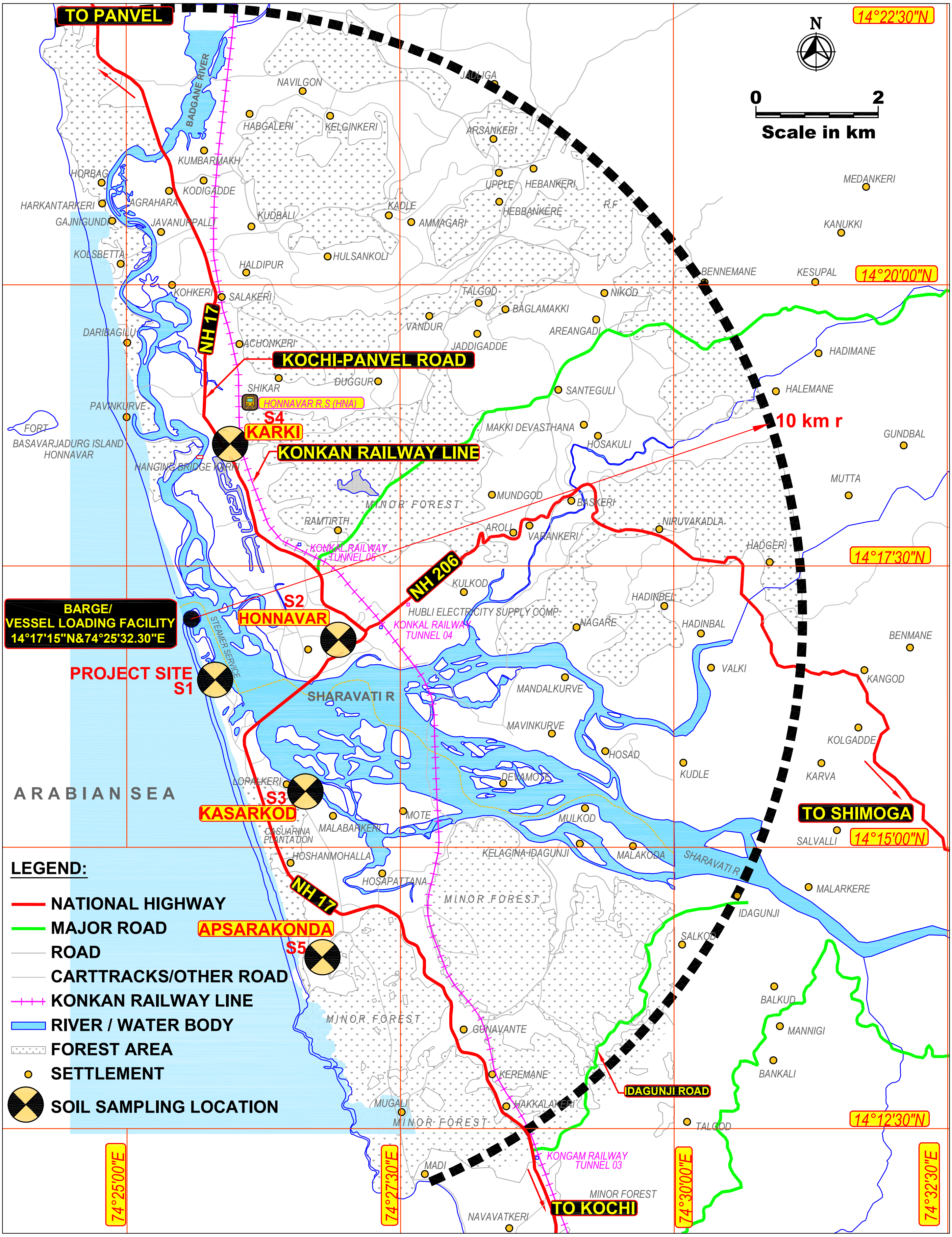

SOIL MONITORING LOCATIONS					
S.NO	LOCATION	LATITUDE	LONGITUDE	DISTANCE (km)	DIRECTION
S1	PROJECT SITE	14°17'15"N	74°25'32.30"E	-	-
S2	HONNAVAR	14°16'48.19"N	74°27'0.40"E	2.4	SE
S3	KASARKOD	14°16'0.00"N	74°26'4.85"E	2.5	S
S4	KARKI	14°18'47.25"N	74°25'45.36"E	2.9	N
S5	APSARAKONDA	14°14'6.54"N	74°26'45.36"E	6.2	S

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PROJECT: EIA FOR BARGE/VESSEL LOADING FACILITIES AT HONNAVAR, KARNATAKA

PROJECT NO: C1111304

TITLE: SOIL SAMPLING LOCATION MAP

DATE: 07.11.2011

MADE: ASN

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FIGURE NO: FD0403

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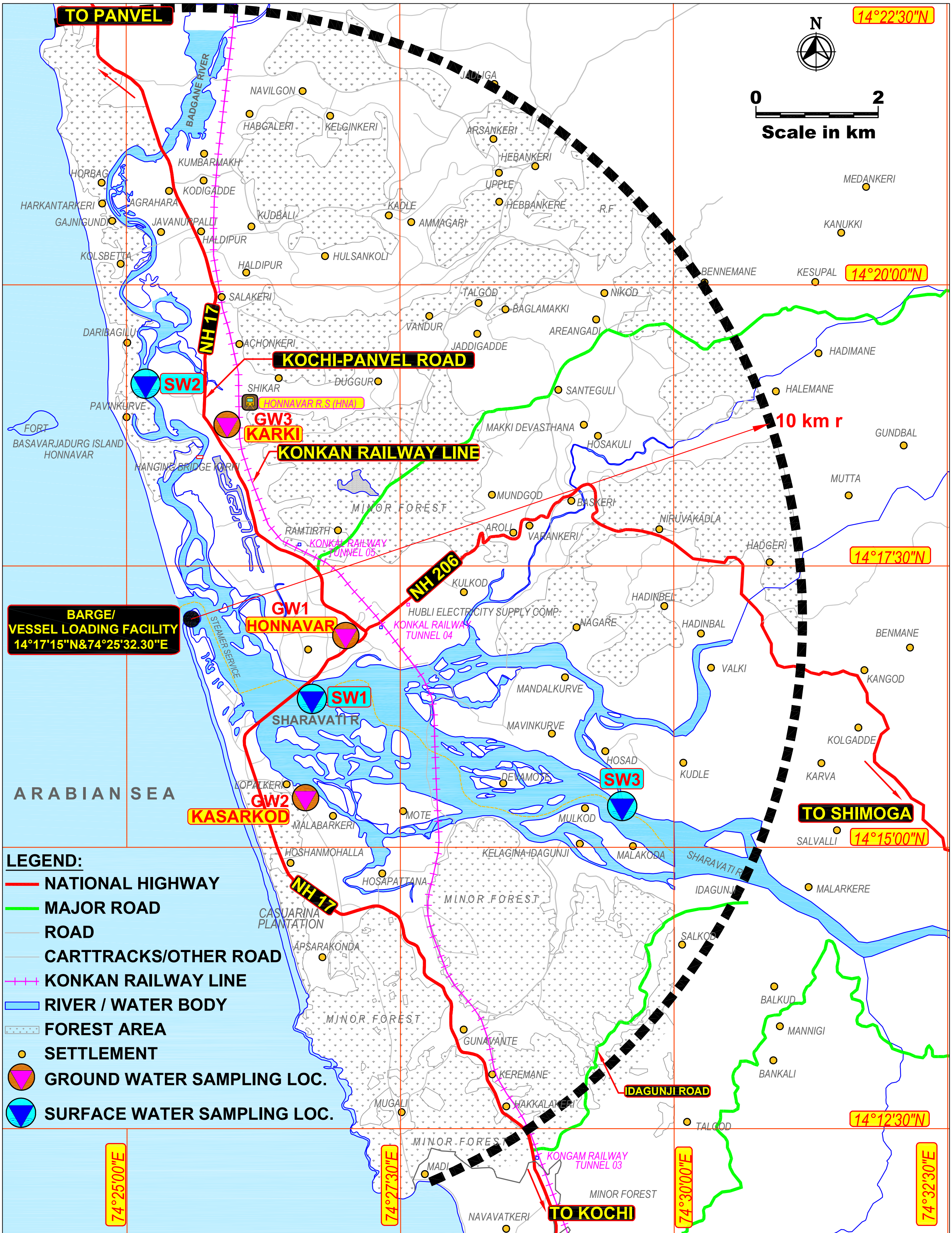

	WATER SAMPLING LOCATIONS				
	GROUND WATER LOCATIONS				
GW1	HONNAVAR	14°16'48.19"N	74°27'0.40"E	2.4	N
GW2	KASARKOD	14°16'0.00"N	74°26'4.85"E	2.5	S
GW3	KARKI	14°18'47.25"N	74°25'45.36"E	2.9	N
	SURFACE WATER LOCATIONS				
SW1	SHARAVATI RIVER NEAR HONAVAR	14°16'36.31"N	74°27'0.49"E	2.8	SE
SW2	BADGANE RIVER NEAR PAVINKURVE	14°19'13.50"N	74°25'7.30"E	4.0	N
SW3	SHARAVATI RIVER NEAR NAGARE	14°16'46.50"N	74°28'43.34"E	6.0	SE

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PROJECT: EIA FOR BARGE/VESSEL LOADING FACILITIES AT HONNAVAR, KARNATAKA

