NAME OF WORK:SOIL INVESTIGATION WORK FOR THE PROPOSED NORTH JETTY

LOCATION: NAVAL BASE

Hide Tide Water : 4.30 M
Low Tide water : 3.70 M

Date of Boring Started : 17.12.2012
Date of Boring Completed : 20.12.2012
Termination Depth : 60.00 M

Table No.27

T-1613

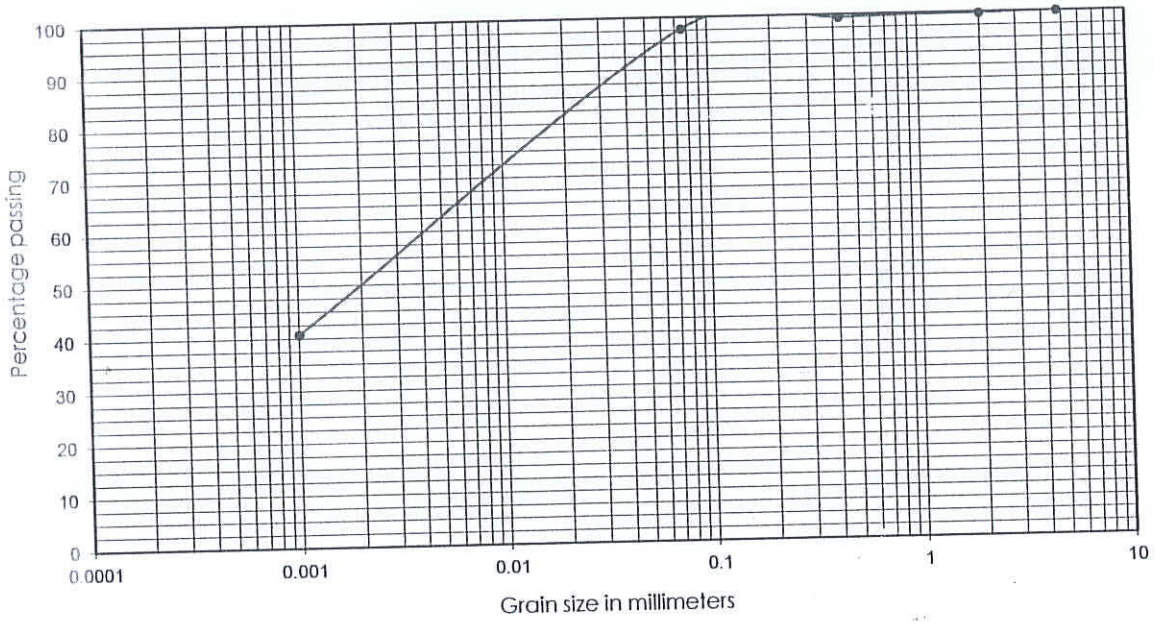
N	DEPTH(M)	SAMPLE	SOIL DESCRIPTION	I.S. CLASSIFICATION	GRAIN SIZE ANALYSIS(%) IS 2720(Part5):1985				NMC(%) IS 2720 (Part2):1973	ATTERBERG'S LIMIT(%)-IS 2720(Part-5): 1985			SL (%)IS 2720(Part6): 1972	FSI (%) IS2720 (Part40):1977	SPG(IS 2720(Part-3/sec1):1980	UNIT WEIGHT (gm/cc)		SHEAR PARAMETERS-IS 2720(Part-13):1986		
					GRA - VEL	SAND	SILT,	CLAY		LL	PL	PI				WET	DRY	METHOD	C kg/cm²	Ø (°)
			BOREHOLE BH/8																	
>100	58.0	SPT32	Silty Sand (P/Grey)	SM	0	57	43	0	19	No Limit										
>100	60.0	SPT33	Silty Sand (P/Grey)	SM	0	61	39	0	15	No Limit					2.61	2.09	1.82	DST	0	38

GEO FOUNDATIONS AND STRUCTURES PVT. LTD

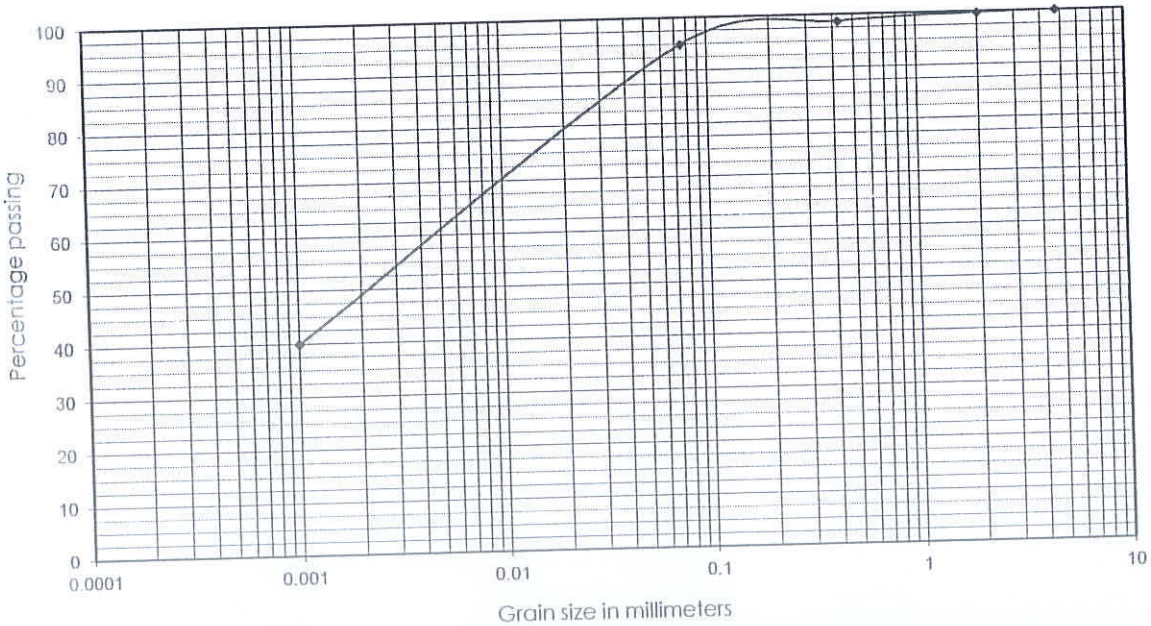
T-1613

PROJECT : SOIL INVESTIGATION WORK FOR THE PROPOSED NORTH JETTY AT NAVAL BASE

GRAINSIZE ANALYSIS TEST



BH No.	Depth	IS Class	Gravel(%)	Sand(%)	Silt(%)	Clay(%)	D60	D10	Cu
BH-08	1.50	CH	0	2	57	41			



BH No.	Depth	IS Class	Gravel(%)	Sand(%)	Silt(%)	Clay(%)	D60	D10	D0
BH-08	4.50	CH	0	5	55	40			

FIG. 147

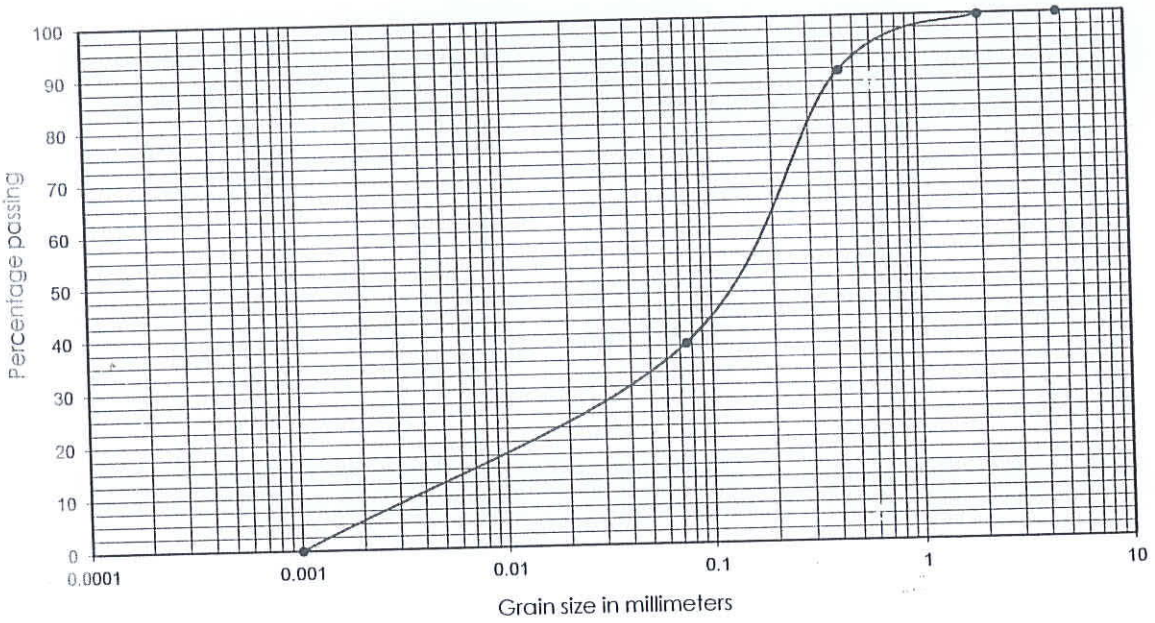
Geo Foundations Structures Pvt Ltd

GEO FOUNDATIONS AND STRUCTURES PVT. LTD

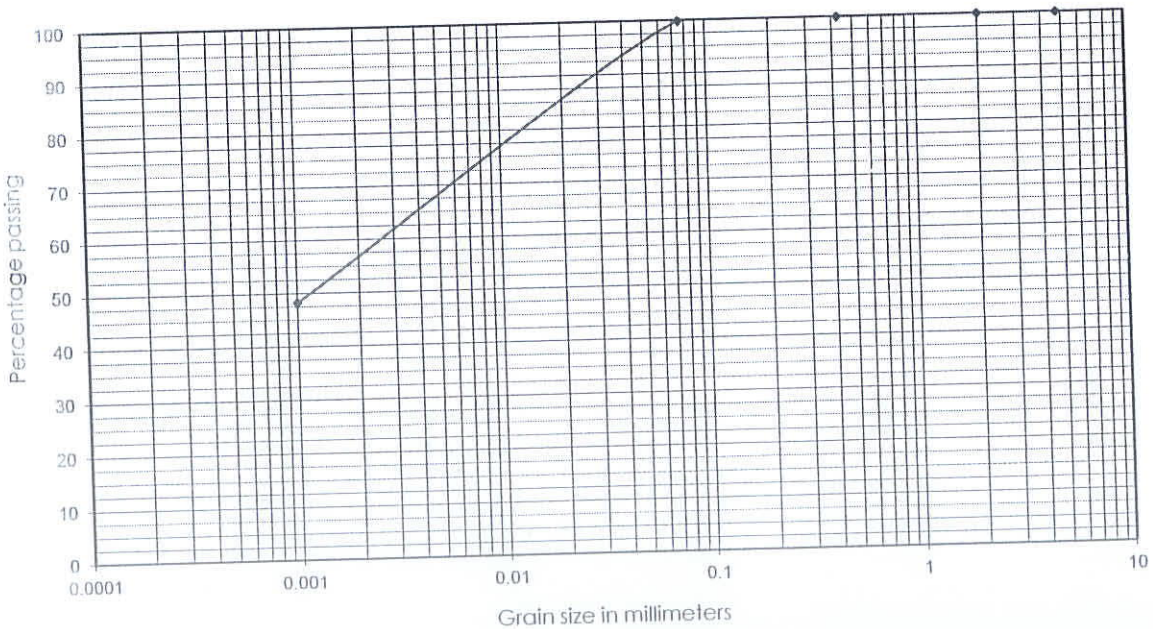
T-1613

PROJECT : SOIL INVESTIGATION WORK FOR THE PROPOSED NORTH JETTY AT NAVAL BASE

GRAINSIZE ANALYSIS TEST



BH No.	Depth	IS Class	Gravel(%)	Sand(%)	Silt(%)	Clay(%)	D60	D10	Cu
BH-08	6.00	SM	0	62	38	0			



BH No.	Depth	IS Class	Gravel(%)	Sand(%)	Silt(%)	Clay(%)	D60	D10	D0
BH-08	7.50	CH	0	0	52	48			

FIG. 148

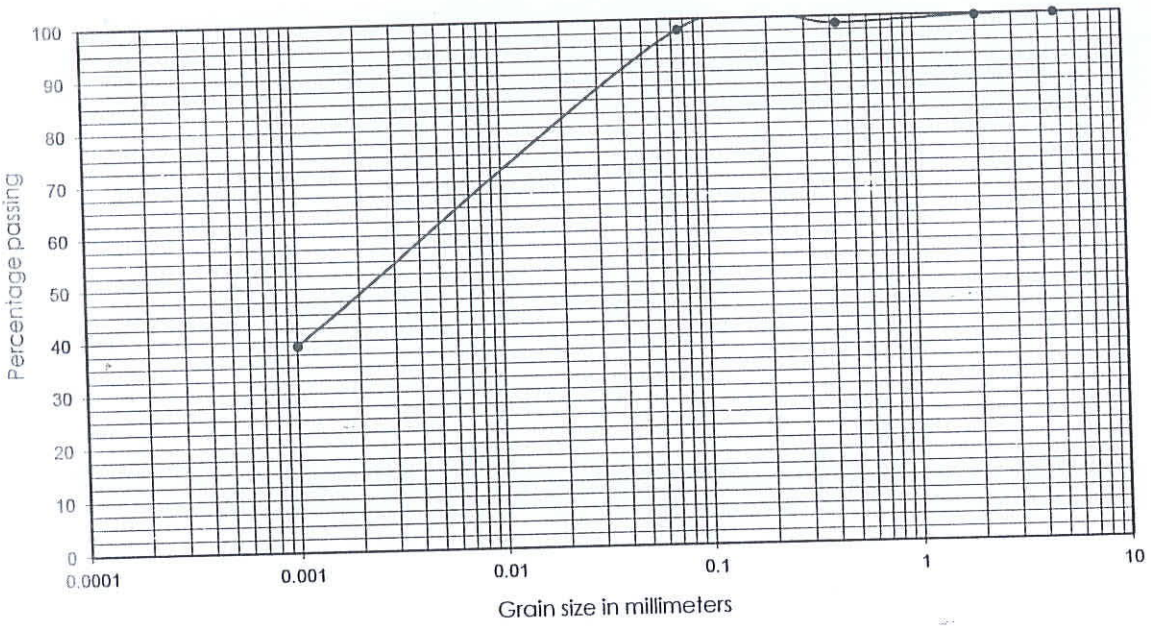
Geo Foundations Structures Pvt Ltd

GEO FOUNDATIONS AND STRUCTURES PVT. LTD

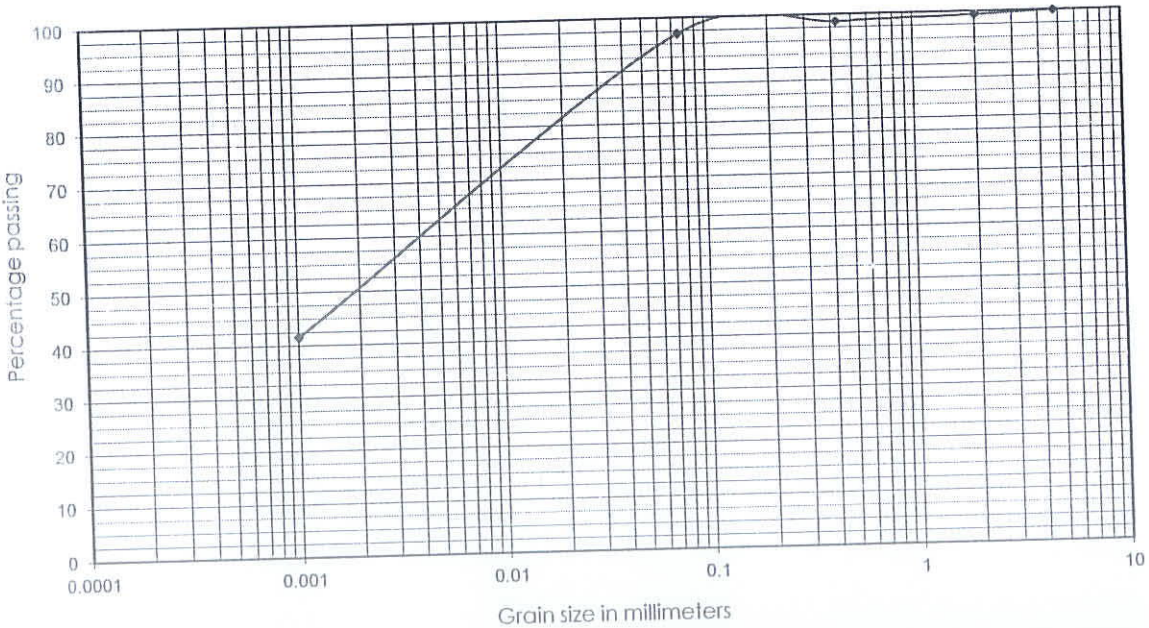
T-1613

PROJECT : SOIL INVESTIGATION WORK FOR THE PROPOSED NORTH JETTY AT NAVAL BASE

GRAINSIZE ANALYSIS TEST



BH No.	Depth	IS Class	Gravel(%)	Sand(%)	Silt(%)	Clay(%)	D60	D10	Cu
BH-08	12.00	CH	0	2	59	39			