TITLE: WATER SAMPLING LOCATION MAP

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DATE:	07.11.2011
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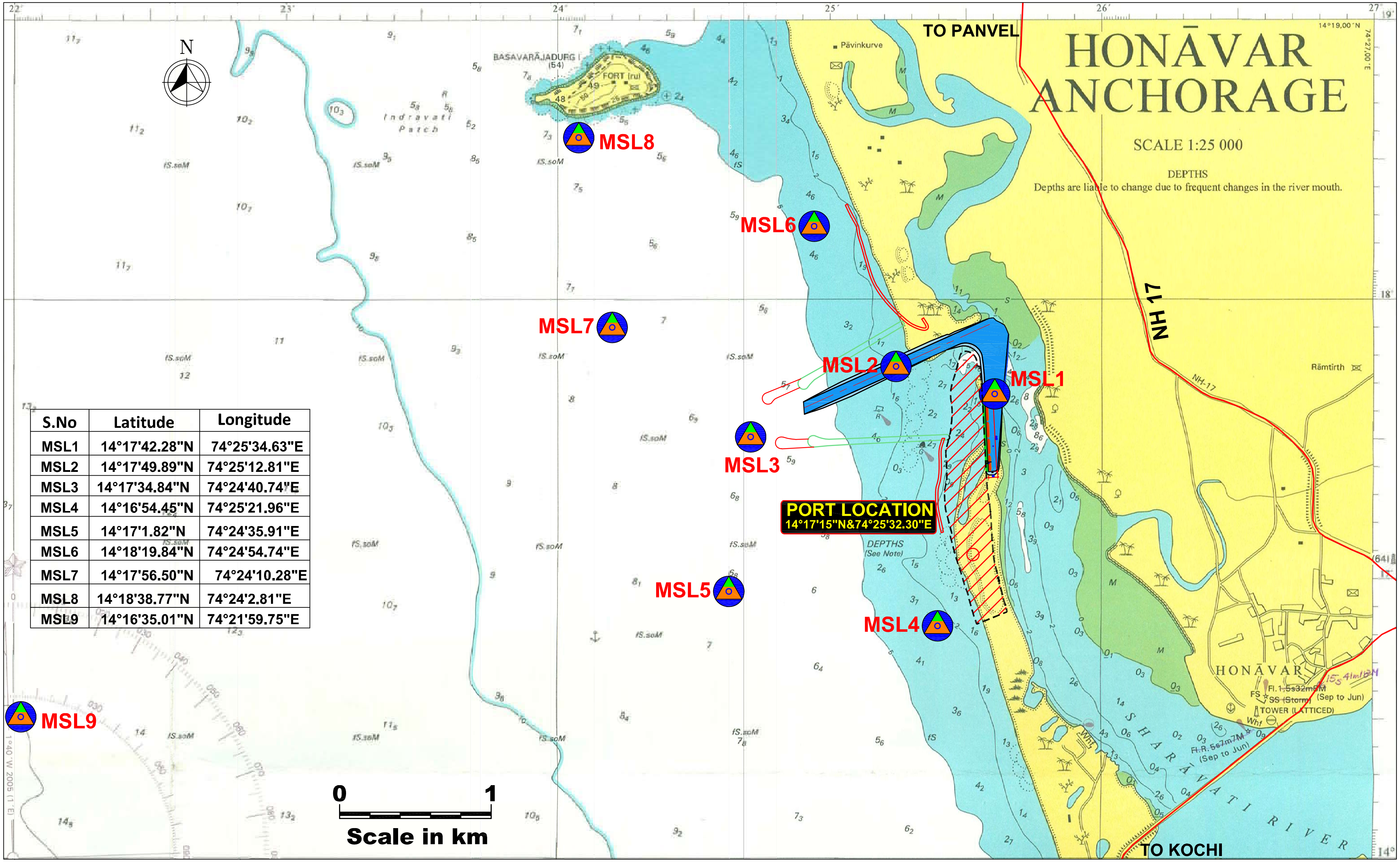

S.No	Latitude	Longitude
MSL1	14°17'42.28"N	74°25'34.63"E
MSL2	14°17'49.89"N	74°25'12.81"E
MSL3	14°17'34.84"N	74°24'40.74"E
MSL4	14°16'54.45"N	74°25'21.96"E
MSL5	14°17'1.82"N	74°24'35.91"E
MSL6	14°18'19.84"N	74°24'54.74"E
MSL7	14°17'56.50"N	74°24'10.28"E
MSL8	14°18'38.77"N	74°24'2.81"E
MSL9	14°16'35.01"N	74°21'59.75"E

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2. ALL DEPTHS ARE IN METRES

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PROJECT: EIA FOR BARGE/VESSEL LOADING FACILITIES AT HONAVAR, KARNATAKA

TITLE: MARINE SAMPLING LOCATIONS

L&T-RAMBØLL CONSULTING ENGINEERS LIMITED

PROJECT NO: C1111304
DATE: 07.11.2011
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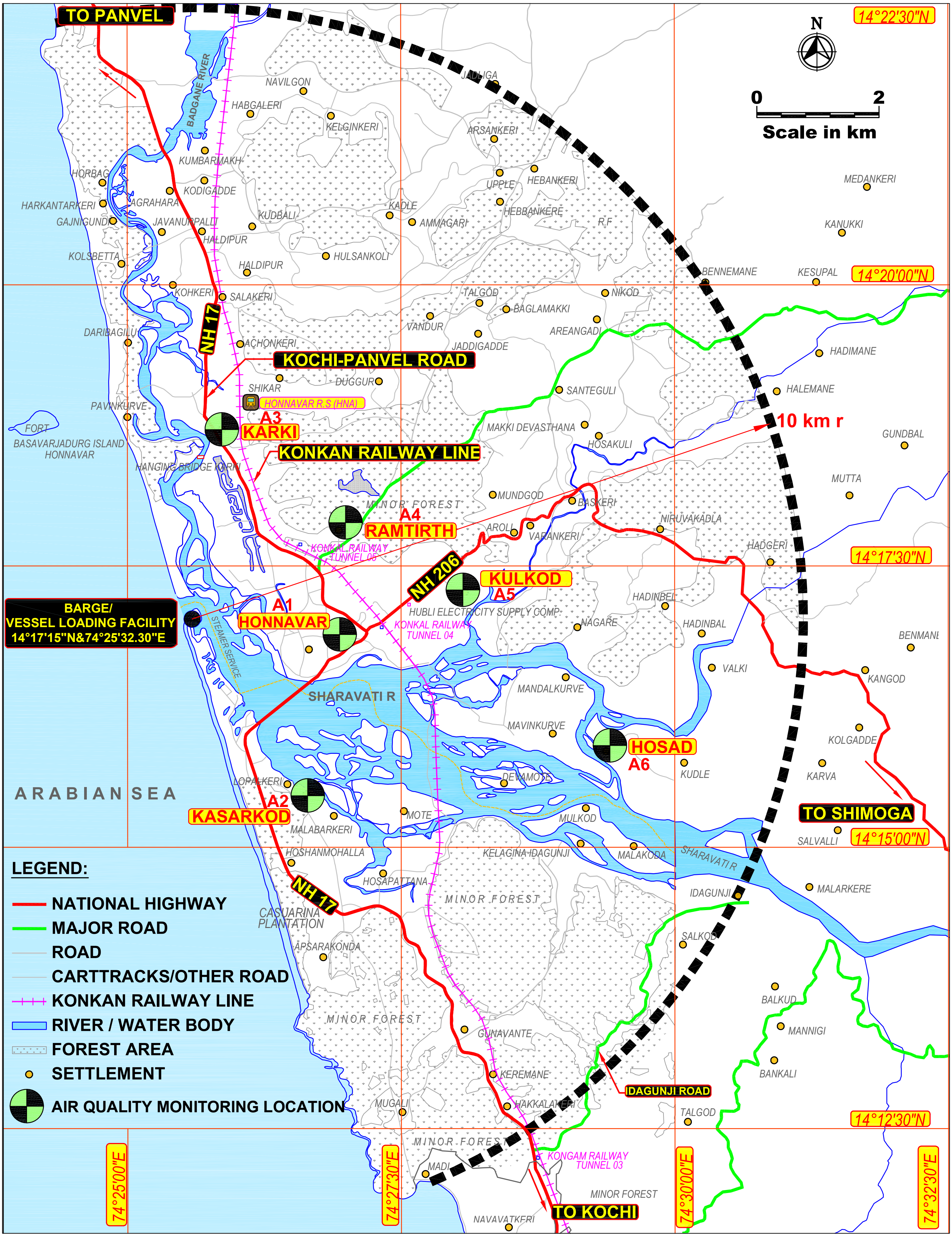
TBA



AIR QUALITY MONITORING LOCATIONS

S.NO	LOCATION	LATITUDE	LONGITUDE	DISTANCE (km)	DIRECTION
A1	HONNAVAR	14°16'48.19"N	74°27'0.40"E	2.4	SE
A2	KASARKOD	14°16'0.00"N	74°26'4.85"E	2.5	S
A3	KARKI	14°18'47.25"N	74°25'45.36"E	2.9	N
A4	RAMTIRTH	14°17'50.86"N	74°27'6.04"E	3.0	E
A5	KULKOD	14°17'27.08"N	74°27'55.04"E	4.3	E
A6	HOSAD	14°15'49.76"N	74°29'22.49"E	7.4	SE

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PROJECT: EIA FOR BARGE/VESSEL LOADING FACILITIES AT HONNAVAR, KARNATAKA

TITLE: AIR QUALITY MONITORING LOCATION MAP

L&T-RAMBØLL CONSULTING ENGINEERS LIMITED

PROJECT NO: C1111304

DATE: 07.11.2011

MADE: ASN

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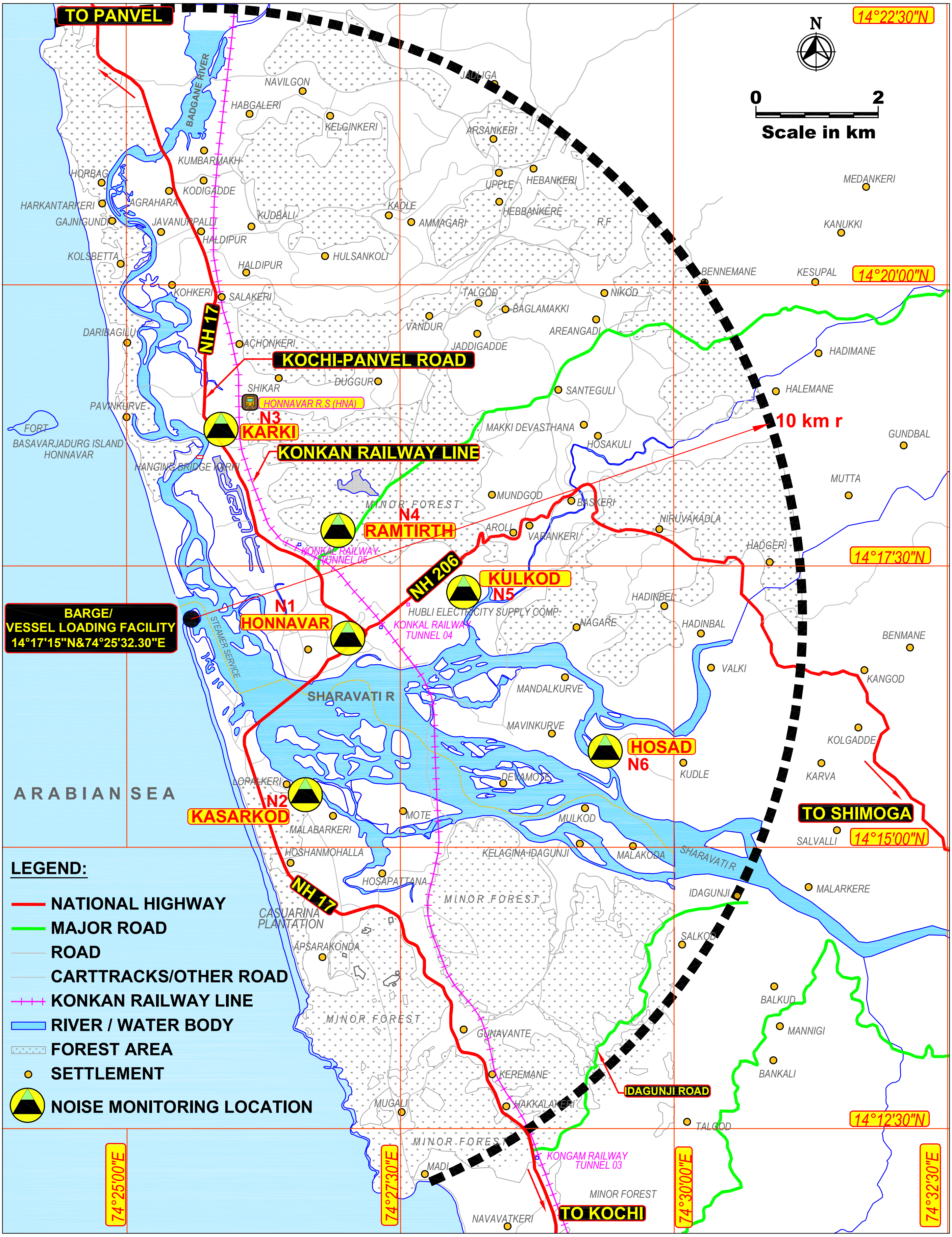

NOISE MONITORING LOCATIONS

S.NO	LOCATION	LATITUDE	LONGITUDE	DISTANCE (km)	DIRECTION
N1	HONNAVAR	14°16'48.19"N	74°27'0.40"E	2.4	SE
N2	KASARKOD	14°16'0.00"N	74°26'4.85"E	2.5	S
N3	KARKI	14°18'47.25"N	74°25'45.36"E	2.9	N
N4	RAMTIRTH	14°17'50.86"N	74°27'6.04"E	3.0	E
N5	KULKOD	14°17'27.08"N	74°27'55.04"E	4.3	E
N6	HOSAD	14°15'49.76"N	74°29'22.49"E	7.4	SE

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PROJECT: EIA FOR BARGE/VESSEL LOADING FACILITIES AT HONNAVAR, KARNATAKA

PROJECT NO: C1111304

TITLE: NOISE MONITORING LOCATION MAP

DATE: 07.11.2011

MADE: ASN

L&T-RAMBØLL CONSULTING ENGINEERS LIMITED

FIGURE NO: FD0407

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Chapter 5
Anticipated Environmental Impacts and Mitigation Measures

5 Anticipated Environmental Impacts and Mitigation Measures

5.0 General

The construction and operational phases of Honnavar Barge/ vessel loading facility involves various landside and marine side construction and operational activities. In this chapter, likely impacts of these activities on environmental attributes have been identified, assessed and presented. To mitigate likely environmental impacts during construction and operational phases due to landside and marine side activities, suitable mitigation measures are incorporated as a part of planning process. The impacts have been assessed both quantitatively and qualitatively for various terrestrial and marine environmental components and additional mitigation measures are proposed.

5.1 Land Environment

5.1.1 Potential Impact due to Project Location

5.1.1.1 Impacts due to Land Acquisition

Government of Karnataka has allotted the land for the proposed development. The land proposed for Rail / Road Corridor is about 30Ha, which includes Government / few patches private land and no families are present in the land proposed to be acquired. Hence, No R&R is envisaged due to the proposed development. The alignment is selected such a way that there will not be any disturbance to the existing structures also.

No impacts are envisaged to land environment with respect to land acquisition due to the proposed project.

5.1.1.2 Impacts due to Changes in Land Use Pattern

Proposed project site comprises completely coastal sand and government land. The project area will be reclaimed up to (+) 4.30 m CD for the development of Back up area, however development will be planned in such a way that the existing drainage pattern will not be disturbed.

5.1.1.3 Impacts due to Changes in Coastline/Shoreline

The shoreline/coastline changes such as erosion/accretion is usually expected due to the construction of marine structures such as breakwaters, groynes, etc. The natural setting if disturbed by construction of breakwaters or dredging a channel to deepen locally the seabed, causes imbalance in sand movement along the coast. It has been seen all along the west coast of India, that a breakwater construction causes accretion on the Northern side and erosion on the Southern side.

In the proposed development, a southern breakwater of length 865m and northern breakwater of length of 820 m will be constructed which may have impact on existing coastline/shoreline. Mathematical model studies were carried out and the details are discussed in subsequent sections.

5.1.1.4 Impacts due to Land Reclamation

Land reclamation will be carried out within port limits. About 1.0 MCM[2] of the dredged material will be used for reclamation. Land reclamation with capital dredged material is likely to impact the reclamation area/site with the turbid saline water. Areas to be reclaimed will be defined during detailed engineering stage and protective reclamation bunds will be constructed around the planned reclamation areas to avoid spreading of dredge material and to reduce turbidity. 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.

But predominantly the backup area to be reclaimed is coastal sand and low lying area sloping 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.

5.1.1.5 Mitigation Measures

Barge/ Vessel loading facility development will take place within the port limits and no agricultural land or settlements are included in the land proposed for development.

Judicial planning of Barge / Vessel loading facilities will be carried out. Existing drainage pattern will not be disturbed. Strom water drainage network at appropriate places will be provided within the facility area.

Reclamation bunds and setting ponds shall be constructed, 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, if necessary. Also minimum required retention time of return water in the reclamation area as well as in the return channel will be ensured.

Regular monitoring of return water (turbid water) from the reclamation area will be carried out at nearby points in the sea.

In order to study variations in groundwater quality of nearby villages due to reclamation, regular water quality monitoring will be carried out.

5.1.2 Potential Impact during Construction

5.1.2.1 Impact on Local Infrastructure

Transportation of Construction and Cargo Material: Transportation of huge quantities of construction material for construction of breakwaters, berths, stockyards, operational and administrative buildings etc results in use of public infrastructure like roads, railways, drainage, water and power supply which in turn results in congestion.

Stones and aggregates required for construction of breakwaters will be sourced from approved quarries nearby Honnavar/ Karwar and Bhatkal. Quantity of quarry stones required

[2]MCM: Million Cubic Meter

is about 4.5 Million Tonnes, which will be transported by road. HPPL will obtain the list of approved quarries from the concern Tahsildar of Honnavar/ Karwar.

To mitigate impacts from transportation of stones and Construction materials, existing roads will be strengthened and widened to enable movement of dumpers. Hence, impacts would not be significant as quarries are accessible.

Also, as a part of infrastructure development for Honnavar Barge/ vessel loading facility, it is proposed to develop 4 km of road from NH-17 to Kasarkod and a new railway of 14.6 km from Manki railway station to the proposed project site. New Proposed railway line will run parallel to existing railway line for a length of about 8 km and then will take a turn towards sea coast which will then run parallel to the sea coast till the proposed project site for the remaining 6.6 km. In order to minimize the strain on the existing infrastructure in the region, dedicated road corridor will be developed at the earliest. Until then existing road will be strengthened and widened to ease the traffic movement.

Construction Workers Camp: There will be a requirement of about 500 work force during the construction phase. To ensure that 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.