BH No.	Depth	IS Class	Gravel(%)	Sand(%)	Silt(%)	Clay(%)	D60	D10	D0
BH-08	15.00	CH	0	3	55	42			

FIG. 149

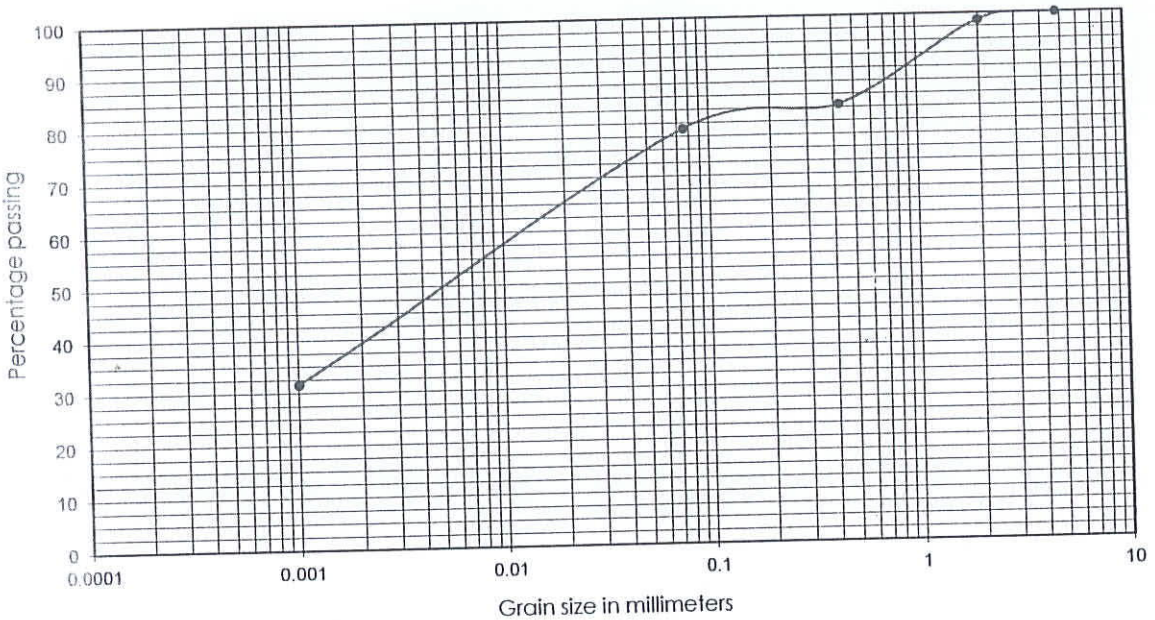
Geo Foundations Structures Pvt Ltd

GEO FOUNDATIONS AND STRUCTURES PVT. LTD

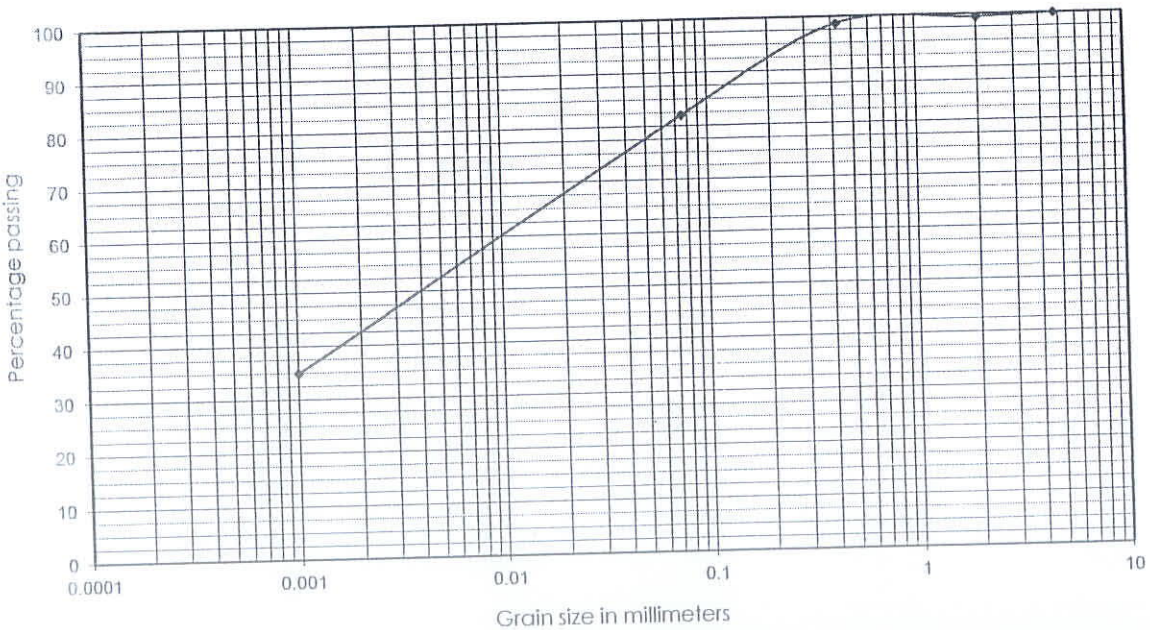
T-1613

PROJECT : SOIL INVESTIGATION WORK FOR THE PROPOSED NORTH JETTY AT NAVAL BASE

GRAINSIZE ANALYSIS TEST



BH No.	Depth	IS Class	Gravel(%)	Sand(%)	Silt(%)	Clay(%)	D60	D10	Cu
BH-08	22.50	CH	0	21	47	32			



BH No.	Depth	IS Class	Gravel(%)	Sand(%)	Silt(%)	Clay(%)	D60	D10	D0
BH-08	25.50	CH	0	18	47	35			

FIG. 150

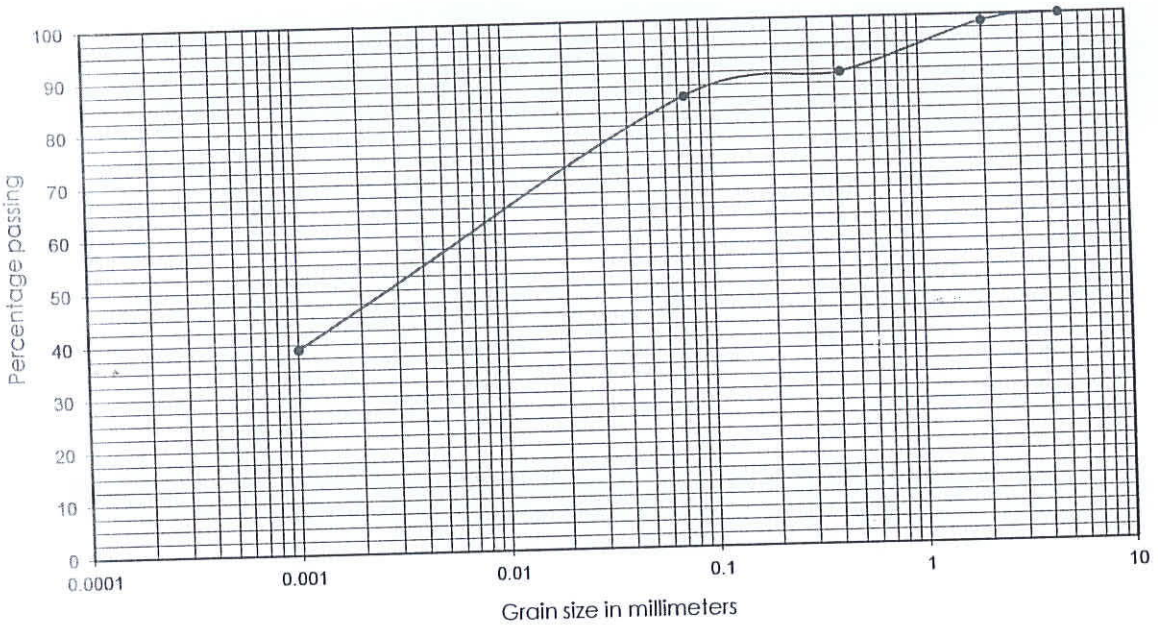
Geo Foundations Structures Pvt Ltd

GEO FOUNDATIONS AND STRUCTURES PVT. LTD

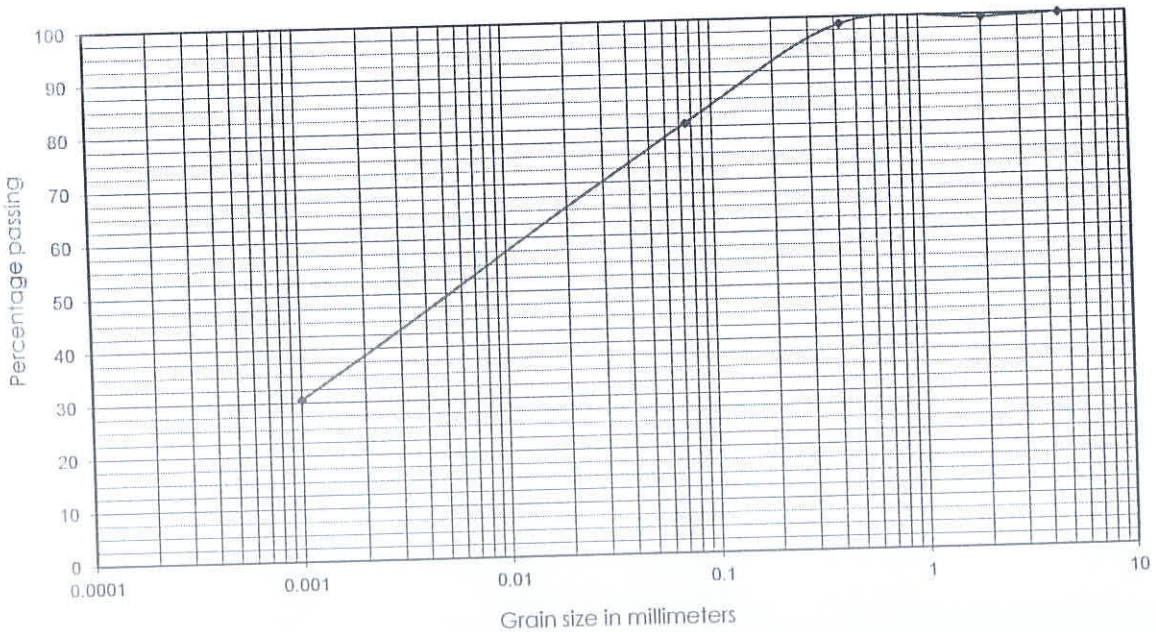
T-1613

PROJECT : SOIL INVESTIGATION WORK FOR THE PROPOSED NORTH JETTY AT NAVAL BASE

GRAINSIZE ANALYSIS TEST



BH No.	Depth	IS Class	Gravel(%)	Sand(%)	Silt(%)	Clay(%)	D60	D10	Cu
BH-08	28.50	CH	0	15	46	39			



BH No.	Depth	IS Class	Gravel(%)	Sand(%)	Silt(%)	Clay(%)	D60	D10	D0
BH-08	30.00	CH	0	19	50	31			

FIG. 151

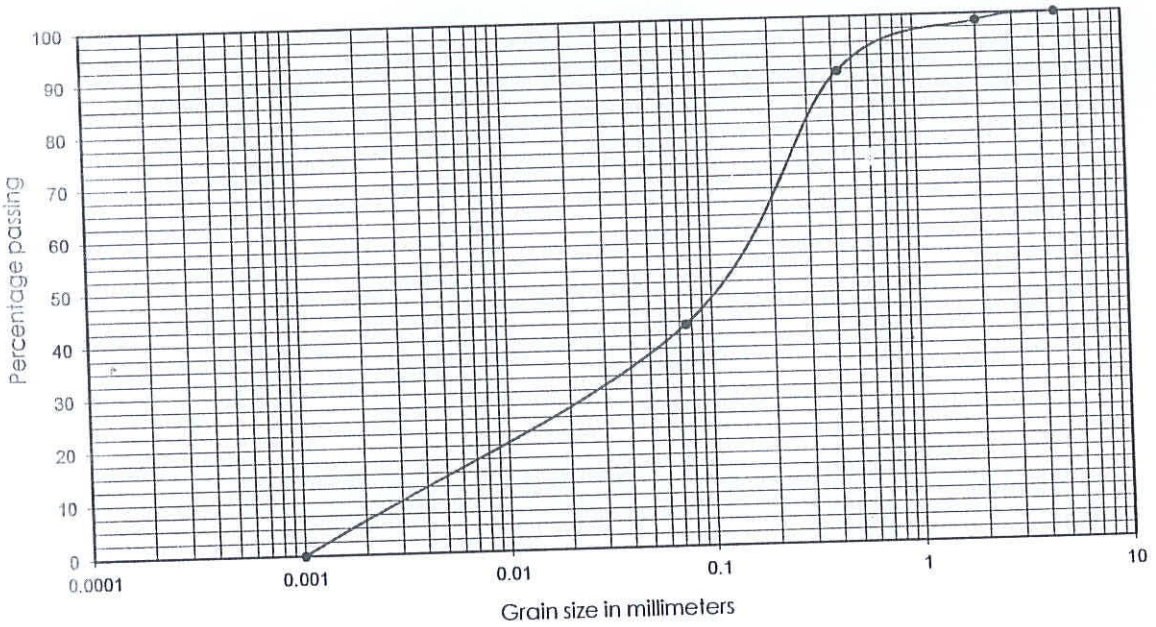
Geo Foundations Structures Pvt Ltd

GEO FOUNDATIONS AND STRUCTURES PVT. LTD

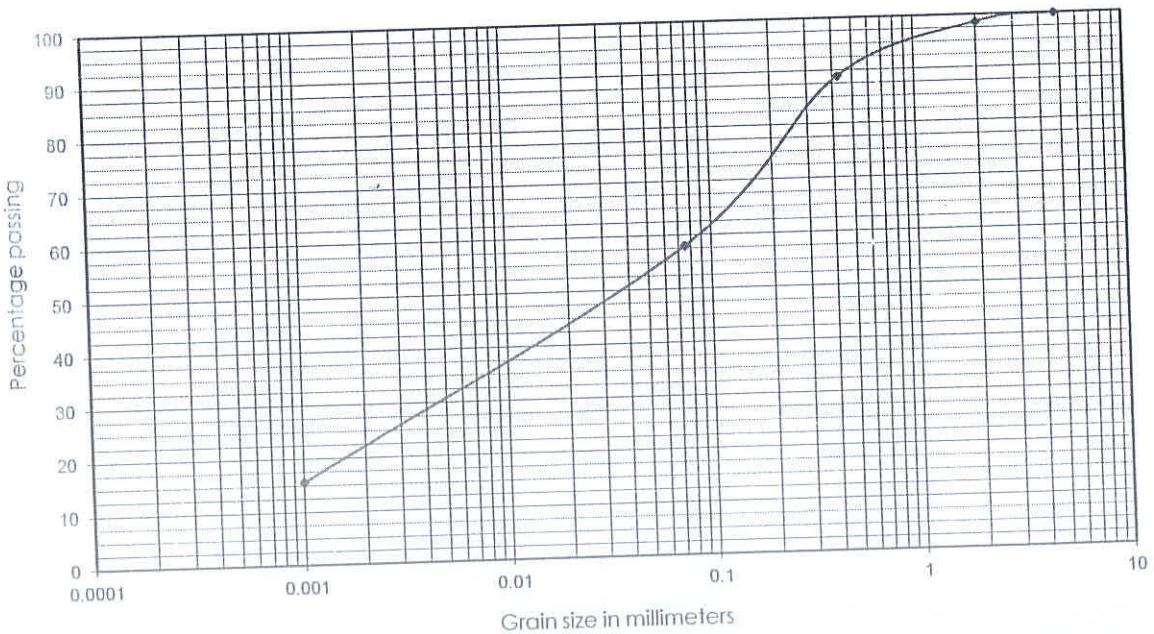
T-1613

PROJECT : SOIL INVESTIGATION WORK FOR THE PROPOSED NORTH JETTY AT NAVAL BASE

GRAINSIZE ANALYSIS TEST



BH No.	Depth	IS Class	Gravel(%)	Sand(%)	Silt(%)	Clay(%)	D60	D10	Cu
BH-08	34.00	SM	0	58	42	0			



BH No.	Depth	IS Class	Gravel(%)	Sand(%)	Silt(%)	Clay(%)	D60	D10	D0
BH-08	36.00	CI	0	42	42	16			

FIG. 152

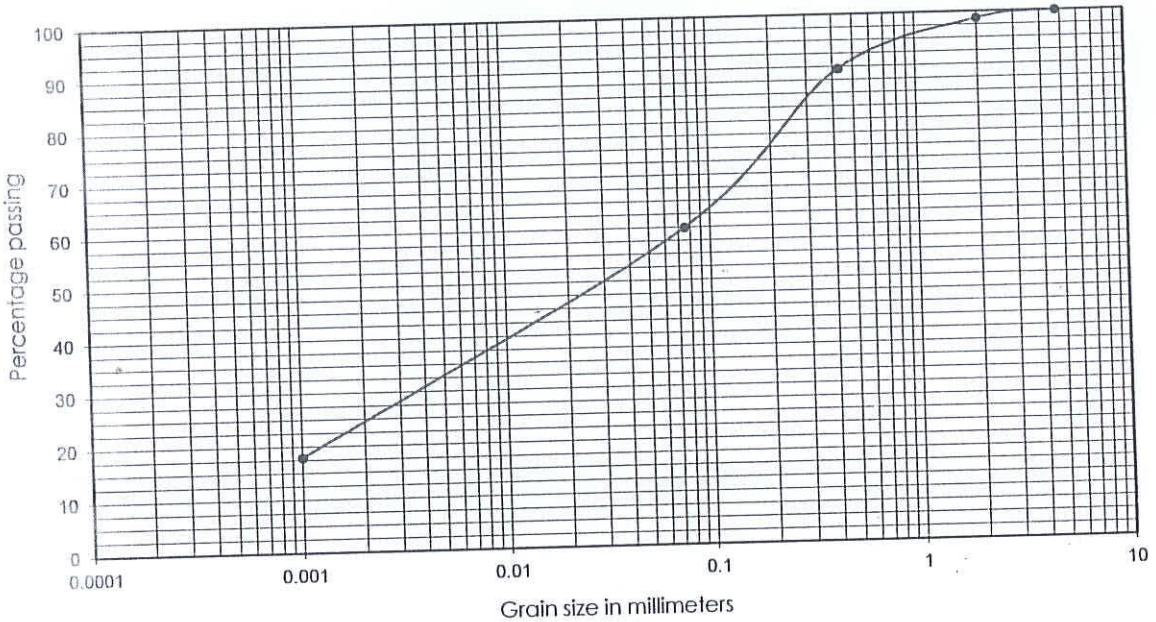
Geo Foundations Structures Pvt Ltd

GEO FOUNDATIONS AND STRUCTURES PVT. LTD

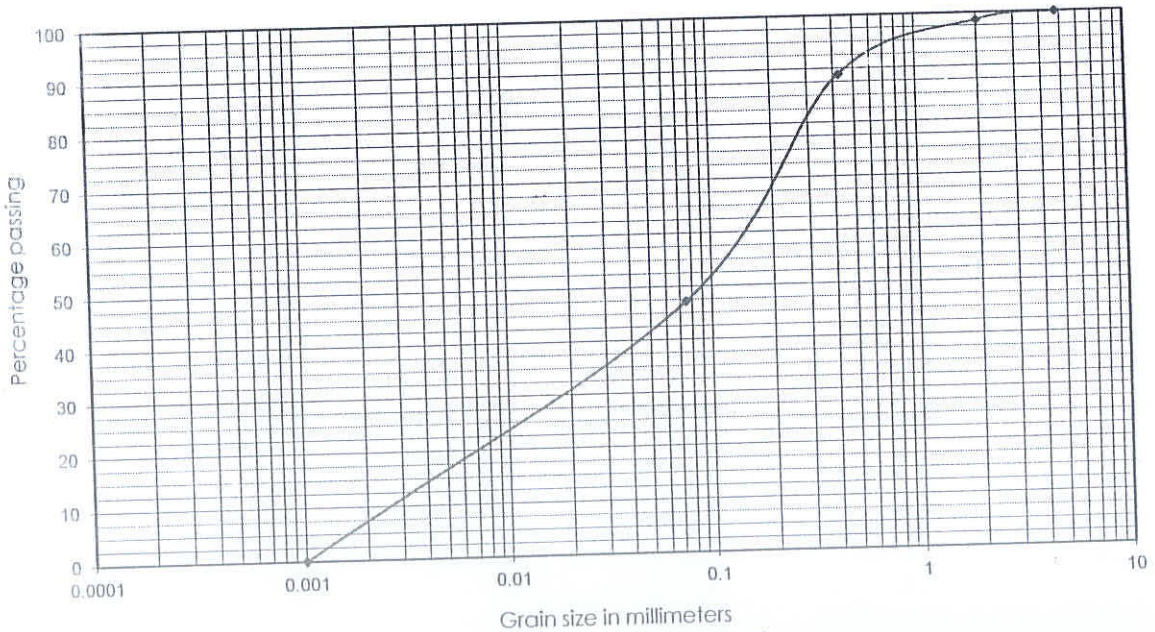
T-1613

PROJECT : SOIL INVESTIGATION WORK FOR THE PROPOSED NORTH JETTY AT NAVAL BASE

GRAINSIZE ANALYSIS TEST



BH No.	Depth	IS Class	Gravel(%)	Sand(%)	Silt(%)	Clay(%)	D60	D10	Cu
BH-08	40.00	CI	0	40	42	18			



BH No.	Depth	IS Class	Gravel(%)	Sand(%)	Silt(%)	Clay(%)	D60	D10	D0
BH-08	44.00	SM	0	53	47	0			

FIG. 153

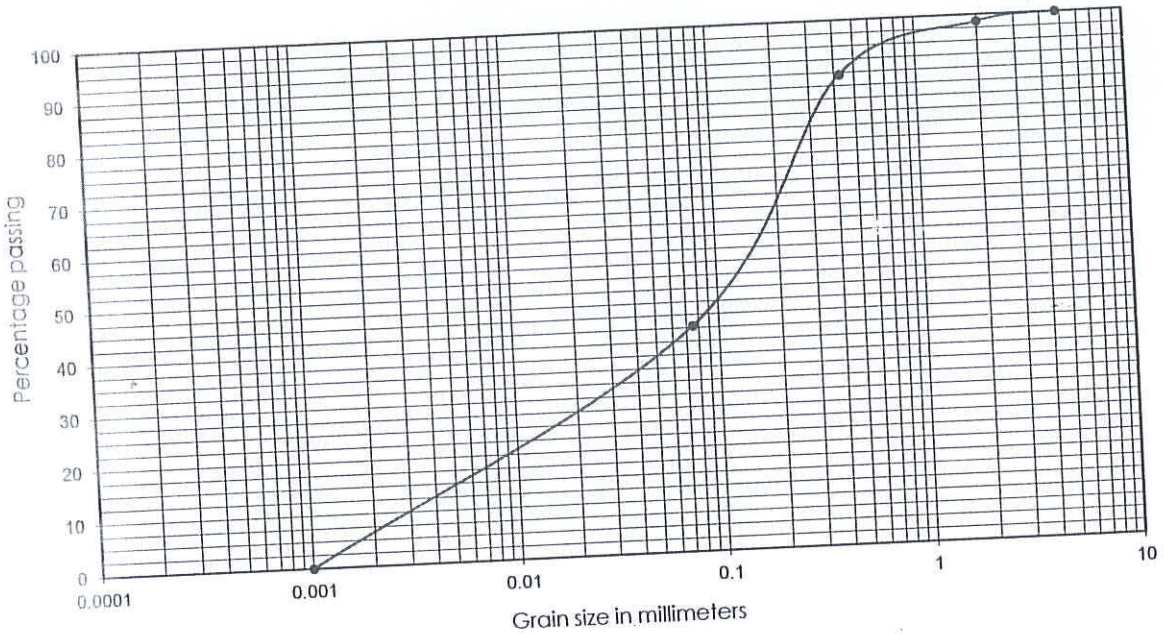
Geo Foundations Structures Pvt Ltd

GEO FOUNDATIONS AND STRUCTURES PVT. LTD

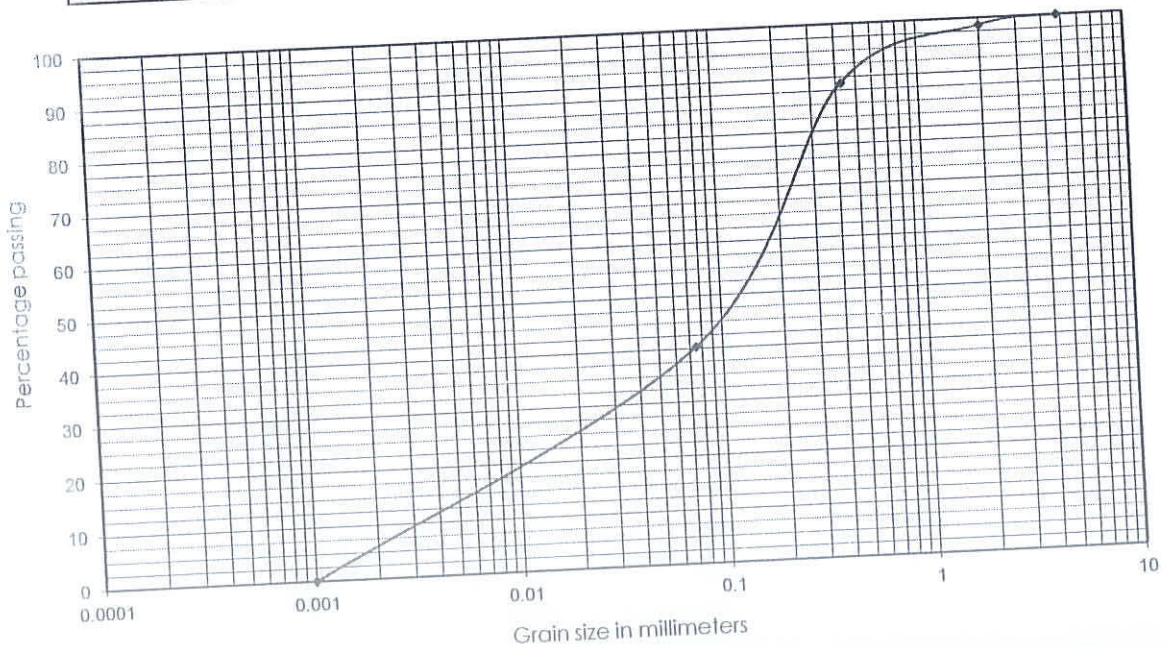
T-1613

PROJECT : SOIL INVESTIGATION WORK FOR THE PROPOSED NORTH JETTY AT NAVAL BASE

GRAINSIZE ANALYSIS TEST



BH No.	Depth	IS Class	Gravel(%)	Sand(%)	Silt(%)	Clay(%)	D60	D10	Cu
BH-08	46.00	SM	0	57	43	0			



BH No.	Depth	IS Class	Gravel(%)	Sand(%)	Silt(%)	Clay(%)	D60	D10	D0
BH-08	50.00	SM	0	60	40	0			

FIG. 154

Geo Foundations Structures Pvt Ltd

Client: Naval Ship Repair Yard

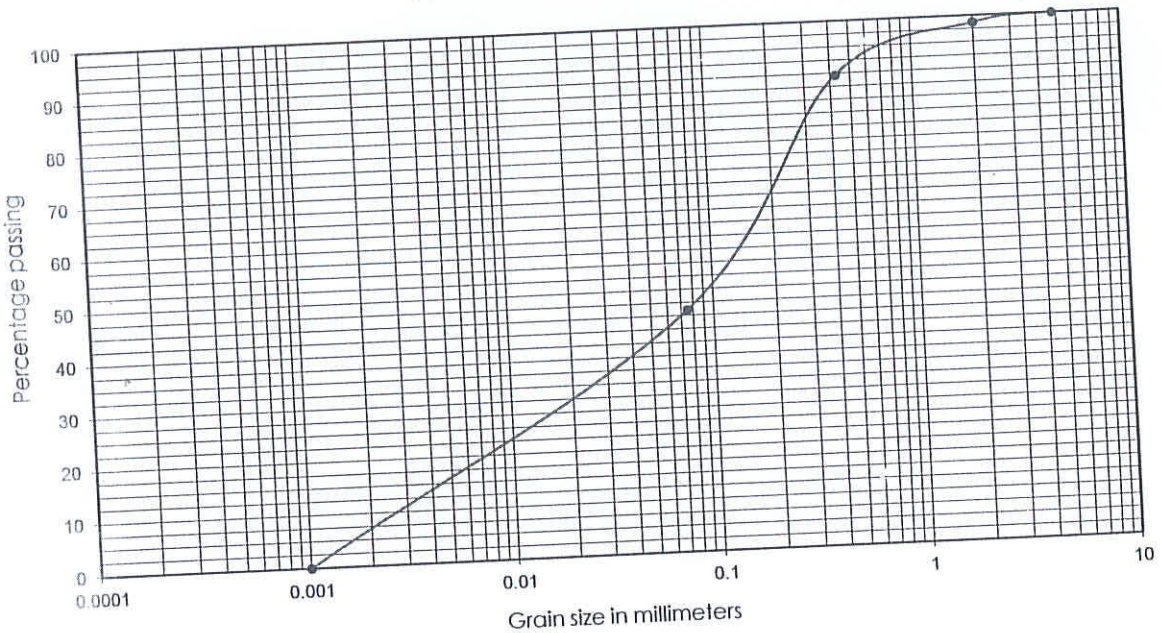
Soil investigation for the proposed North Jetty