5.1.2.2 Mitigation Measures

- The dedicated road corridor will be utilised for the transportation of construction material and usage of public roads will be minimised.
- Temporary approach roads may be developed with prior permission from competent authority.
- Transportation Management will be adopted for movement of dumpers transporting quarry stones and construction materials and traffic will be regulated.
- Trucks with construction material susceptible for fugitive suspension will be covered with tarpaulin.
- Vehicles deployed will conform to emission norms (air/noise) of CPCB and with valid Pollution Under Control (PUC) certificates.
- Dumpers and trucks will comply with standards for exhaust emissions and noise levels
- The Worker camps will be adequately equipped with all the necessary facilities such as water supply, power supply, wastewater collection, solid waste collection and sanitation, fuel supply etc.
- The domestic wastes generated from the worker camps will be collected properly treated and disposed after complying with the norms stipulated by statutory authorities.
- No bore wells will be driven for the drinking 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

5.1.3 Potential Impact during Operations

5.1.3.1 Discharges from Barges on Land

No discharge of wastewater/waste from the Barges/vessel calling at Honnavar Barge loading facility will be permitted into the area.

5.1.3.2 Shoreline Changes – Erosion/Accretion

Analysis of shoreline change and prediction of shoreline behaviour in the presence of coastal structures have become important for integrated coastal zone management. The shoreline occurring between land and sea is dynamic which under goes short term and long term geomorphological changes under the influence of near shore coastal hydrodynamics. These changes to the coastal morphology are cyclic which have continued over the years.

Assessment of Shoreline Evolution with Proposed Breakwaters

Long shore sediment transport takes place when waves approach obliquely to the shore. This process of sediment transport is a cyclic process where river adds sediment to the coast which is transported by waves. The cycle of sediment transport by the waves to and from the coast is continuous which has aided in keeping the equilibrium of the coastline balanced over the geological times. Any change to the sediment transport cycle leads to imbalance to the prevailing shoreline dynamics.

In the normal condition the shoreline undergoes oscillation due to wave and wave induced current. The predominant quantity of sediment transport along shore takes place within the depth of closure. Coastal structure similar to groyne or a breakwater connected to the land when introduced into the sea obstructs the sediment transport resulting in accretion / erosion of sediment.

The proposed development consists of two breakwaters designated as northern (820 m) breakwater and southern (865 m) breakwater extending into the sea to a water depth of (-) 5.0 m respectively. The approach channel will be dredged to (-) 10 m CD. The Channel will be aligned in South West direction.

Shoreline Change Modelling using LITPACK model:

Department of Meteorology and Oceanography, Andhra University, Visakhapatnam has conducted mathematical model study to evaluate the shoreline changes using LITPACK model in the MIKE 21 software.

Out of various modules of LITPACK, LITLINE is best suited for understanding the coastline changes with time provided the wave, bathymetry (one dimensional, profiles) and sediment characteristics are given. LITLINE calculates the coastline position based on input of the wave parameters as a time series. The model is based on a one-line theory, in which the cross-shore profile is assumed to remain unchanged during erosion/accretion. Thus, the coastal morphology is solely described by the coastline position (cross-shore direction) and the coastal profile at a given long-shore position. The main equation in LITLINE is the continuity equation for sediment volumes:

$$\frac{\partial y_c}{\partial t} = -\frac{1}{h_{act}}\frac{\partial Q}{\partial x} + \frac{Q_{sou}}{h_{act}\Delta x}$$

In which y_c is the coastline position, t is time, Q the longshore transport rates, x the longshore position, Q_{sou} the supply of sediment from sources. The total height of the active profile h_{act} consists of three contributions: 1. The active depth relative to mean water level 2. The height of the beach above mean water level that moves forth and back with the coastline position and finally 3. Possible "dunes", which may erode if the coastline reaches their position during erosive states, but will not accrete again.

The continuity equation for sediment volumes is solved using an implicit Crank-Nicholson scheme, giving the development of the coastline position in time. The variation in time and place of sources and sinks may be included in the calculations by a separate time series, allocated to describe the appearance of sediment sources (or sinks). Both point sources (one single grid point) and distributed sources (coastline stretch) can be considered.

Model setup:

The reference baseline and coastline are given as initial inputs for computing the changes in shoreline. The background wave data extracted at 10 m depth are extended for 10 years using LITPACK toolbox. Beach profiles up to active depth are extracted from the bathymetry file. The Two breakwaters proposed in the layout are included in the model setup for future predictions.

Results:

The model has been simulated for two cases:

- Case I: With breakwaters and without shore protection on the northern side of inlet
- Case II: With breakwaters and with sea wall on the northern side of inlet

Case I:

It is observed that erosion may occur towards northern side of the north-breakwater with shoreline recession of around 20-30m for 10 years (2-3 m/yr). Whereas, on the southern side, deposition occurs with a shoreline advancement of 50-60 m as shown in Figure 5-1.

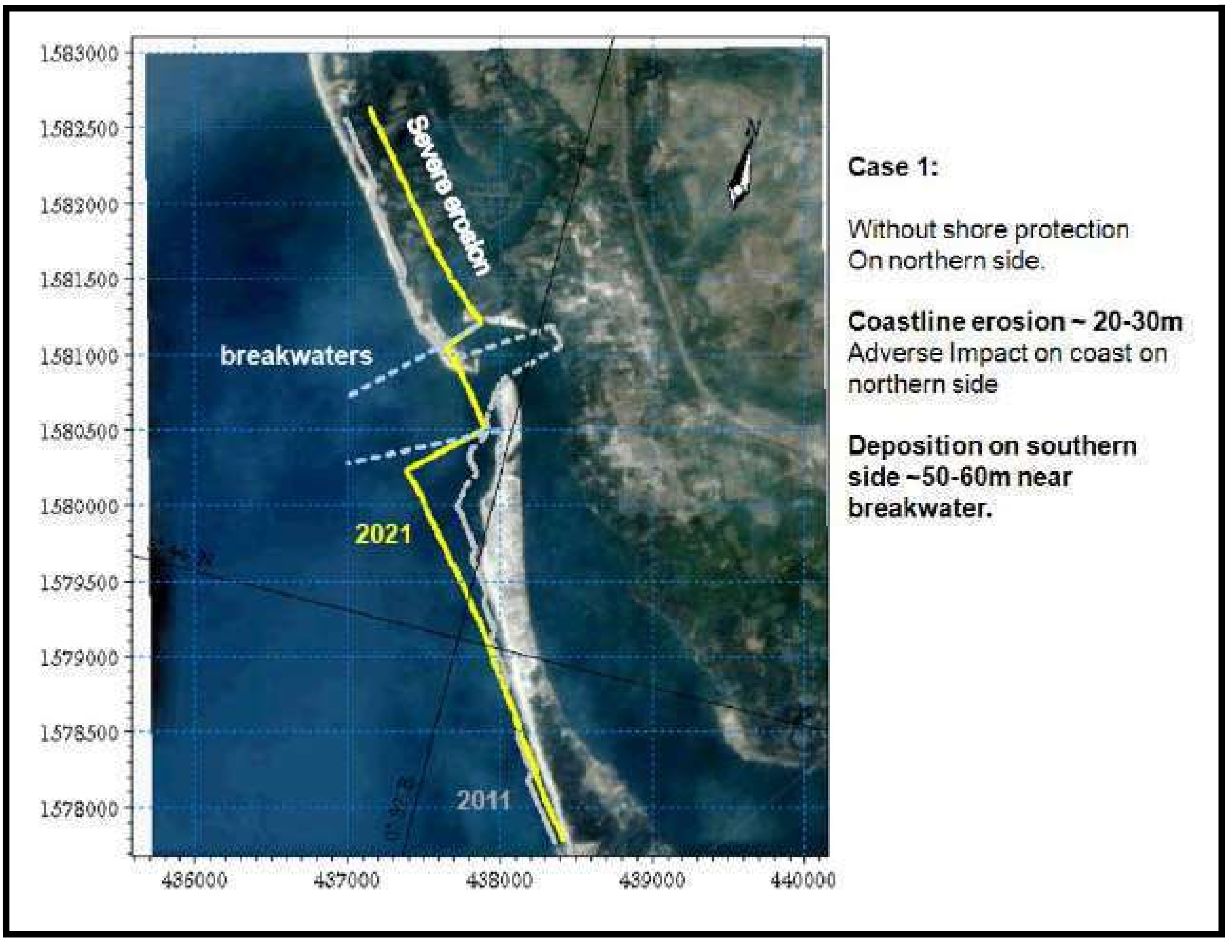

Figure 5-1: Shoreline Evolution without Shore Protection

Case II:

When a shore protection strategy like sea wall is constructed on the northern side of the facility, it is observed that the coast is almost stable and no net change in shoreline towards northern side is observed. Whereas, on the southern side, slight deposition occurs with a shoreline advancement of 30-40 m after 10 years as shown in Figure 5-2.