GEO FOUNDATIONS AND STRUCTURES PVT. LTD

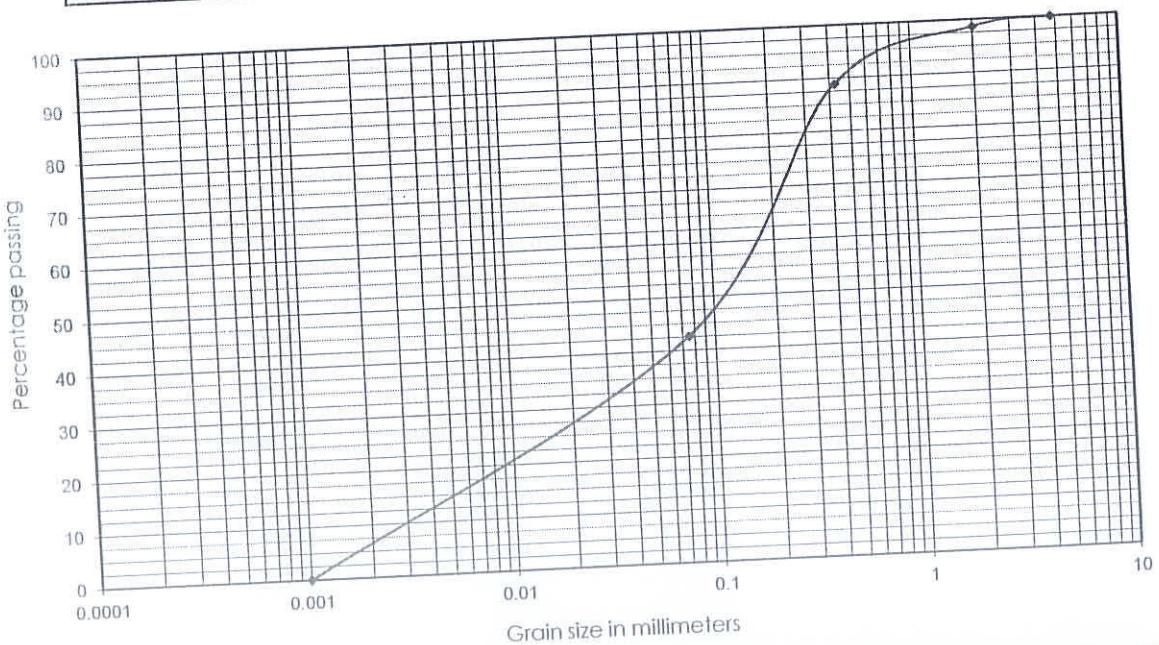
T-1613

PROJECT : SOIL INVESTIGATION WORK FOR THE PROPOSED NORTH JETTY AT NAVAL BASE

GRAINSIZE ANALYSIS TEST



BH No.	Depth	IS Class	Gravel(%)	Sand(%)	Silt(%)	Clay(%)	D60	D10	Cu
BH-08	52.00	SM	0	54	46	0			



BH No.	Depth	IS Class	Gravel(%)	Sand(%)	Silt(%)	Clay(%)	D60	D10	D0
BH-08	58.00	SM	0	57	43	0			

FIG. 155

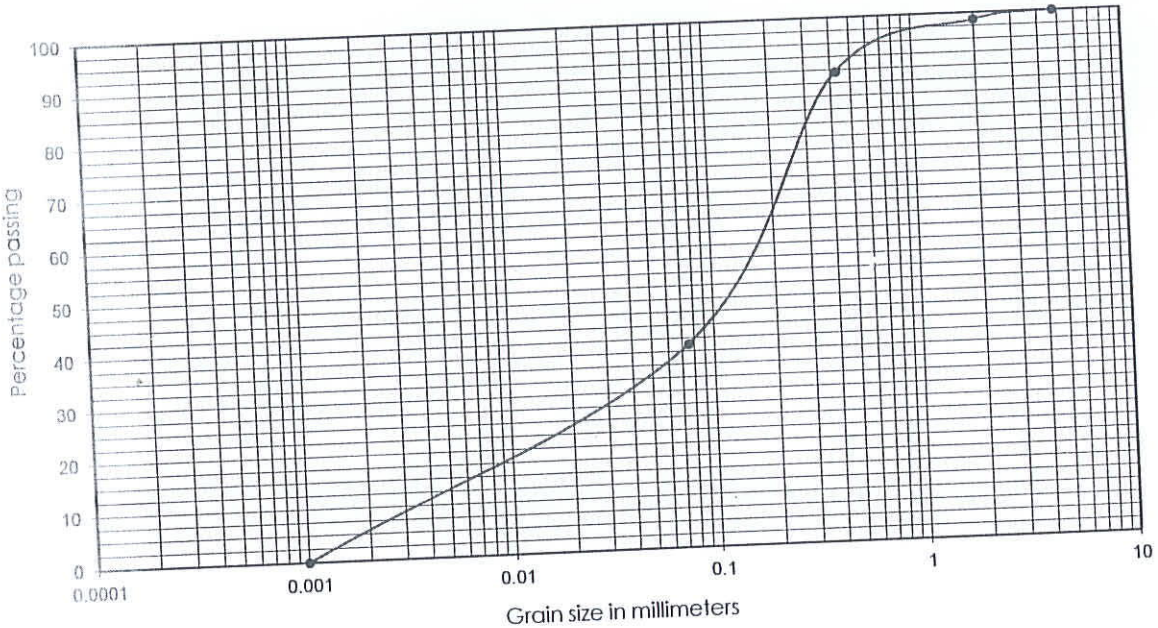
Geo Foundations Structures Pvt Ltd

GEO FOUNDATIONS AND STRUCTURES PVT. LTD

T-1613

PROJECT : SOIL INVESTIGATION WORK FOR THE PROPOSED NORTH JETTY AT NAVAL BASE

GRAINSIZE ANALYSIS TEST



BH No.	Depth	IS Class	Gravel(%)	Sand(%)	Silt(%)	Clay(%)	D60	D10	Cu
BH-08	60.00	SM	0	61	39	0			

FIG. 156

Geo Foundations Structures Pvt Ltd

DIRECT SHEAR TEST

BORE HOLE NO: BH-08 ,
SAMPLE NO : SPT4
DEPTH : 6.0M
C = 0.02 Kg/cm^2 ϕ = 30^0

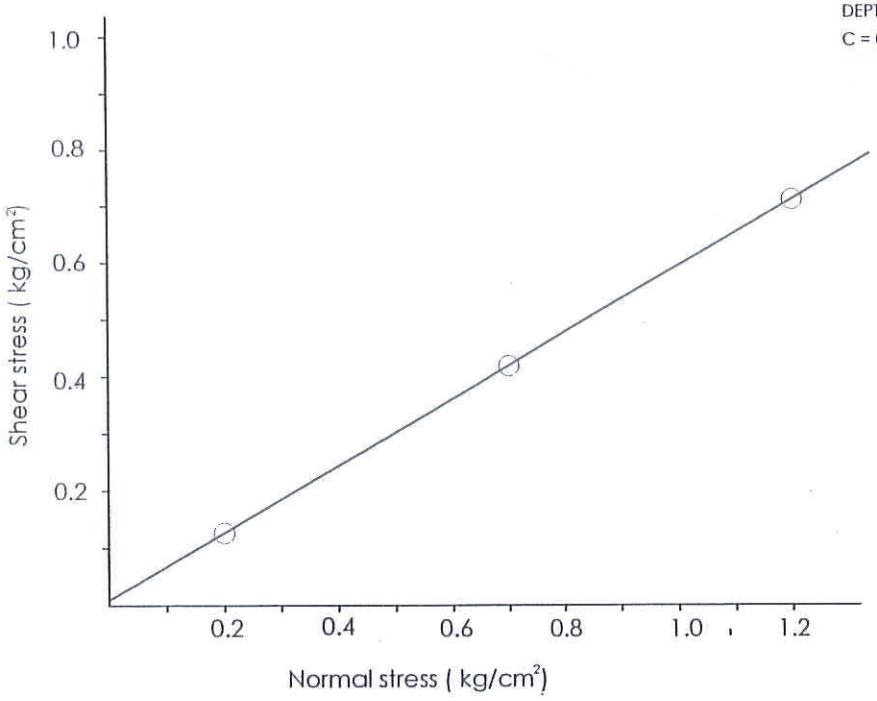


FIG (157)

TRI AXIAL TEST

BORE HOLE NO:BH-08
SAMPLE NO : UDS-2
DEPTH : 15.0 M
C = 0.23 Kg/cm^2 ϕ = 0 ^{0}

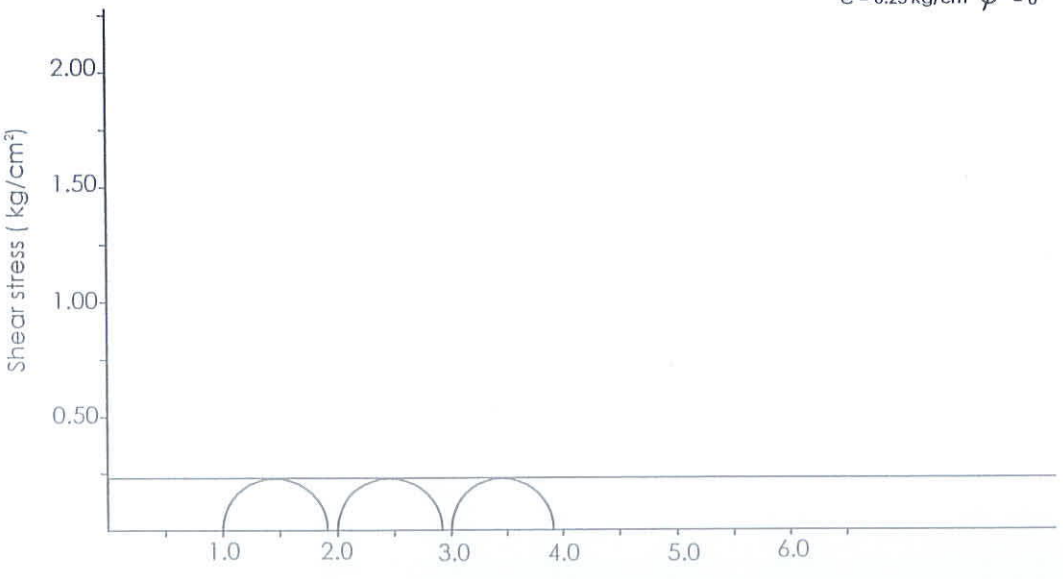


FIG (158)

DIRECT SHEAR TEST

BORE HOLE NO: BH-08
SAMPLE NO : SPT20
DEPTH : 34.0M
C = 0.02Kg/cm^2 ϕ = 31^0

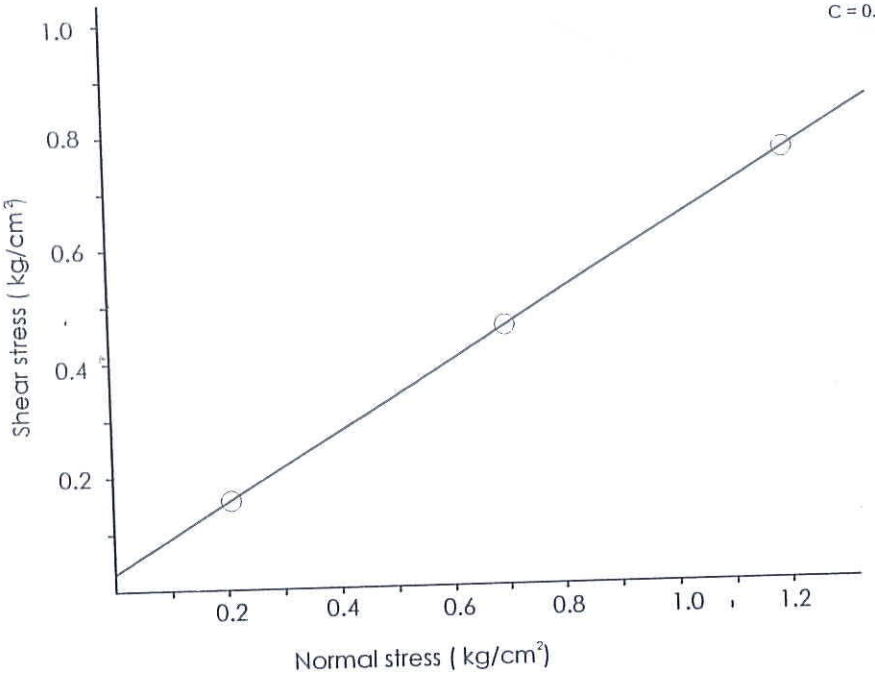


FIG (159)

DIRECT SHEAR TEST

BORE HOLE NO: BH-08
SAMPLE NO : SPT25
DEPTH : 44.0M
C = 0 Kg/cm^2 ϕ = 36^0

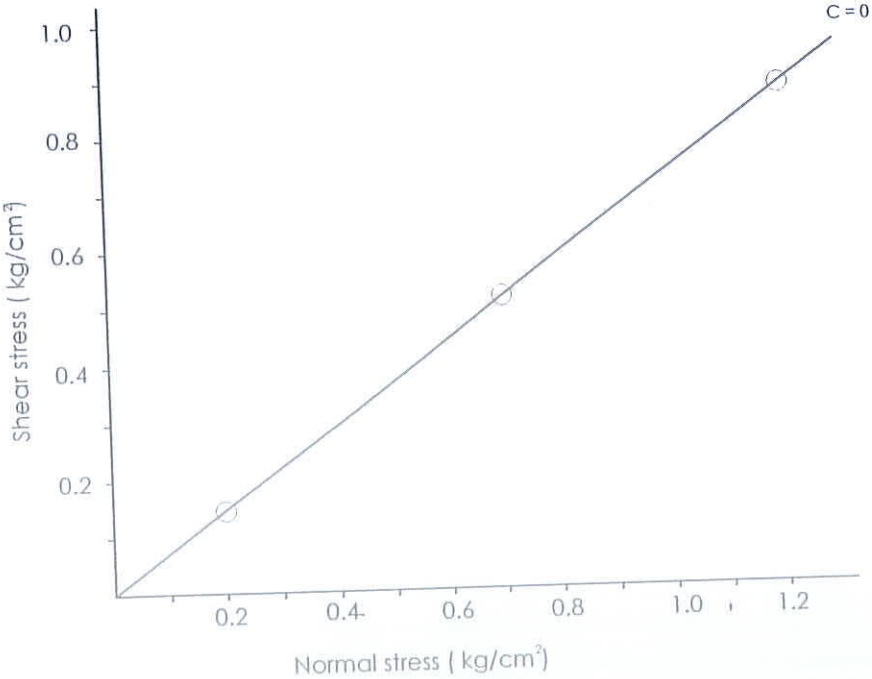


FIG (160)