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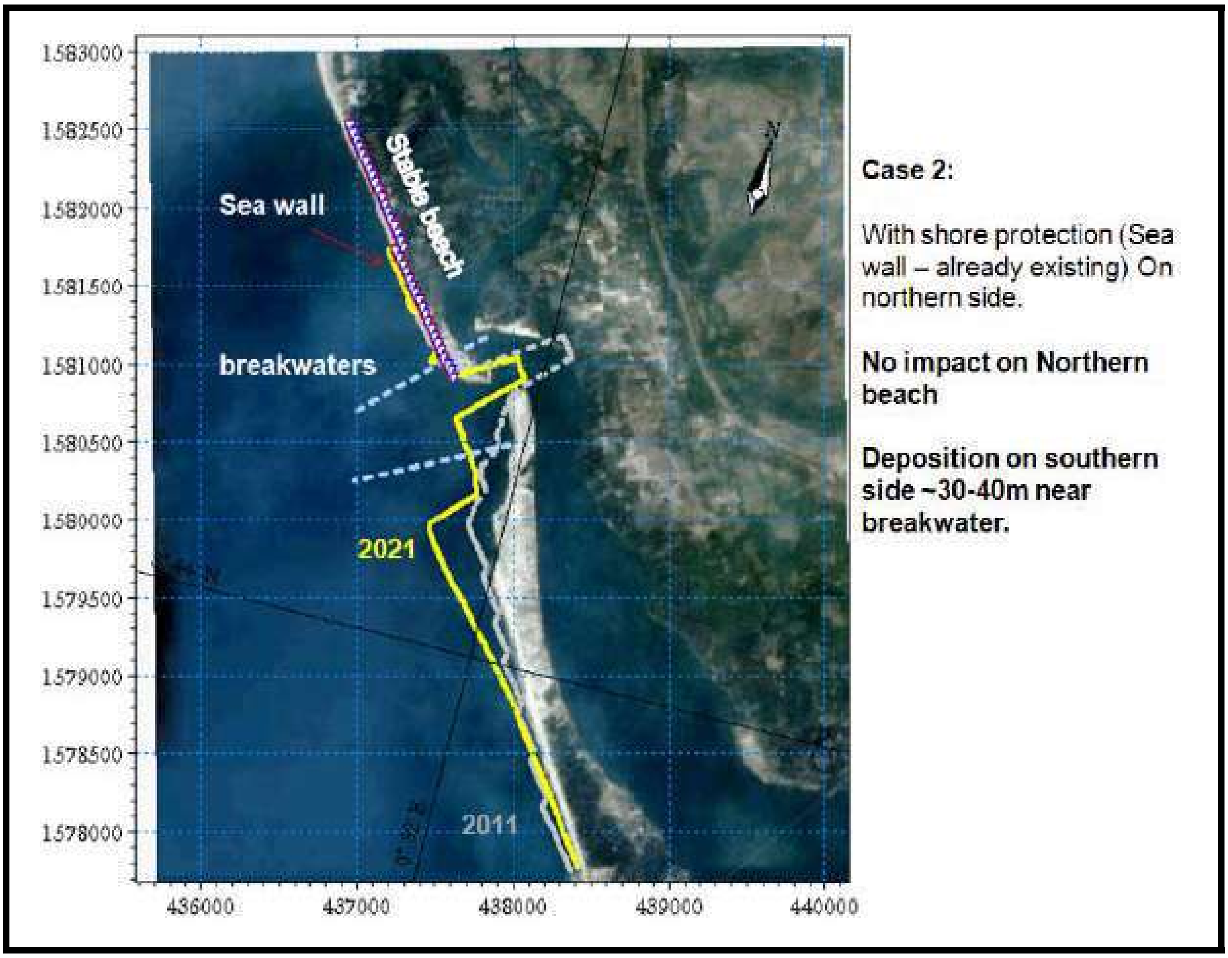

Figure 5-2: Shoreline Evolution with Shore Protection

The predominant direction of alongshore sediment transport is towards north due to S, SSW and SW waves and the net transport of sediment is around 0.6×10^6 m^3 directed towards north. Overall, the model studies show a general depositional trend along the coastline.

5.1.3.3 Mitigation Measures

Continuous monitoring of shoreline with the help of high resolution satellite imageries, during operation phase and ground truthing/Shoreline surveys.

5.2 Water Environment

5.2.1 Potential Impact due to Barge/ Vessel Loading Facility Location

5.2.1.1 Impact on Existing Water Resources

Water requirement during the construction is expected to be around 15 m^3/day. Water demand during operational phase of barge/vessel loading facility is estimated at 7 m^3/day. The water requirement will be met from Karnataka Rural Water Supply and Sanitation Agency which includes supply to Barge/vessels, staff and users. In addition to that water required for dust suppression system and fire fighting will be sourced from Sharavati River

It is not envisaged to draw groundwater to avoid any possible impacts to local groundwater resources. A dedicated water supply system will be developed by the HPPL for dust suppression, potable water and fire fighting purpose. As water requirement is proposed to be met from water supply department and surface water resource through a dedicated system and not relying on existing facilities, significant impacts are not envisaged.

5.2.1.2 Impact due to Stagnation of Wastewater in Harbour

The construction of marine structures such as breakwaters will change the current patterns and results in tranquil conditions suitable for the operation of the facility. In case, the untreated wastewater from the domestic as well as industrial activities in the vicinity of the barge/vessel loading facility flows into the harbour, it results in stagnation of water. The discharges of the Sharavati River may stagnate in the harbour. There are fishing vessel movements in the mouth of Sharavati River, the discharges from the barge/vessel loading facility visiting vessels and fishing vessels in the harbour may affect the harbour waters. These conditions may deteriorate through increase of phytoplankton and a decrease of dissolved oxygen, resulting from eutrophication of water, caused by effluents containing nutrient salts (chemical compounds including N and P). Anaerobic water leads to the generation of hydrogen sulphide (H_2S). Breakwaters shall be constructed in a way to maintain good tranquil conditions without disturbing the river flow. No discharges from the vessels will be permitted in the harbour area. Further, the area surrounding the barge/vessel loading facility location is undeveloped which will not generate significant sewage and industrial discharges into water resources.

5.2.1.3 Mitigation Measures

The wastewater and sewage generated during construction at site, at labour camp and operation phase will be collected in septic tank followed by soak pit.

5.2.2 Potential Impact due to Construction

5.2.2.1 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. But predominantly the barge/vessel loading facility land proposed to be reclaimed is coastal sand which is saline in nature and is separated by Sharavati River from the land located towards East. Hence; no significant impact is anticipated due to reclamation on ground water.

5.2.2.2 Mitigation Measures

The return sea water quality from the reclaimed area and groundwater quality of nearby villages will be monitored regularly.

General Mitigation Measures/ Wastewater Management during Construction Phase

The environmental management for sanitary wastewater, vehicle wash water, hydrotest water and storm water is addressed below:

- 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 settling tank for removing grit.
- Sewage generated at site will be collected in the septic tank followed soak pit.
- Run-off from project site will not be discharged into the river.

5.2.3 Potential Impact during Operation

5.2.3.1 Impact on Water Quality due to Cargo Operations

Storm water runoff will be directed into open concrete lined channels alongside the roads and paved areas in the cargo storage areas and other areas of the barge/vessel loading facility. The polluted runoff from berths and stockpiles of cargo storage areas will be intercepted and directed to septic tank .The runoff from uncontaminated areas will be discharged into the greenbelt area. Contaminated storm water will be collected and conveyed to settling tank for removing grit.

The oil contaminated water will be sent to oil water separator, separated oil will be sent to KSPCB approved vendors and water will be sent soak pits

5.2.3.2 Mitigation Measures/Wastewater Management

Mitigation measures are proposed to be adopted to minimise the impacts from wastewater and runoff generated from cargo storage areas. The storage area will be provided with an extensive drainage system so that the contaminated water from the stockyard area does not flow directly into the natural water bodies or into the groundwater system.

The sewerage system will be provided to collect the sewage from administration building; canteen and operation buildings and sent to septic tanks followed by soak pits.

5.3 Marine Environment (Coastal Hydrology/Bottom Contamination, Sea/Harbour Water Quality)

5.3.1 Potential Impact due to Barge/ Vessel Loading Facility Location

5.3.1.1 Sediment Transport

Sediment transport takes place under the action of waves and currents. The oblique wave breaking and currents mainly decides the sand movement in coastal areas. The action of wave is the principal cause of sediment transport as it initiates sediment motion generated by wave breaking current. The proposed barge/vessel loading facility includes breakwaters, navigational channel and turning basin planned near the Sharavati and Badgani river mouth may affect the wave and current pattern in the vicinity and in turn the local sediment transport pattern. The presence of Sharavati and Badgani river confluence points in the harbour area can also influence the local sedimentation pattern. Hence, to study the sediment movement in the near-shore, estimate the maintenance dredging quantity and the erosion/deposition patterns, it is essential to include the environment parameters like waves and current during evaluation of sediment transport.

Flow Model description:

MIKE 21 Flow Model is a modelling system for 2D free-surface flows. MIKE 21 Flow Model is applicable to the simulation of hydraulic and environmental phenomena in lakes, estuaries, bays, coastal areas and seas. It may be applied wherever stratification can be neglected. The hydrodynamic (HD) module is the basic module in the MIKE 21Flow Model. It provides the hydrodynamic basis for the computations performed in the Environmental Hydraulics modules.