DIRECT SHEAR TEST

BORE HOLE NO: BH-08
SAMPLE NO : SPT33
DEPTH : 60.0M
C = 0 Kg/cm^2 ϕ = 38^0

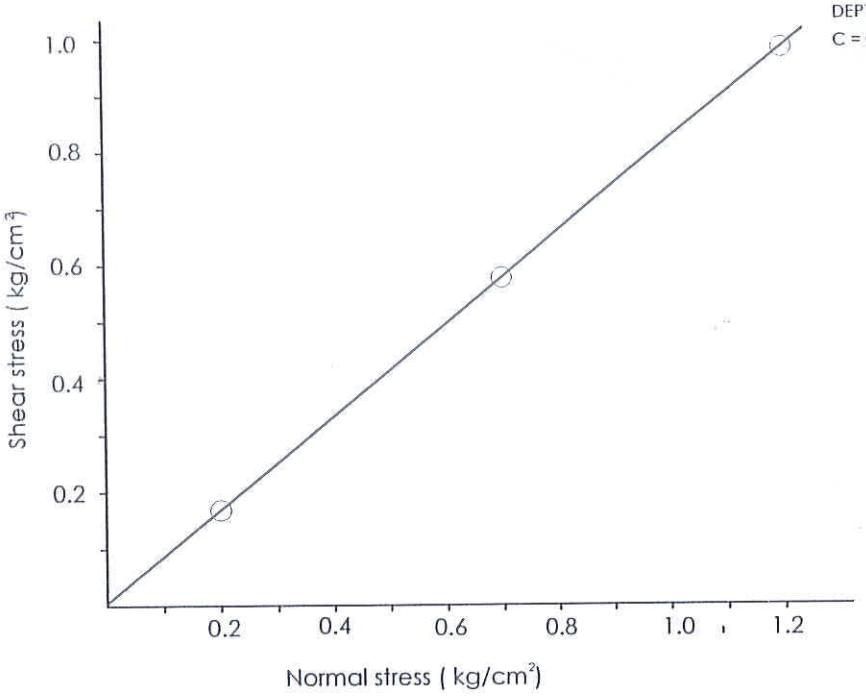


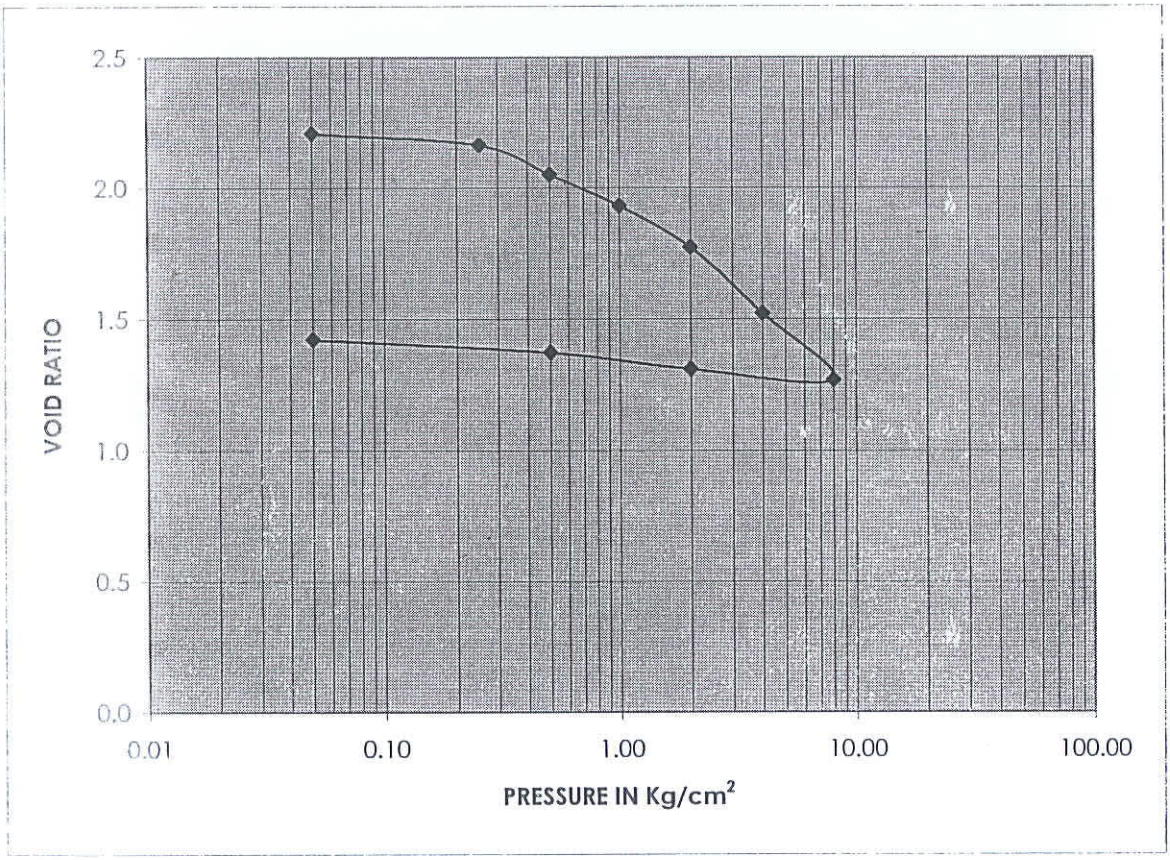
FIG (161)

GEO FOUNDATIONS AND STRUCTURES PVT. LTD

T-1613

Project: Geotechnical Investigation work for the proposed North Jetty

RESULTS OF CONSOLIDATION



VOIDS RATION VS LOG P CURVE

BH NO.	UDS-NO.	DEPTH(M)	Cc	eo
BH-8	UDS-1	12.00	0.85	2.21

Fig. 162

SOIL INVESTIGATION FOR THE PROPOSED NORTH JETTY

CHEMICAL ANALYSIS ON WATER

BH No.	Test Results		
	Chlorides (PPM)	Sulphates (PPM)	PH Value
1	23450	1350	7.5
2	24200	1018	7.5
3	24350	1225	7.5
4	25450	1464	7.5
5	17420	908	7.5
6	19600	855	7.5
7	20400	1013	7.5
8	14450	806	7.5

Permissible Limit as per IS 456:2000

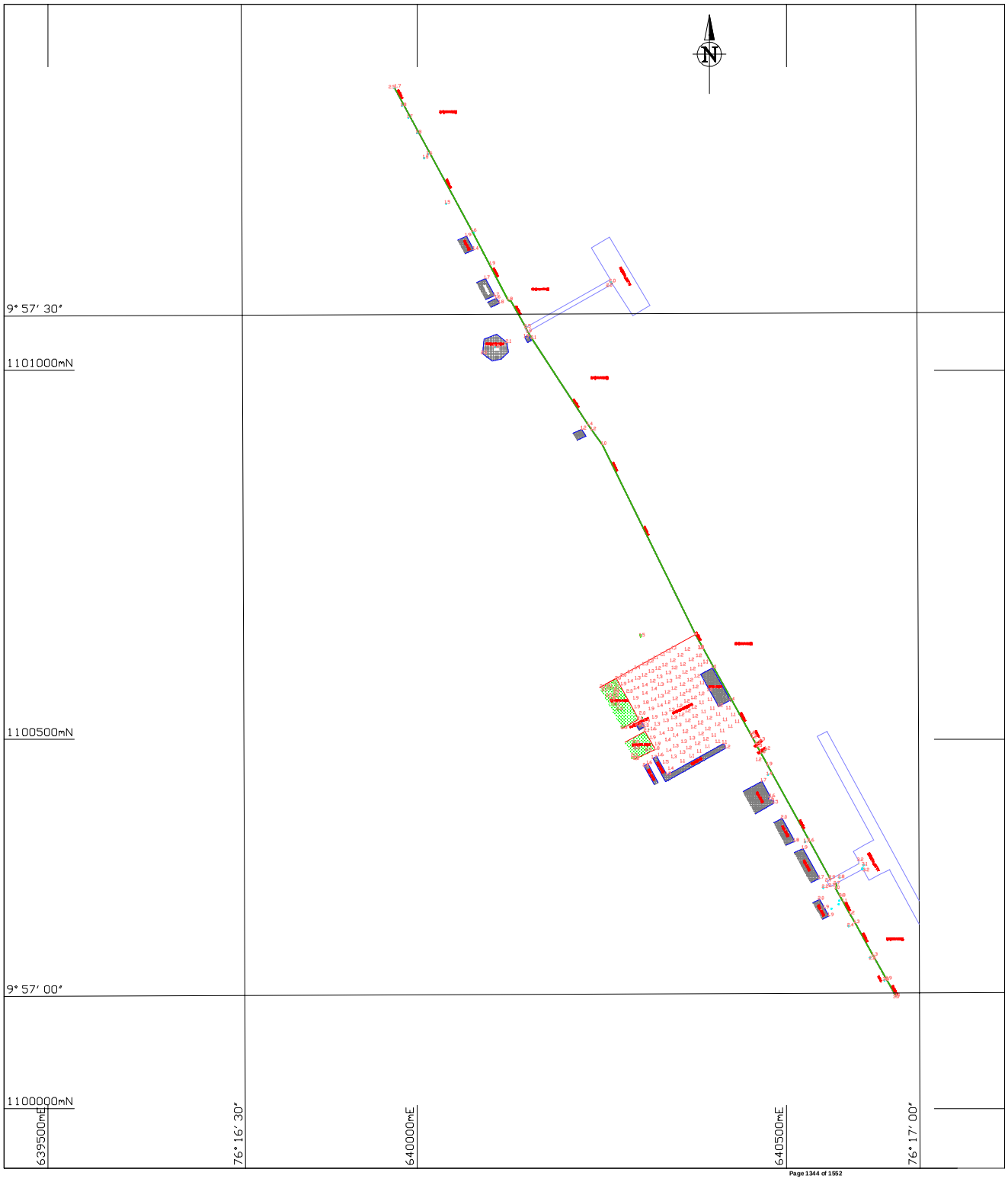
	For PCC	For RCC
Chlorides(PPM)	2000	1000
Sulphates(PPM)	500	500
Ph Value	6 to 9	6 to 9

SOIL INVESTIGATION FOR THE PROPOSED NORTH JETTY

CHEMICAL ANALYSIS ON SOIL

BH No.	Depth(m)	Test Results		
		Chlorides (PPM)	Sulphates (PPM)	PH Value
1	16.5	0.026	Nil	7.5
2	32.0	0.032	Nil	9.0
3	19.5	0.034	Nil	7.5
4	40.0	0.030	Nil	7.5
5	50.0	0.030	Nil	9.0
6	40.0	0.034	Nil	7.0
7	50.0	0.028	Nil	9.0
8	24.0	0.028	Nil	9.0

VOLUME – IV
SECTION – 12
TOPOGRAPHICAL SURVEY REPORT



LEGENDS:

GENERAL

- UTM GRID INTERSECTION
- GEOGRAPHICAL GRID
- SPOT LEVELS
- COCONUT TREE
- BANIYAN TREE
- OTHER TREES
- BUILDING
- BOUNDARY
- RUBBLE

GEODETIC PARAMETERS:

HORIZONTAL CO-ORDINATE SYSTEM : WGS 84

PROJECTION : Transverse Mercator (UTM)

NOTES :-

1. LEVELS ARE IN METRES & DECIMETRES.
2. SPOT LEVELS ARE REDUCED TO CHART DATUM WHICH IS 0.662M BELOW MSL.

CLIENT

INDIAN NAVY

CONSULTANT

WAPCOS LIMITED
(A GOVERNMENT OF INDIA UNDERTAKING)
76-C, Institutional Area, Sector - 18, Gurgaon - 122015, Haryana, INDIA

PROJECT

CONSULTANCY AND FEASIBILITY STUDY FOR
DEMOLITION & RE-CONSTRUCTION OF NORTH JETTY AT KOCHI

TITLE

TOPOGRAPHY SURVEY MAP

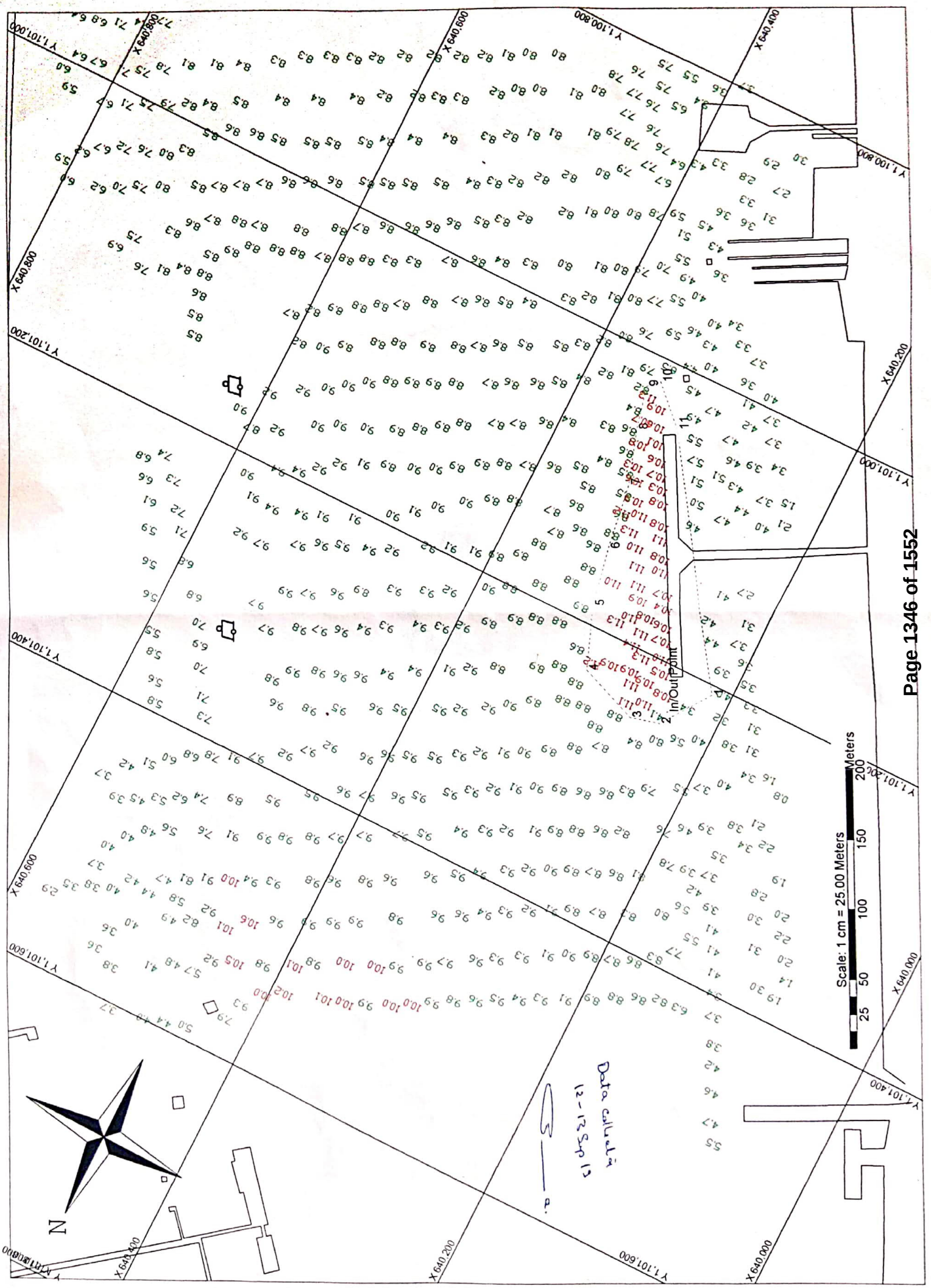
SCALE 1 : 5000

Vessel :		Survey Date: -12 June 2012				
Rev. No.	Date:	Description:	Surveyed :	Geo :	Drawn:	Appr:
0	28/07/12		AD	AD	MSP	

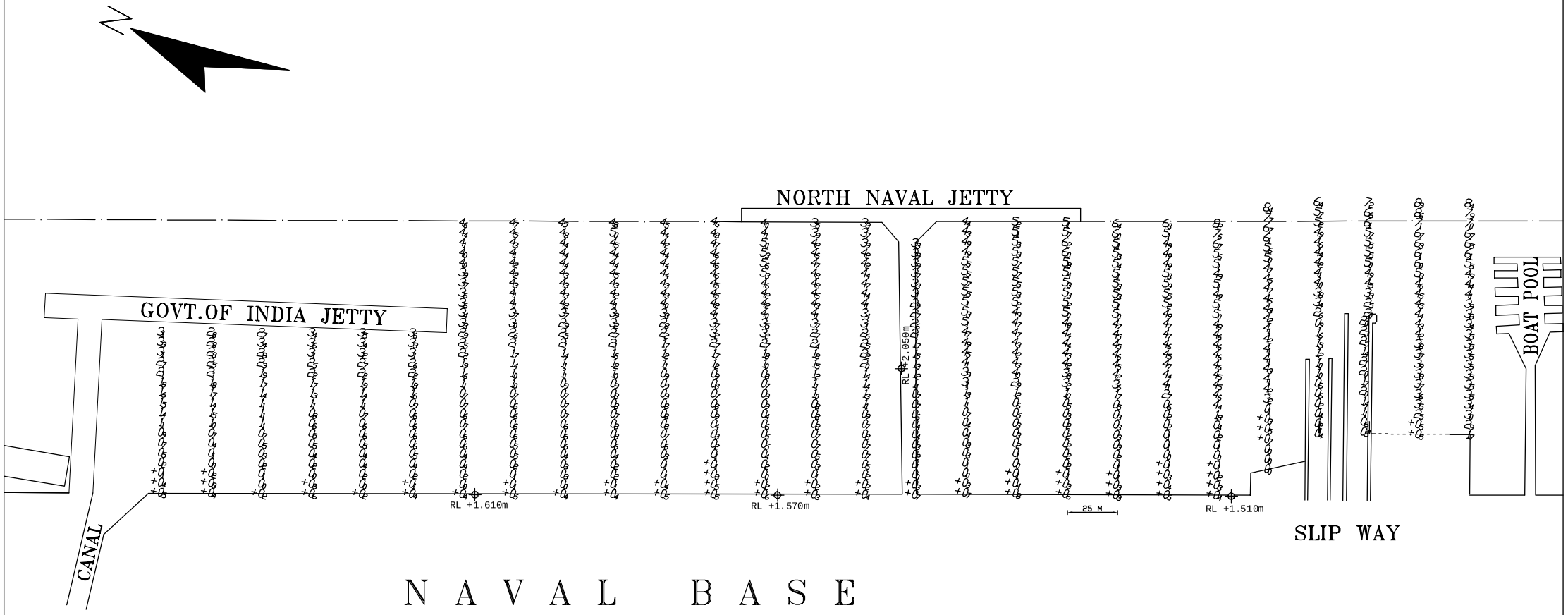
Drawing File Name: Fig. 8.2

Sheet: 01 OF 01

VOLUME – IV
SECTION – 13
OCEANOGRAPHIC SURVEYS



MAR/09/B/F/1



Scale: 1cm = 20.00 Meters

20 40 80 120 160 200

NOTE:-

(1) SOUNDINGS AT 5M INTERVAL & 25M INTERVAL CROSS SECTIONS

(2) SOUNDINGS ARE IN METRES AND DECIMETRES AND REDUCED TO COCHIN PORT CHART DATUM, WHICH IS 0.582 m BELOW IMSL

(3) SOUNDINGS ARE TAKEN WITH LEADLINE

COCHIN PORT TRUST

HYDROGRAPHIC SURVEY SUB-DIVISION

DETAILED SOUNDINGS BETWEEN NORTH NAVAL JETTY AND SHORELINE FROM GoI JETTY TO NAVAL SLIPWAY

SURVEYED ON 5,7,8 NOVEMBER 2019

DATE- 11/11/2019	DRG.NO HS/D/110/19	SCALE: 1:200(

HYDROGRAPHIC SURVEYOR (i/

VOLUME – IV
SECTION – 14
ENVIRONMENTAL CLEARANCE CONDITIONS

INDIAN NAVY

ENVIRONMENTAL IMPACT ASSESSMENT STUDY FOR DEMOLITION AND RECONSTRUCTION OF NORTH JETTY AT KOCHI NAVAL BASE

WAPCOS LIMITED

(A Government of India Undertaking)

76 C, Sector 18, Gurgaon - 122015, Haryana, INDIA

Tel. +91-124-2397396,

Fax. +91-124-2397392

Email: environment@wapcos.gov.in

November 2014

CONTENTS

CONTENTS

LIST OF FIGURES

CHAPTER-1

INTRODUCTION

CHAPTER-1

INTRODUCTION

1.1 GENERAL

The Southern Naval Command presently has two jetties at Kochi for berthing of ships of Indian Navy and Coast Guard. The operations of Kochi Naval Base includes the berthing and movement of India Naval ships including Aircraft carrier and submarine, Fueling, Troop embarkation, Ammunition, Operational Turn Round (OTR), surveillance and patrolling operations, exercises with foreign Navies etc.

The existing north jetty was constructed during the period from 1948 to 1950. This RCC jetty is 178m in length and 9m in width with 124.5m long approach from land. The deck slab is supported with RCC piles of 500 mm x 500m, 78 rows along the north east direction with 5 nos. piles in each row. The deck slab on approach jetty is supported with piles of 450 mm dia. 41 rows along east west direction with 4 nos. of piles in each row. The Index Map of the project site is enclosed as Figure 1.1.

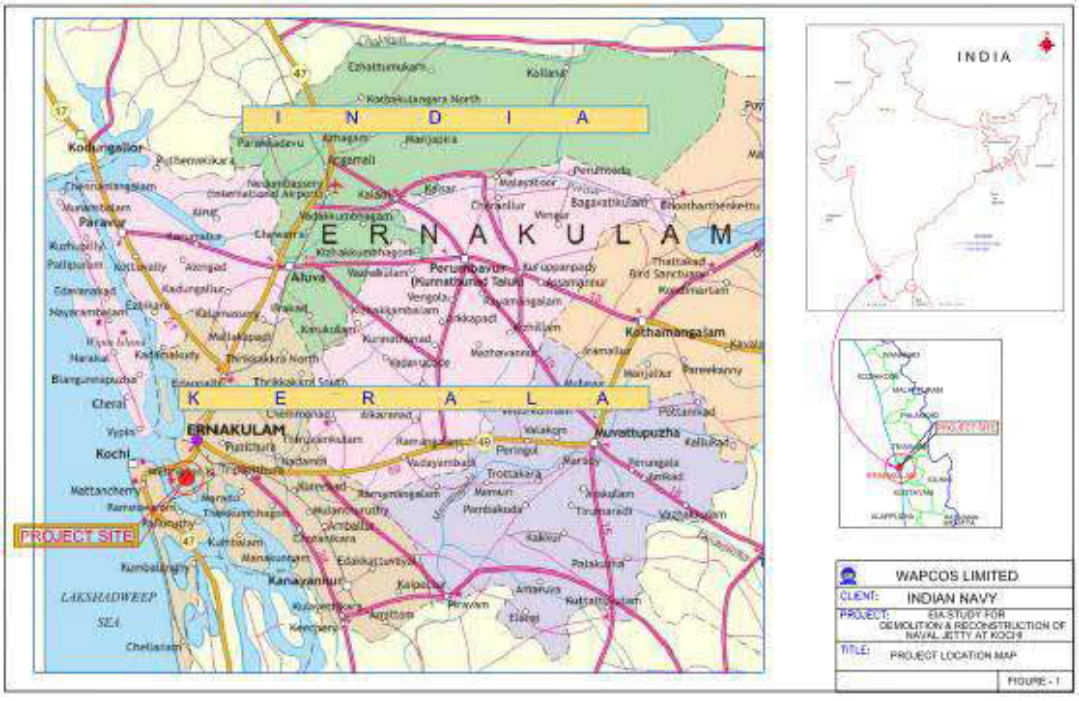


Figure 1.1 Index map

1.2 NEED FOR THE PROJECT

As mentioned earlier, North Jetty at Naval Base Kochi was constructed during the period from 1948-1950 and the strength bearing structures like bollards, pillars, columns, etc, have deteriorated with passage of time. The width of the jetty is mere 9.0m, which poses severe restrictions on movement of vehicles and cranes on the Jetty. The length of the present jetty is 178 m and is just adequate to berth two ships alongside. Also, the pier on which approach road to the jetty is built, does not allow movement of two vehicles simultaneously.

Apart from the physical condition North Jetty, in its present configuration is insufficient in size to cater for the increased requirement of berthing space for refit ships of Southern Naval Command. Considering the Maritime Capability Perspective Plan, the number of warships in the Southern Naval Command would Increase. Hence, to meet the future requirements, it is essential to have a dedicated jetty for operational reasons and repairs / overhaul of ships, with appropriate facilities required for this purpose. Therefore, Indian Navy examined the viability of extending the North jetty to the northern and southern sides with all associated facilities for berthing of ships of the command undergoing refit.

It was thus decided to demolish and reconstruct the 'North Jetty' as a modern jetty with State of the Art' shore and berthing facilities to meet the Navy's future basing requirements. The new North RCC jetty shall be 300 m in length and 18 m in width appropriate approach of length 72 m from land. The deck slab of main jetty shall be supported with RCC piles of 1200 mm dia.

Indian Navy has commissioned WAPCOS Limited for carrying out the Detailed Design Study and Environmental Impact Assessment (EIA) Study for Demolition and Reconstruction of North Jetty.

1.3 OBJECTIVES OF THE EIA STUDY

The objectives of Environmental Impact Assessment study for demolition and reconstruction of North Jetty Kochi Naval Base are to assess the likely impacts on the existing quality of land, marine water, noise, air quality, marine environment as well as terrestrial ecology and socio-economic environment.

The key components of the EIA study are:

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

1.4 POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORK

The principal Environmental Regulatory Agency in India is the Ministry of Environment and Forests (MOEF), Government of India. MOEF formulates environmental policies and accords environmental clearance for the projects. The State Pollution Control Board (SPCB) accords No Objection Certificate (NOC) Consent for Establishment and consent for Operation for the projects. As per the list of projects or activities requiring prior environmental clearance given in the EIA Notification issued by MoEF on 14th September 2006, proposed project

is listed on S.No. 7e and requires Environmental Clearance from MoEF. Since, the project is proposed in the coastal area, CRZ Clearance would also be required as per the CRZ Notification of January 2011.

As per the guidelines, pertaining to Environmental Clearance issued by Ministry of Environment and Forests (MoEF) dated September 14, 2006, the Terms of Reference (TOR) for the EIA study is to be approved by MoEF. In this connection, Form-I along with TOR in the prescribed format was submitted to MoEF. The same was reviewed by the Environmental Appraisal Committee (EAC) for Defence Projects of MoEF on 11.02.2014. The TOR was approved by MoEF, vide letter no. F.No.J-13015/43/2013-JA-1 dated 30/5/2014. A copy of the TOR approved by MoEF is enclosed as Annexure-I.

1.5 STUDY AREA

As per the Ministry of Environment & Forests (MOEF) guidelines, the Study Area for the EIA study has been considered as the 10 km radius keeping the proposed project site at the centre. The study area map is enclosed as Figure-1.2.

1.6 METHODOLOGY ADOPTED FOR THE EIA STUDY

The purpose of this section is to enumerate the steps carried out in an Environmental Impact Assessment (EIA) study. The same are briefly described in the following paragraphs.

a) Environmental Baseline Status

Before the start of the project, it is essential to ascertain the baseline levels of appropriate environmental parameters which could be significantly affected by the implementation of the project. The planning of baseline survey emanated from shortlisting of impacts prepared during identification. The baseline study involved both field work and

review of existing documents, which is necessary for identification of data which may already have been collected for other purposes.

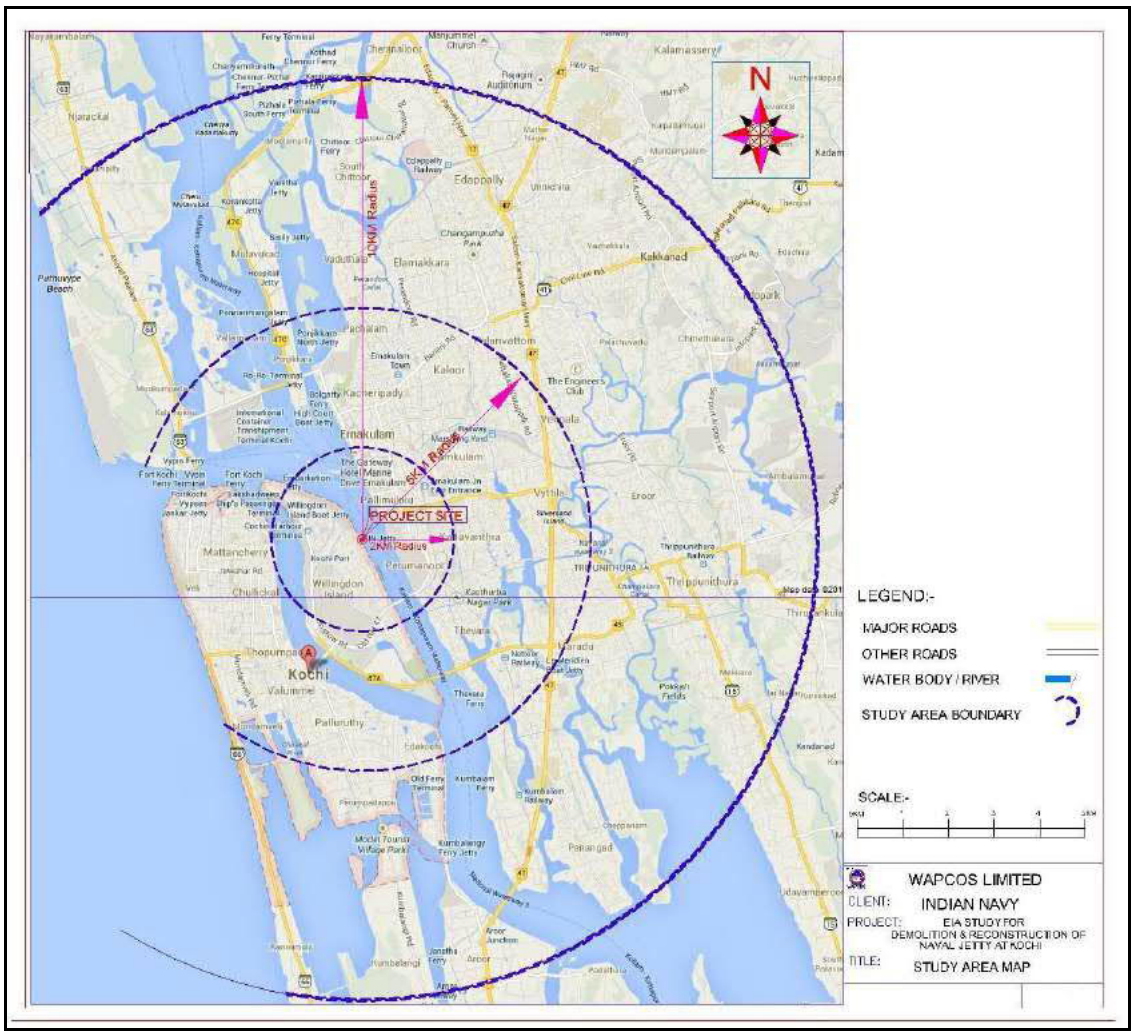


Figure-1.2. Study area map

The baseline data on various environmental parameters, e.g., landuse pattern, water quality, noise, meteorology, air quality, demography and socio-economics, terrestrial ecology and marine ecology was collected through field studies, literature review and collection of secondary data as available with various departments. The methodology adopted for various aspects of data collection is briefly described in the following paragraphs.

Marine Ecology

The marine ecological survey was conducted in the month of March 2014. Both surface as well bottom water samples were collected using mechanized vessels. Each location was fixed on benchmark and after reaching the site, the vessel was anchored. Parameters like temperature, salinity and dissolved oxygen were estimated by an YSI temperature, salinity oxygen meter respectively at the site itself.

Plankton samples were collected by filtering a known volume of water by a plankton net of <60 μ mesh size bolting silk. Surface water was collected using a clean bucket without causing any disturbances. Likewise, bottom water samples were collected by Nansen bottle. Sediment samples were collected by a grab sampler operating from the vessel.

The data on various aspects like major aquatic floral and faunal species, rare and endangered species, fisheries, mangroves, etc. was also collected as a part of primary data collection. Apart from this, secondary data/information as available from the reported literature too have been appropriately utilized in the EIA report.

Ambient Air quality

Ambient air quality monitoring was conducted for a period from 30.12.2013 to 20.03.2014 at four locations in and around the project area. The frequency of monitoring was twice a week for 12 consecutive weeks at each station. The parameters monitored were PM_{10}, $PM_{2.5}$, SO_2 and NO_2.

Noise Environment

Noise levels in the study area were recorded with A- weighted noise level meter at various sampling locations in and around the project area. The readings were taken during day and night time and equivalent noise levels were estimated and used in the EIA report.

Socio-economic Aspects

The data on demographic profile of the study has been collected from secondary sources, mainly Census 2011 data.

Land use Pattern

The land use pattern of the study area has been studied using digital satellite data, procured from National Remote Sensing Agency (NRSA), Hyderabad. Resourcesat-2, LISS III satellite data was used to study the land use. Detailed ground truth studies were conducted for formulation of signature data set. A supervised classification was then conducted using the GIS & IMAGINE processing software packages.

b) Assessment of Impacts

With knowledge of the baseline conditions, project characteristics, the intensity of construction and operation activities and current critical conditions, detailed projections were made for the influence of the proposed project on physico-chemical, biological and social environment in the area. The impacts on environment due to construction and operation activities of the proposed project were identified and assessed. The various aspects of the environment covered as a part of the Impact Assessment were:

- Land Environment
- Air Environment
- Noise Environment
- Terrestrial Environment
- Socio-Economic Aspects.

An attempt was made to predict future environmental scenario quantitatively to the extent possible. However, for non-tangible impacts, qualitative assessment has been done, so that decision makers are aware of their existence as well as their possible implications.

c) Environmental Management Plan

The Environmental Management Plan (EMP) was delineated to ensure that the adverse impacts likely to accrue are altogether removed or minimized to the extent possible. After selection of suitable and feasible environmental mitigation measures, cost required for implementation of various environmental management measures has been estimated.

d) Environmental Monitoring Programme

An environmental monitoring programme has been suggested to oversee the environmental safeguards, to ascertain the agreement between prediction and reality and to suggest the remedial measures not foreseen during the planning stage but during the operation phase and to generate data for further use. The equipment, manpower and cost required for the implementation of Environmental Monitoring Programme have also been suggested as a part of the study.