The hydrodynamic module simulates water level variations and flows in response to a variety of forcing functions in lakes, estuaries and coastal regions. The effects and facilities include:

- Bottom shear stress
- Wind shear stress
- Barometric pressure gradients
- Coriolis force
- Momentum dispersion
- Sources and sinks
- Evaporation
- Flooding and drying
- Wave radiation stresses

The following equations for the conservation of mass and momentum integrated over the vertical, describe the flow and water level variations.

$$\frac{\partial \zeta}{\partial t} + \frac{\partial p}{\partial x} + \frac{\partial q}{\partial y} = \frac{\partial d}{\partial t}$$

$$\frac{\partial p}{\partial t} + \frac{\partial}{\partial x}\left(\frac{p^2}{h}\right) + \frac{\partial}{\partial y}\left(\frac{pq}{h}\right) + gh\frac{\partial \zeta}{\partial x}$$

$$+ \frac{gp\sqrt{p^2+q^2}}{C^2 \cdot h^2} - \frac{1}{\rho_w}\left[\frac{\partial}{\partial x}(h\tau_{xx}) + \frac{\partial}{\partial y}(h\tau_{xy})\right] - \Omega_q$$

$$- fVV_x + \frac{h}{\rho_w}\frac{\partial}{\partial x}(p_a) = 0$$

$$\frac{\partial q}{\partial t} + \frac{\partial}{\partial y}\left(\frac{q^2}{h}\right) + \frac{\partial}{\partial x}\left(\frac{pq}{h}\right) + gh\frac{\partial \zeta}{\partial y}$$

$$+ \frac{gq\sqrt{p^2+q^2}}{C^2 \cdot h^2} - \frac{1}{\rho_w}\left[\frac{\partial}{\partial y}(h\tau_{yy}) + \frac{\partial}{\partial x}(h\tau_{xy})\right] + \Omega_p$$

$$- fVV_y + \frac{h}{\rho_w}\frac{\partial}{\partial xy}(p_a) = 0$$

Where h(x,y,t) is the water depth, d(x,y,t) is the time varying depth(m), z (x,y,t) is the surface elevation (m), p and q (x,y,t) are the flux densities in x and y-directions ($m^3/s/m$)=(uh,vh); (u,v) = depth averaged velocities in x and y-directions, C(x,y) is the Chezy resistance ($m^{1/2}/s$), g is the acceleration due to gravity (m/s^2), f(V) is the wind friction factor, W (x,y) is the coriolis parameter, pa(x,y,t) is the atmospheric pressure ($kg/m/s^2$), rw is the density of water (kg/m^3), t is the time in seconds, t_{xx}, t_{xy}, t_{yy} are the components of effective shear stress.

Flow Model Validation:

The HD model has been validated with the measured water levels inside the river as well as in the channel provided by Indomer Coastal Hydraulics, Chennai and are shown in Figure 5-3:

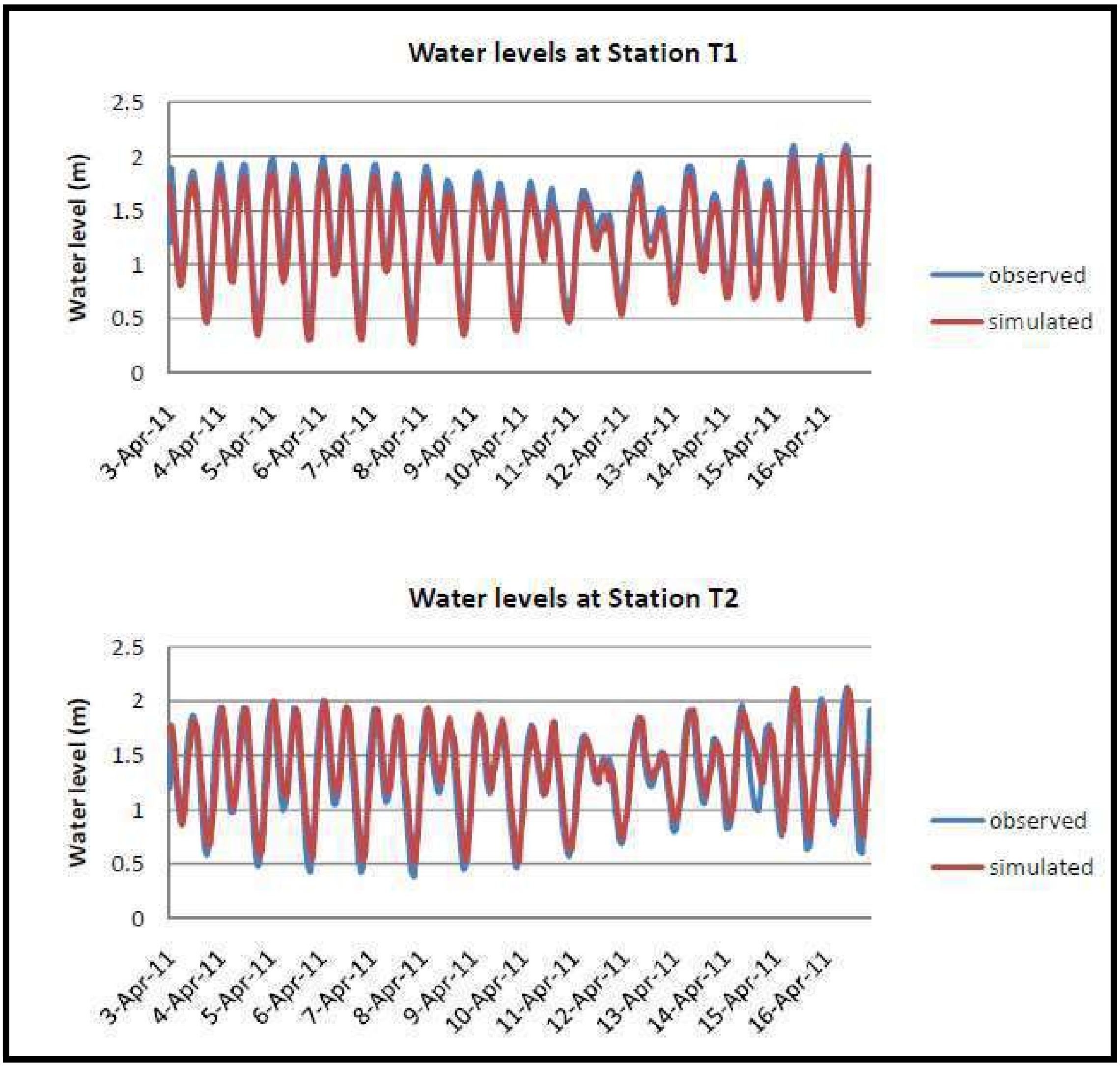

Figure 5-3: Validation of HD model results at tide stations T1 (river mouth) and T2 (inside the river)

<u>Simulated currents for Case-I (without proposed Facility):</u>

(a) Wet season:

The simulated currents for wet season with high river discharge conditions are shown in Figure 5-4 for stations T1, T2 and T3. Peak discharge value of 300 m^3/s recorded in the month of August as provided by Karnataka Power Corporation Ltd. At Gerusoppa dam has been used in the model. SW waves have been included into the model since they appear to be dominant during the wet season. The current patterns for ebb and flood phases of tide during springs and neaps are presented in Figure 5-5 to 5-8:

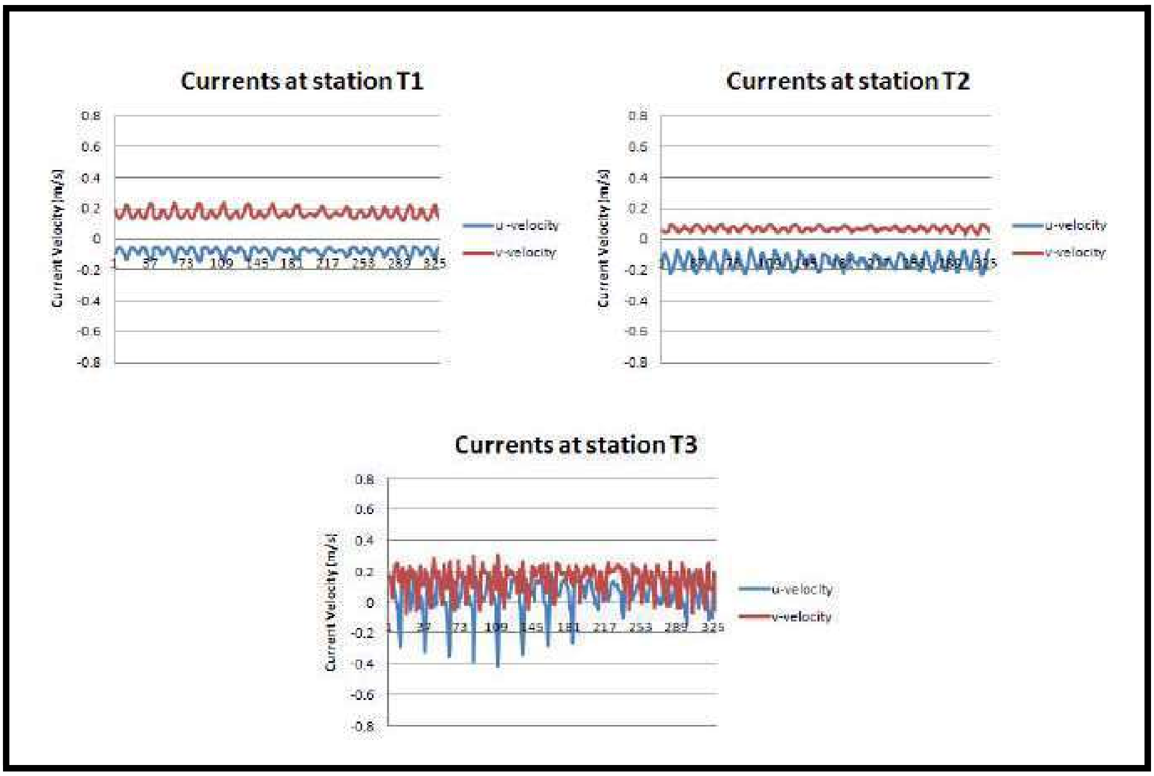

Figure 5-4: Simulated tidal currents during Wet season

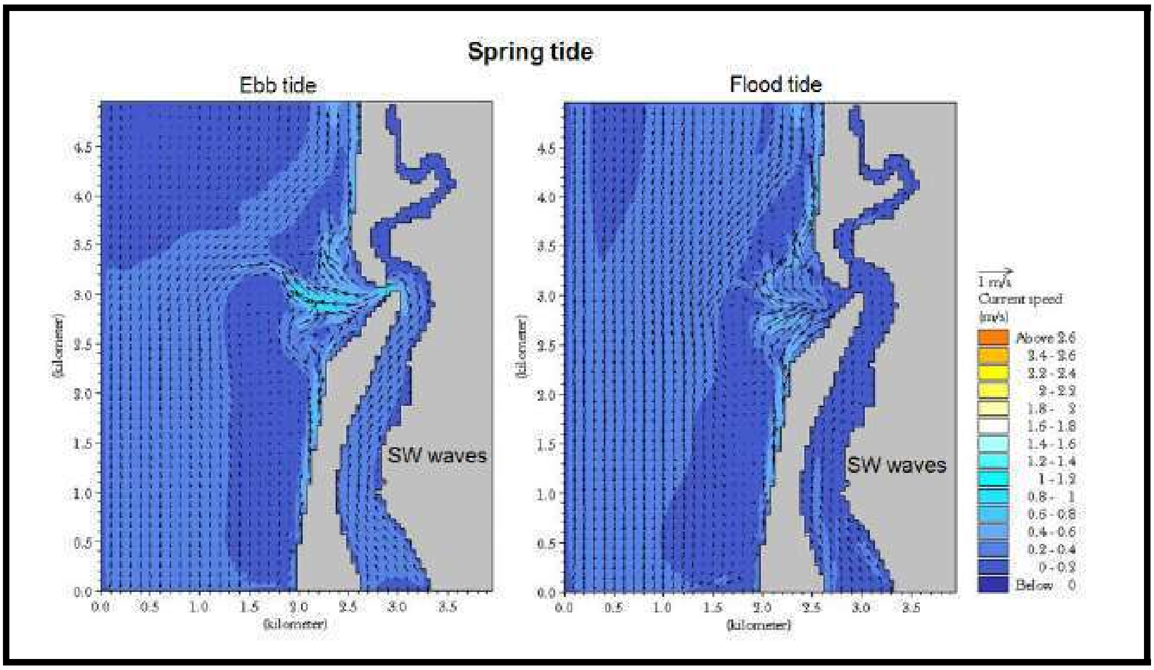

Figure 5-5: Currents for wet season during ebb and flood periods (Spring tide) case-I

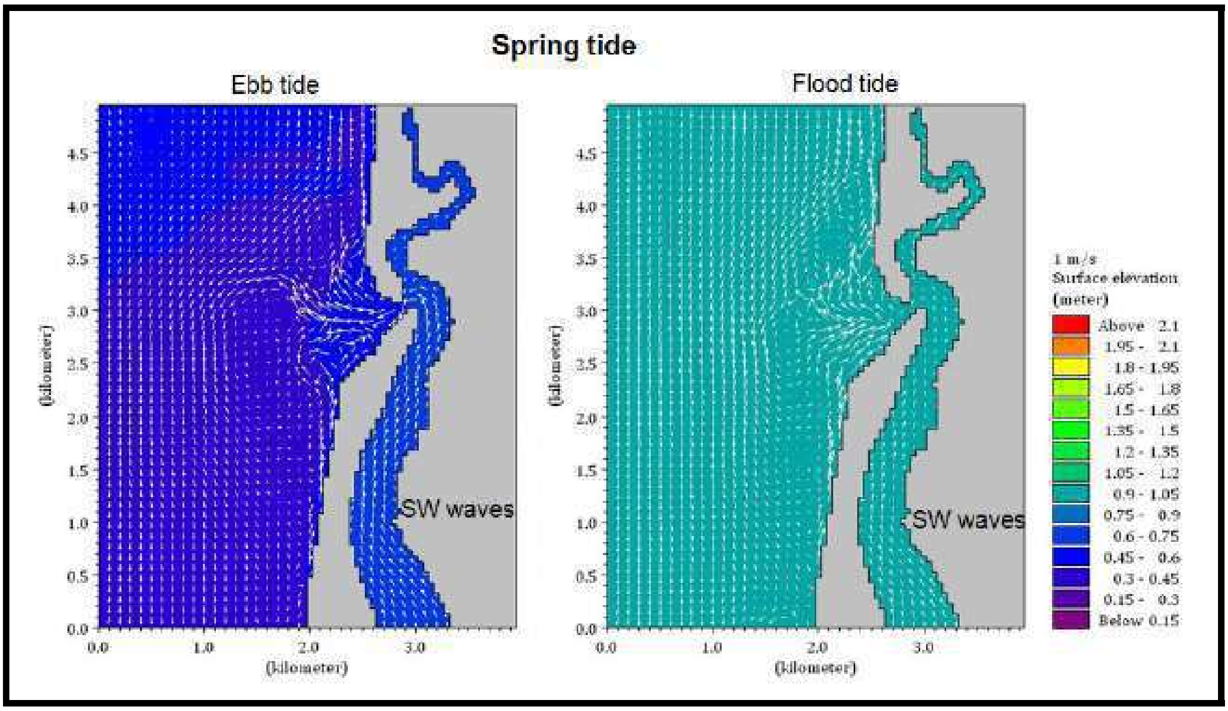

Figure 5-6: Water levels for Wet season during ebb and flood periods (Spring tide)

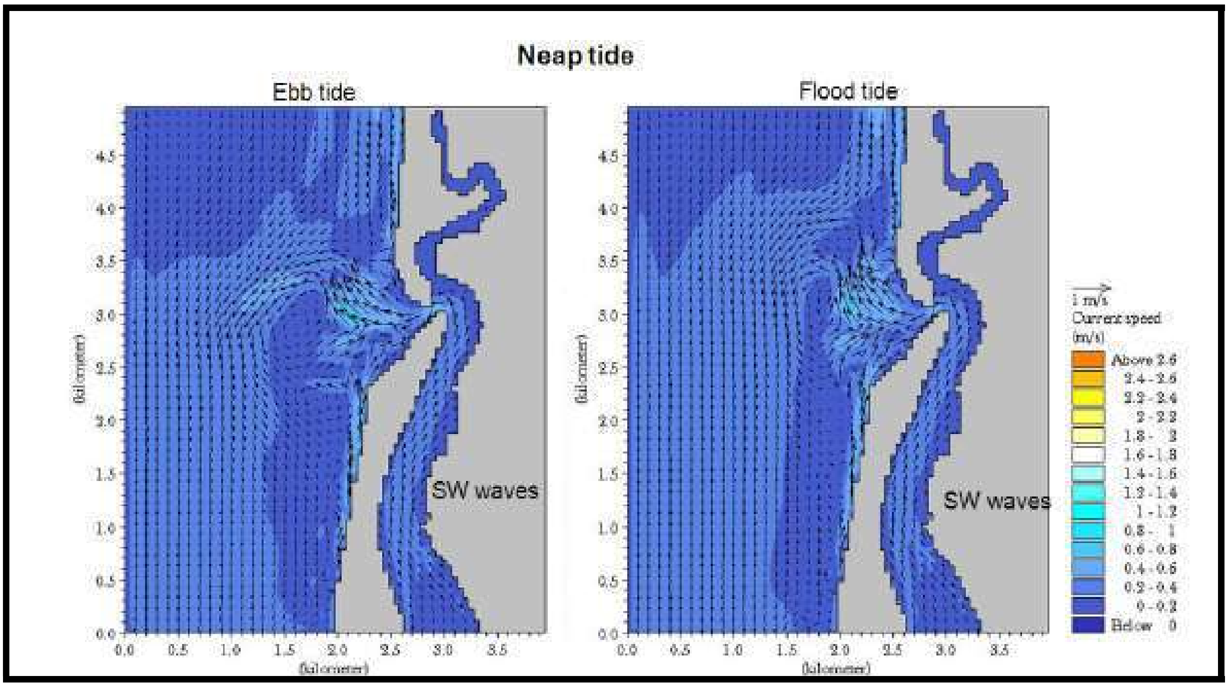

Figure 5-7: Currents for wet season during ebb and flood periods (neap tide)

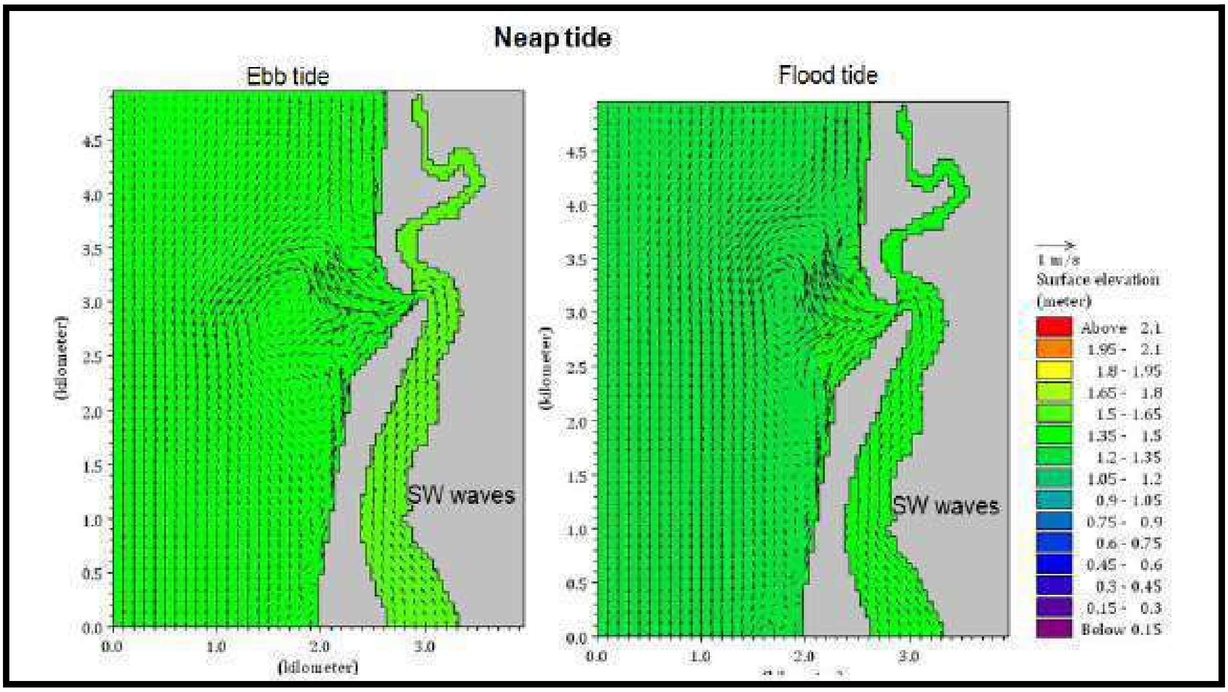

Figure 5-8: Water levels for wet season during ebb and flood periods (neap tide)

b) Currents in dry season:

The simulated currents for dry season at stations T1, T2 and T3 are shown in Figure 5-9. Minimum river discharge of 50 m^3/s and dominant wave direction of WNW have been used for this season. The current patterns for ebb and flood phases of tide during springs and neaps are presented in Figure 5-10 and 5-13.