1.7 OUTLINE OF THE REPORT

The contents of the EIA report are arranged as follows:

Chapter 1: The chapter gives an overview of the need for the project, objectives and need for EIA study etc. The methodology adopted for conducting the EIA study for the proposed demolition and reconstruction of North Jetty at Kochi Naval Base is also described in this chapter.

Chapter 2: A brief write-up on various project appurtenances, infrastructure available at the port, etc. has been covered in this chapter.

Chapter 3: Baseline environmental conditions including physical, biological and socio-economic parameters, resource base and infrastructure have been described in this Chapter. Before the start of the project, it is essential to ascertain the baseline conditions of

appropriate environmental parameters which could be significantly affected by the implementation of the project. The planning of baseline survey emanated from shortlisting of impacts prepared during identification. The baseline study involved both field work and review of existing documents, which is necessary for identification of data which may already have been collected for other purposes.

Chapter 4: Anticipated positive and negative impacts as a result of the construction and operation of the proposed project were assessed in this Chapter. Prediction is essentially a process to forecast the future environmental conditions of the project area that might be expected to occur as a result of the construction and operation of the proposed project. An attempt has been made to predict future environmental conditions quantitatively to the extent possible. But for certain parameters, which cannot be quantified, general approach is to discuss such intangible impacts in qualitative terms so that planners and decision-makers are aware of their existence as well as their possible implications.

Chapter 5: Environmental Management Plan (EMP) for amelioration of anticipated adverse impacts likely to occur as a result of the proposed project. The approach for formulation of an Environmental Management Plan (EMP) is to maximize the positive environmental impacts and minimize the negative ones. After selection of suitable environmental mitigation measures, cost required for implementation of various management measures has also been estimated.

Chapter 6: Outlines the Disaster Management Plan to be implemented in the event of an emergency.

Chapter 7: Environmental Monitoring Programme for implementation during project construction and operation phases has been delineated in this Chapter. The objective is to assess the adequacy of various environmental safeguards and to compare the predicted and actual scenario during construction and operation phases to suggest remedial

measures not foreseen during the planning stage, but arising during these phases and to generate data for further use. The cost required for implementation of Environmental Monitoring Programme has also been summarized in this chapter.

Chapter 8: Summarizes the cost required for implementation of various measures outlined in the Environmental Management Plan and Environmental Monitoring Programme.

CHAPTER-2

PROJECT DESCRIPTION

CHAPTER-2

PROJECT DESCRIPTION

2.1 GENERAL

The proposed project envisages the demolition and reconstruction of "North Jetty" as a modem jetty with State of the Art' shore and berthing facilities to meet the Navy's future basing requirements. The coordinates of North Jetty are 9^0 57' 32" N and $76^0$16' 47"E. The jetty is located along the east bank of Willingdon Island in the Ernakulam Channel about 1600 m downstream of Venduruthy Bridge on National Highway No. 47. As a result of concavity of the Ernakulam channel at the site, right bank always has better depths. The depths along the Willingdon Island side are relatively shallow. The proposed location of the jetty lies close to the slipway on the left bank of the Ernakulam Channel, on the opposite side of the Kochi Shipyard area.

2.2 EXISTING NORTH JETTY

The existing north jetty is a T type wharf. This RCC jetty is 178m in length and 9 m in width and has 125m long approach. The deck slab is supported with RCC square piles of 500mm x 500mm, 78 rows along the north-east direction with 5 nos. piles in each row. The deck slab on approach jetty is supported with piles of 450mm dia. 41 rows along east-west direction with 4 nos. piles in each row.The existing north jetty is 1948 vintage and the strength bearing structures like bollards, pillars, column etc. are deteriorated. The salient features of the existing jetty are given below:

Main Jetty

Length of Jetty	-	178.00m
Width of Jetty	-	9m
No. of piles rows	-	78 (5piles in each row)
Size of pile	-	500mm x 500mm
C/c distance between Piles along width	-	2.3 m along length and 2.0 m

Flare

Width of flare	-	7m
Length of flare	-	10.00m
No. of piles rows	-	4 each in 1st and 2nd row from bottom, 6 nos.in 3rdrow, 8 nos. in4th row and 10 nos. in 5throw
Size of pile	-	500mm Dia.
C/c distance bet. Piles along width	-	2.3m along length and 2.0m

Approach

Length of Approach	-	124.50m
Width of Approach	-	7m
Carriageway Width	-	4.86m
No. of piles rows	-	41 (4piles in each row)
Size of pile	-	450mm Dia.

Allied Facilities

Bollards	-	17 Nos. (Cast Iron)
Diameter of Bollard	-	0.60m
C/c Distance between Bollards	-	21.0m
Light Mast	-	5 nos. in Approach, 3 nos. in Jetty
Fender type	-	Rubber &Pneumatic fenders
Diameter of fenders	-	0.50m
C/c Distance between fenders	-	4.64m
No rail mounted crane on Jetty		
Hand rails from Approach to Jetty		

The general arrangement drawing of existing north jetty is given as **Figure-2.1**. As per BS 7543:1992 - Guide to Durability of buildings and building elements, products and components defines “normal life” as a minimum of 60 years. The same codal provisions has been followed in the present project as well.

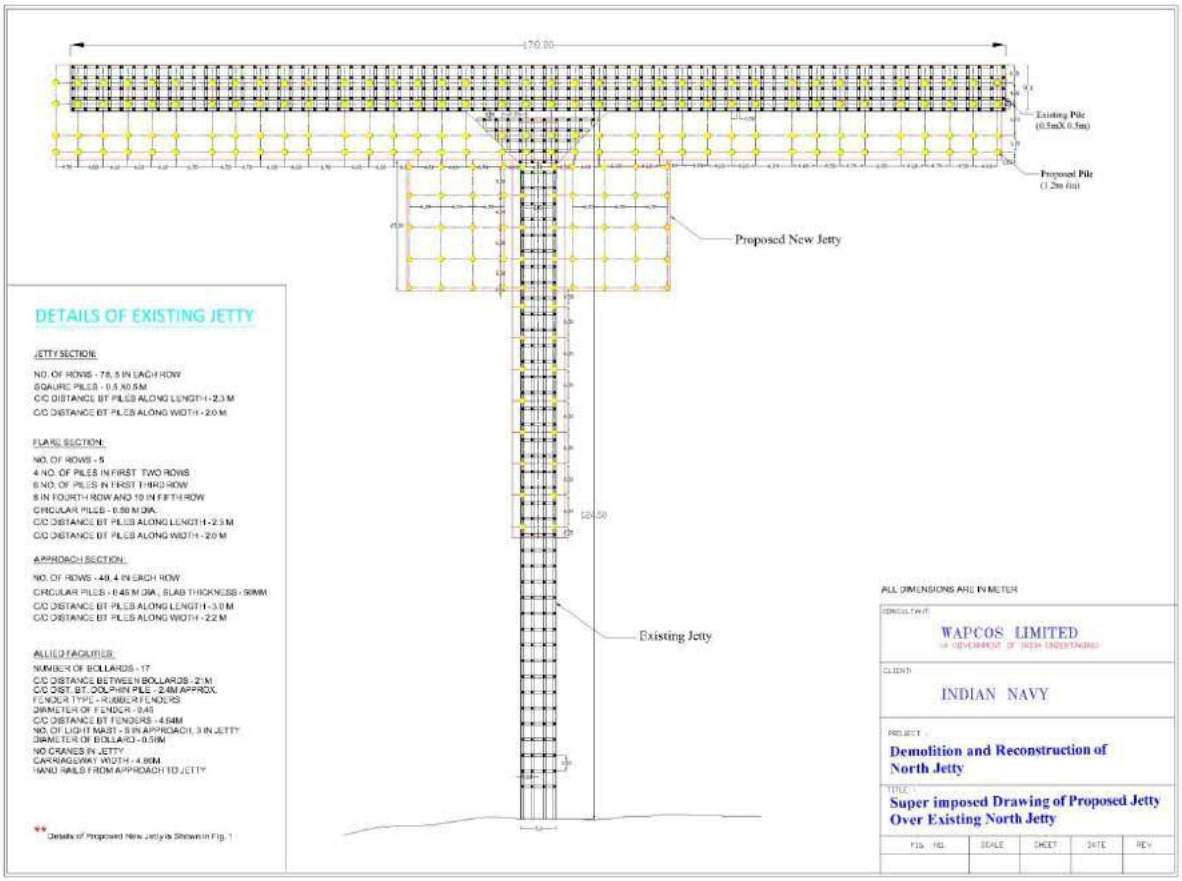


Figure- 2.1 Proposed jetty superimposed on existing North jetty

2.3 DEMOLITION

It is proposed to demolish the existing "North Jetty" before the reconstruction of new jetty at the same location. There are different methods of demolition. Different factors influence the choice of demolition method which are listed as below:

- Location of structure to be demolished
- Surrounding area
- Foundation or general conditions
- Amount of work space available
- Existence of local restrictions
- Existing Environmental requirement

When selecting the most suitable method of demolition, the knowledge of the site is applied and the interdependency of elements and the nature of the structure is taken into account. Each of the basic principles of structural demolition, i.e. progressive, deliberate collapse or deliberate removal is considered. These same principles shall be

applied whether there is full or partial demolition, or where structural alterations are to be carried out.

Methods of Demolition

There are multiple types of demolition procedures used to take down structures. The choice of demolition method depends on the project conditions, site constraints, and sensitivity of the neighbour hood and availability of equipment. Several methods of demolition can be used in combination or at different parts of the demolition site. In general, the choice of technique should enable the re-use and/or the recycling of materials arising from the demolition. Irrespective of which demolition method is adopted, its choice should be based on minimizing the risk to personnel. The various methods available for demolition are given below:

(i) Manual method using hand-held equipment
(ii) Mechanical method using machines (Hammers, Breakers)
(iii) Mechanical method using hydraulic attachment(Crushers)
(iv) Mechanical method using non-hydraulic attachment (Wrecking Ball)
(v) Blasting / Implosion
(vi) Sawing and drilling (Diamond Core Drilling & Diamond Wire Sawing)
(vii) Chemical agents (Explosives, Bursting agents, Combustible Gases)
(viii) High pressure water jetting

After analysis of different types of demolition methods keeping safety and pollution aspects in to consideration following special type of cutting system for demolition and disintegration of RCC structure using diamond cutting is found to be most suitable for the proposed project:-

- Diamond Wire Saw
- Diamond Wall Saw
- Diamond Floor Saw
- Hydraulic Breaker
- Electrical Breaker
- Core Cutting Equipment

Methodology for Demolition

The following methodology for demolition of existing North jetty has been suggested:-

(a) Two (Nos) huts, MS Pipes, cables, fenders, wooden scandals and all other service line shall be dismantled/removed manually and the debris taken out.

(b) 100 mm thick pre-cast slab, ducts etc. shall be sliced using Diamond Floor Saw, in convenient size to lift by Hydra Crane. Marking shall be carried out on RCC deck slab in between beams, however, keeping in mind the maximum weight up to 5.00 ton limit in order to lift by Hydra Crane. 100-120 mm dia holes shall be carried out on slab using Core Cutting Equipment. Marked slab shall be sliced using Diamond Wall Saw keeping hydra crane hanging.

(c) Sliced duct slab shall be placed on low bed tractor and transported to yard for breaking. Holes for hooking shall be marked on beam as well, in appropriate size, using Core Drilling Equipment as stated above. Marked beam shall be sliced suing Diamond Wire Saw Equipment and lifted by Telescopic Crane with 30 Ton capacity and RCC blocks shall be loaded on Tipper Truck and transported to the yard for braking.

(d) All piles in First row of existing North jetty is proposed to be cut at dredging Level ie -10m and 2nd and 3rd row at +0.9 level and 4th and 5th row at +1.0 level where construction of proposed new jetty will not be hindered by existing piles. All other piles in flare and approach Trestle is proposed to be cut at +1.1 level. Thus, sliced piles also shall be lifted using Hydra Crane with minimum 5 ton capacity loaded on low Bed Tractor and transported. Stacked RCC blocks shall be broken using Hydraulic Breaker and the re-bars shall be disintegrated.

(e) Rebars after disintegration shall be stacked for account of credit and debris shall be disposed as per the requirement of the Department/users (Specific Location is to be identified.

The speed of demolition attained in this method varies from 0.4 m^2 to 1.2 m^2 cross section area of the structure for per hour of operation. This is the most economical method of demolition.

2.4 PROPOSED FACILITIES

The proposed project envisages the construction of waterfront and navigation facilities including the construction of 18 m wide and 300 m long jetty, 40 m long and 10 m wide approach trestle, carriage way. Project also includes the construction of G+2 administrative building of 15x15m dimension near the proposed jetty. Details of the facilities envisaged as a part of the proposed project are given in Table. 2.1. The line diagram of the proposed facilities is given in Figure 2.2

Table- 2.1 Details of proposed facilities

A	**Shore Establishment**	**Dimensions**
(i)	Main Jetty	300m length x 18m width
(ii)	Flair	50m length x 25m width
(iii)	FIC Bays (2 Nos)	40m length x 4m width
(iv)	Approach Trestle	47+25*m length x 10m width
B	**Reclaimed land**	2 ha (i.e. 400m x 50 m)
C	**G +2 Building**	15m x 15m
	Ground Floor	
(i)	Pump House	14.8m x 9.7m
(ii)	Office room-	4.8m x 4.8m
(iii)	Toilet (2 Nos)	1.8m x 2m
	First Floor	
(i)	Store room	14.8m x 9.7m
(ii)	Office room	4.8m x4.8m
(iii)	Toilet (2 Nos)	1.8m x 2m
	2nd Floor	
(i)	Office com Accommodation	14.8m x 9.7m
(ii)	Reception and Waiting room	4.8m x 4.8m
(iii)	Pantry	1.97m x 2.1m
(iv)	Toilet (2 Nos)	1.8m x 2m
D	DG set room	15m x 15m
E	Sentry Post (2 Nos)	5m x 2m
F	Fire Fighting System	10m x 15m

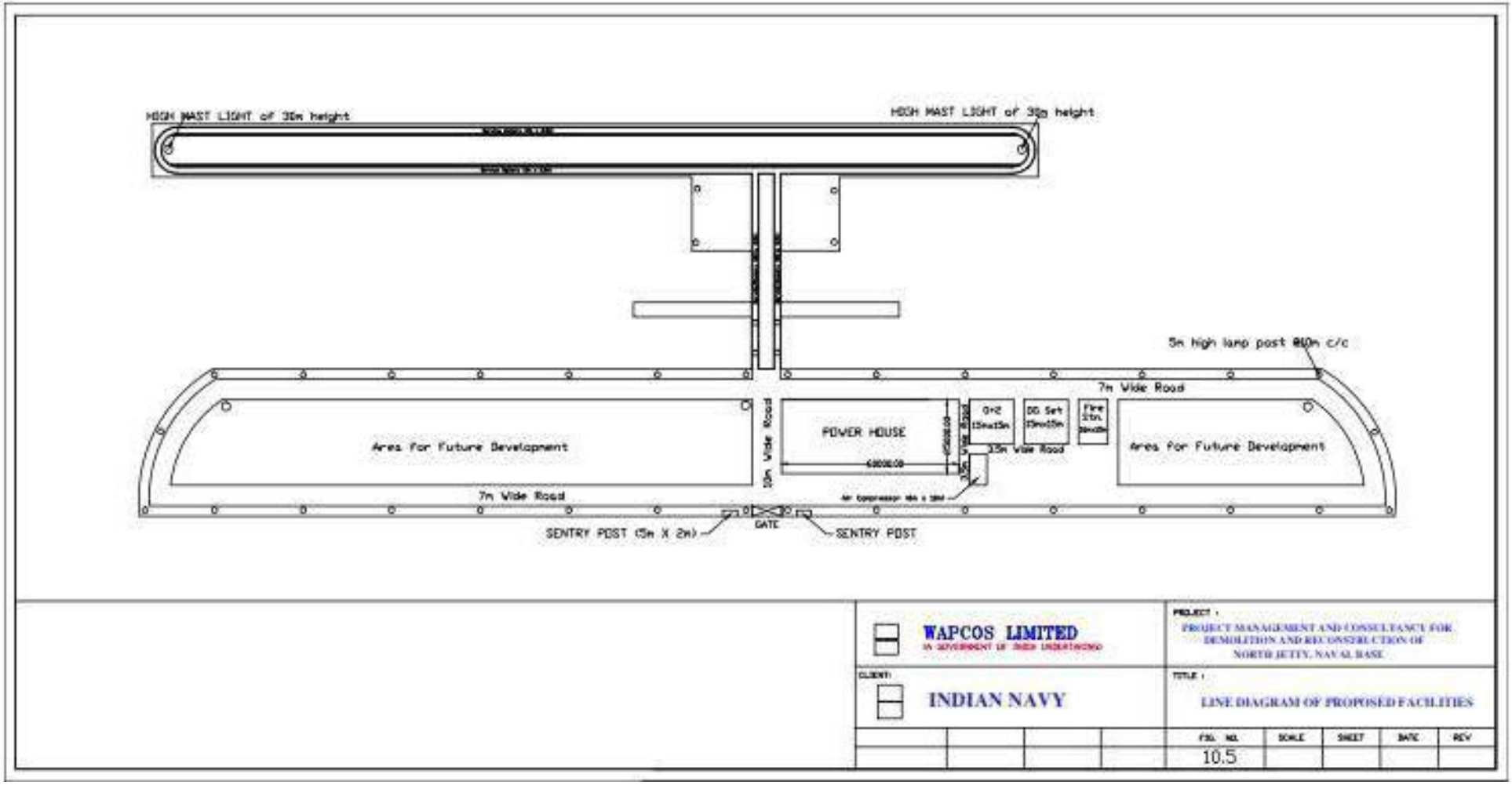


Figure 2.2 - Line diagram of the proposed facility

2.4.1 Water front and navigation facilities

The planning of water front and navigation facilities is based on various national and international standards, codes of practice and PIANC regulations applicable for the planning of berthing and operational areas of the ships. The planning of water front and navigation facilities should be carried out to accommodate all ships, for which, the first requirement is to determine the dimensions of the Design Vessel Size.