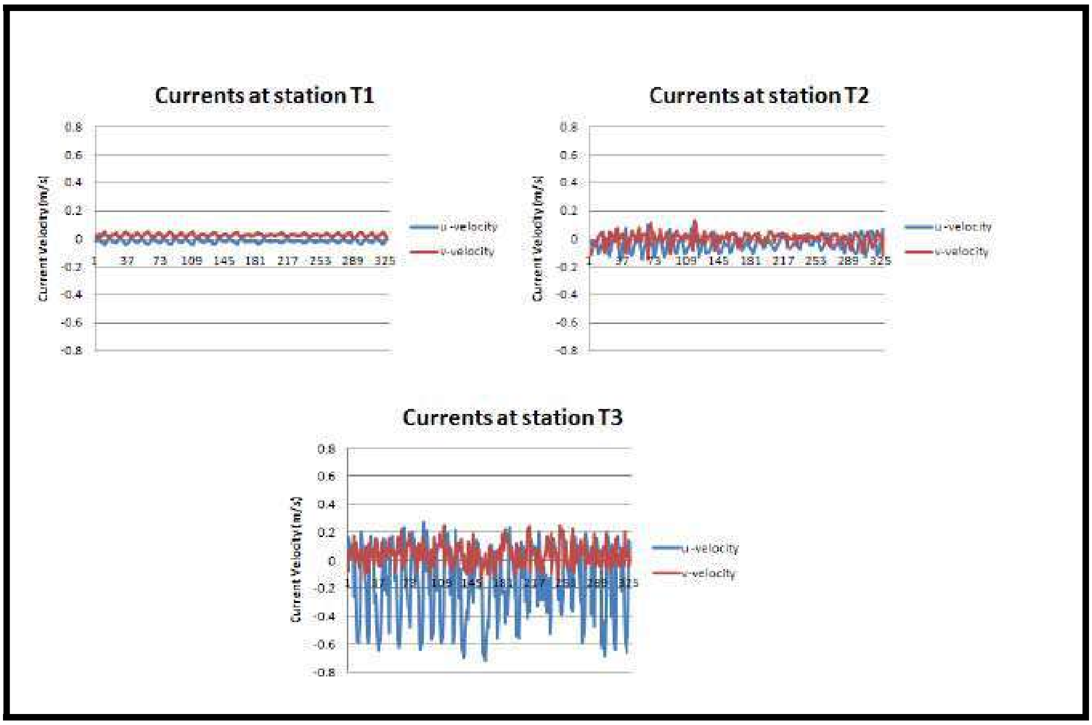

Figure 5-9: Simulated tidal currents during Dry season

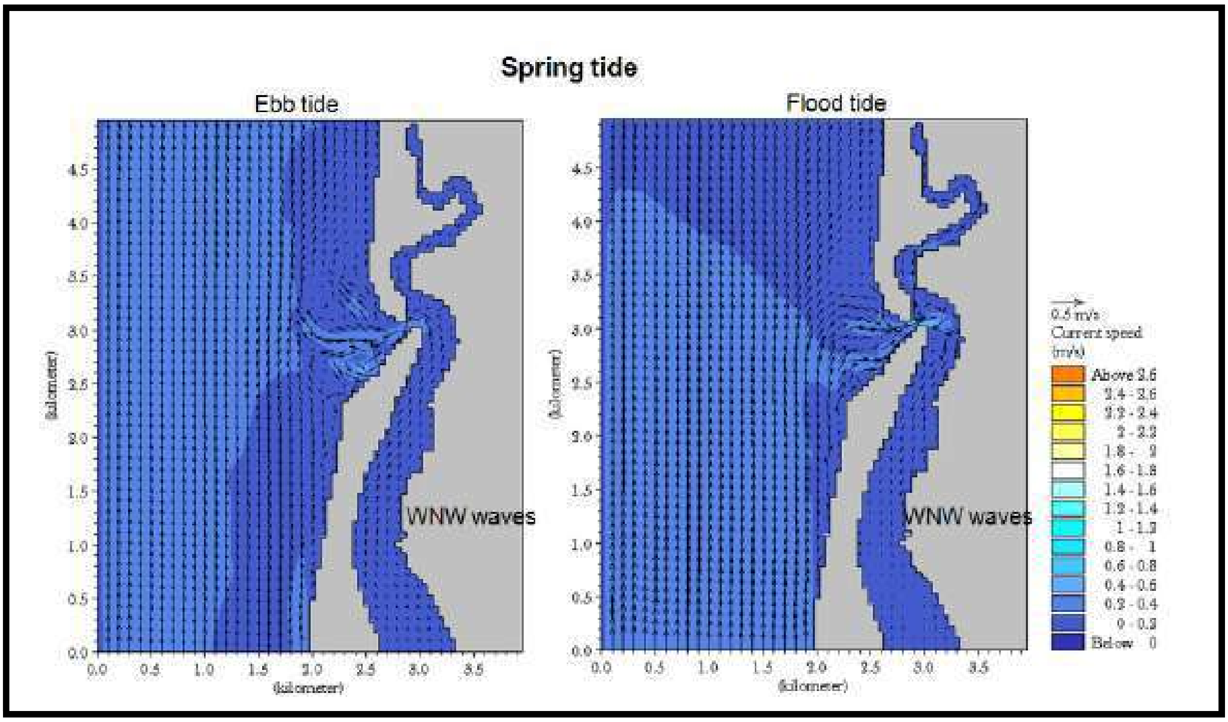

Figure 5-10: Current patterns for dry season during ebb and flood periods (Spring tide)

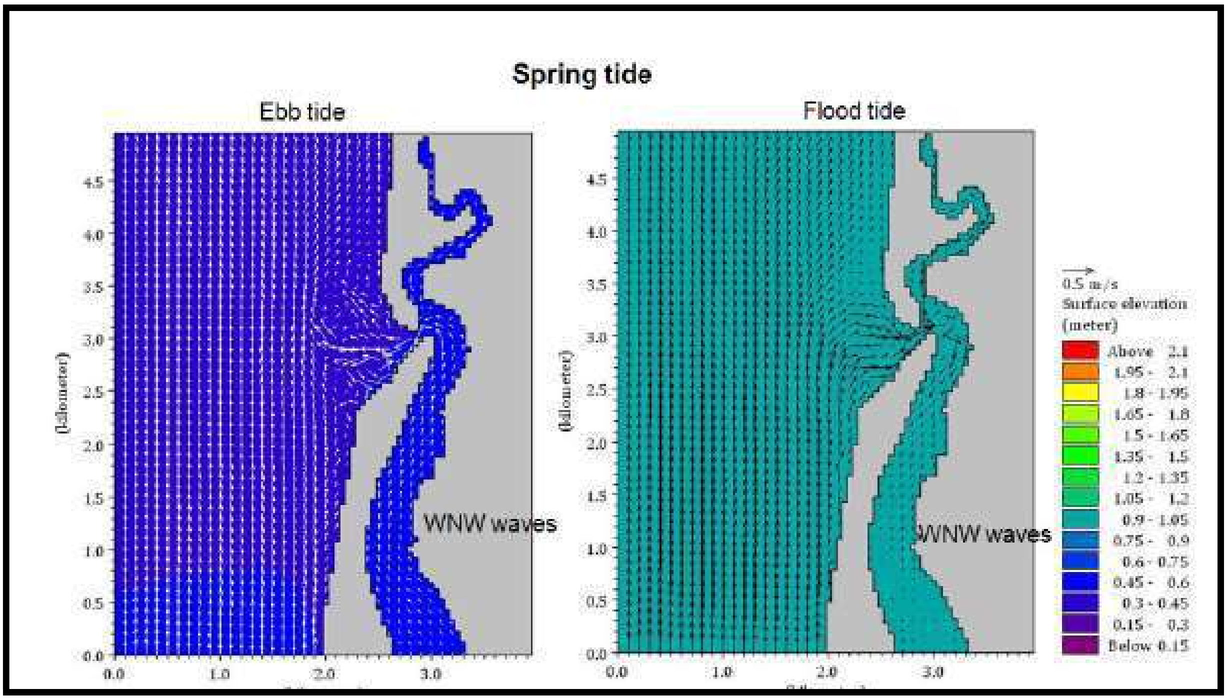

Figure 5-11: Water levels for dry season during ebb and flood periods (Spring tide)