2.4.2 Design Vessel Size

The design vessel size may be defined as the composite of the largest dimensions of the ships planned to use the jetty. Since, there is a proportional relation between length, beam (breadth of ship), draft and dead-weight of ships, the largest DWT ship expected usually serves as the Design Ship and its dimensions are accepted for designing berths, channels, turning circles etc. Design vessel size and its dimensions taken for planning of berthing and operational are shown in Table 2.2.

Table 2.2: Vessel sizes expected at the jetty

Name of Vessel	Standard Load (Ton)	Full Load (Ton)	Length Overall (m)	Beam (m)	Draft (m)
Vikrant (IAC)	34000	41000	262.5	62.45 (Flared) 32.40 (at WL)	8.8
INS Viraat Aircraft Carrier	23900	28700	226.9	52.0 (Flared) 27.4 (at WL)	8.8
Delhi Class Destroyer	6700	6900	163.0	17.4	6.5
R-Class Destroyer	3950	4974	147.0	15.8	5.0
Training Vessel (TIR)	-	3200	105.9	13.2	4.8
Offshore Petrol Vessel	-	1890	101.1	11.5	3.0
Survey Ship	1929	1960	87.8	12.8	3.3
Fuel Base	-	1000	53.0	9.1	4.6
Fast Interceptor Craft (FIC)	-	90	16.3	3.8	0.8

In the instant case the critical existing vessel in terms of length and beam is of IAC Vikrant having length of 262.5m, beam of 32.40 m and draft of 8.8m. Therefore, IAC Vikrant is the Design vessel. Accordingly, water area planning and all design calculations have been based on IAC Vikrant.

2.4.3 Berth Planning

The salient features of the proposed berth would be as follows:

a. **Length of Berth:** As per BIS: 4651 (Part V) – 1980, the length of the berth should be 10% more than the overall length of the largest vessel expected, subject to a minimum of 15 m. The length of vessels the expected at the berth is 262.5m. Hence, 300m long berth has been proposed at the same location.
b. **Width of Berth:** Width of the berth is based on the functional requirement ofrail-mounted cranes and adequate maneuvering space for other equipment. Berth width of 18m has been proposed as per Unified Facilities Criteria (UFC) Code UFC 4-152-01. No separate fire lane has been proposed. Fire tenders are proposed to be moved between crane tracks.
c. **Depth at Berth**: BIS: 4651 (Part V) – 1980 recommends that the water depth should be 10% more than the loaded draft of design vessel in the sheltered parts viz. berths and hauling out spaces. The depth requirement in the area atsea side of berth is 10.0m and leeside of the berth is 6.0m.

d. **Deck Elevation**: BIS: 4651 (Part V) – 1980 recommends that the deck elevation is recommended to be at or above highest high water springs plus half height of an incident wave at the berth location plus a clearance of 1 m. The HHWS at Cochin (Near to the project site) is +1.20 m above CD. Utility corridor of 1.8m height has been proposed below deck level. Considering the above aspects, it is recommended to keep the deck elevation at +4.85 m above CD for Proposed North Jetty.

2.4.4 Approach Trestle Planning

Approach is required to provide access from shore to wharf located offshore. The approach is oriented at right angle to the shoreline. Approach consists of open-type trestle structures that minimize impediments to water flow and disturbances to the characteristics and ecology of the shoreline. Two-way 7.3 m wide curb-to-curb roadway is proposed to be provided. Walkway is proposed to be attached to the vehicle traffic lane with a provision of a minimum width of 0.8 m clear, from curb to safety railing. Accordingly, the width of the approach trestle is proposed to be 10 m. The approach length from jetty upto reclaimed land works out to 72 m.

2.4.5 Design of Ship's Operational Areas

This involves designing the layout, width and depth of approach channels along with the size of maneuvering areas for the ships. Dimensioning or designing of approach channel is of critical importance for safety and efficiency of ship operations in the port. The design parameters are depth, breadth (or diameter), length, location and alignment.

2.4.6 Channel Alignment

The Ernakulam Channel is already existing which shall be used as approach to the proposed new jetty. This channel is suitable for providing comfortable entry/exit to the proposed new jetty for the Navy Vessels.

2.4.7 Width of Channel

The required width of any channel, measured at bed level, is expressed in terms of the beam of the Design Vessel. In accordance with BIS: 4651 (Part V) – 1980, the channel width should be 3.3 to 5.0 times the beam of the Design Vessel for one-way traffic. For two-way traffic, BIS recommends the channel width to be 6.1 to 8.0 times the

beam of the Design Vessel. Thus, the design (maximum) channel width is computed to be 160 m for one-way navigation and 260 m for two-way navigation of 32.4 m wide design vessel size and as per the recommendations of BIS.

2.4.8 Depth of Channel

As per BIS Code IS: 4651 (Part V) – 1980, the channel depth should be 10% more than the draft of the design vessel in the channel, 15% at the turning circle and 20% in the unsheltered areas. Design depths in various water areas for design ship sizes to be handled at the berths using BIS recommendations are given in Table-2.3

Table-2.3: Under-Keel-Clearances and Water Depth Required

Water Area	(% of Draft)	Outer side of berth for IAC Vikrant		Inner side of berth Small Vessels	
		UKC (m)	Water Depth (m)	UKC (m)	Water Depth (m)
Approach Channel	20	1.76	10.56≅10.50	1.00	6.00
Turning Circle	15	1.32	10.12≅ 10.00	0.75	5.75
Berth and hauling-out space	10	0.88	9.68≅ 10.00	0.50	5.50

Hence, optimum dredged level works out to -10.0 m at outer side of berth which will facilitate the navigation of 41000 t vessel allowed to run at 10knots speed and -6.0m at inner side of berth which will facilitate the navigation of up to R-Class destroyer vessels.

2.4.9 Diameter of Turning Circle

As per BIS Code IS: 4651 (Part V) – 1980, the minimum diameter of turning circle should be 1.70 to 2.0 times the length of the largest vessel to be turned. The factor of 1.70 is for protected basins, and factor of 2.0 is for exposed locations. Hence, diameter of turning circle is recommended as 450m.

2.4.10 Jetty Layout

A jetty of 300m length and 18m width has been proposed and the jetty layout is shown in **Figure-2.3.**The project layout contemplates 1500 m long and 160 m wide approach channel. The proposed jetty location is deep inside the Ernakulam Channel thus well protected from waves. At the end of approach channel, a turning circle of diameter 450m has been provided. Also, a 72m long and 10m wide approach trestle has been provided. The existing trestle bridge shall be reconstructed after demolition. About 36 nos. cope boxes are proposed to be provided at suitable interval.

2.4.11 Port Connectivity

The proposed project is located at the North jetty at Kochi Naval base, which is well connected by road. Approach Trestle is required to provide access from shore to wharf which is located offshore. The approach Trestle is oriented at right angle to the shoreline. Approach consists of open-type trestle structures that minimize impediments to water flow and disturbances to the characteristics and ecology of the shoreline.

A 10m wide road on reclaimed land is proposed for connecting existing road network inside the Naval Base and Proposed North Jetty; 7 m wide road is proposed to be connected to 10 m road, which chains along the margin of reclaimed area and 3.5 m wide road also planned for internal connectivity between proposed facilities. Due to the underlying clayey strata, the roads would have water bound macadam topping in order to allow settlement in the base clayey strata. The black topping would be provided when the desired initial settlement is achieved. The layout of the proposed road is already shown in Fig.2.2.

2.4.12 Area Drainage

The project site is not having backup land for shore side facilities. The land for the project purpose is to be made available through reclamation of sea bed and there would be no acquisition of land at project site. The area proposed for reclamation would be 2 ha. Storm Water Drainage will be through a system of underground covered drains provided to discharge the collected runoff into the already existing natural waterways so that storm water gets drained from all areas of new jetty operations quickly. 1m x 1m drains are proposed to be provided. Typical drawing of 1m x 1m Underground covered Drain is shown in Fig.2.2.

2.4.13 Details of construction material

The construction of the proposed jetty will require about 29860 cu.m of concrete and 5016 Mt of steel. Apart from the construction material about 104000m^3 of sand would be required for reclamation of an area of 2 ha, which is proposed to be developed for associated facilities. The concrete shall be extracted from the stone to be sourced from existing quarries at Vallamattom Stone Quarry, district Ernakulam, Kerala which is about 40 km South East from project site and stone quarry at Perumpilavu, district Kunnamkulam, Kerala which is about 40 km north from project site.

2.5 DREDGING REQUIREMENTS

The navigation channel and the berth are proposed to be maintained at –10.0 m CD at outer side of berth and -6.0m CD at inner side of berth, so all dredging is planned for this level. The total quantity of dredging works out to about 9,96,954 m^3. The maintenance dredging as per the modelling studies has been estimated as 20,000 m^3. In the present scenario, it is proposed to use Cutter Suction Hydraulic dredger. This type of dredger has a powerful cutter for dislodging the soil particles in addition to the hydraulic suction and transportation arrangements. The main advantages of the cutter suction dredger are as under:

- The ability to dredge a very wide range of material by pumping with water directly to the disposal or reclamation area.
- The ability to operate in shallow water and to produce a uniform level bottom with high rates of production.
- The ability, in case of modern dredgers to dredge to a pre-defined profile e.g. in channels.

2.6 RECLAMATION

The project site is not having backup land for shore side facilities. The land for the project purpose is to be made available through reclamation of sea bed and there would be no acquisition of land at project site. Accordingly, it is proposed that dyke would be constructed to retain dredged material from basin, turning circle and entrance channel so that land could be created for the project. The area proposed for reclamation would be 2 ha. The length of dyke required to create land area for reclamation is 400m. The top level of the area has been kept as +3m. The quantity of sand required for reclamation would be about 104000m^3. The quantity of up to 500 kg stones for armour slope would be 10000t. The stones can be extracted from Vallamattom Stone Quarry, district Ernakulam, Kerala which is about 40 km South East from project site and stone quarry at Perumpilavu, district Kunnamkulam, Kerala which is about 40 km north from project site. Geo-textiles are proposed to be placed below stone armour to protect river bank from erosion due to currents or lapping.

The demolished material will consist of broken/crushed/sliced deteriorated concrete. The total demolished concrete quantity from existing jetty, approach and flare has been estimated as 1535 m^3. The demolished material can be crushed further and used as reclamation material. Though the dredged spoil mainly consist of clay but the soil can be stablised with suitable additives like lime, cement, etc.

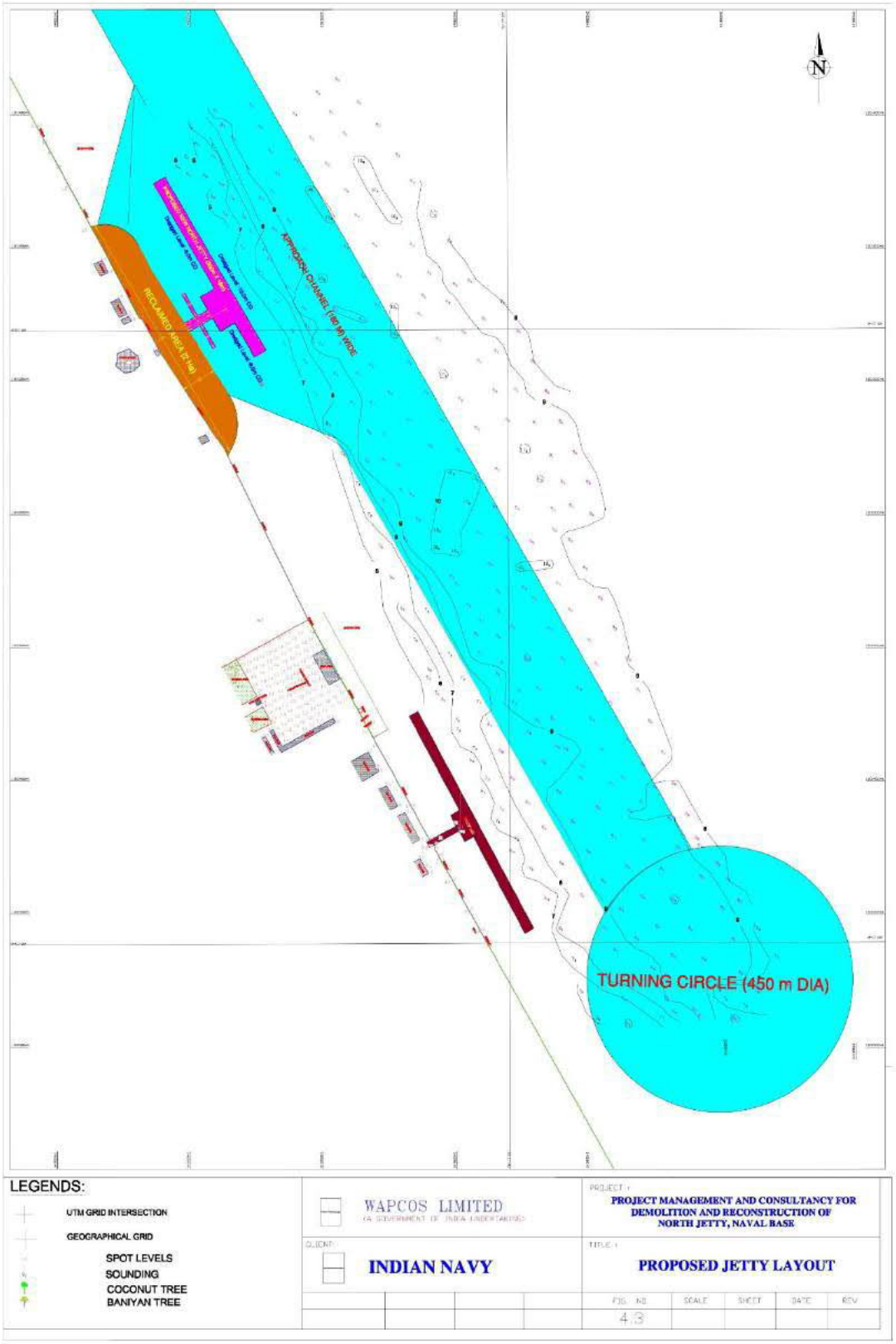


Figure-2.3 Proposed Jetty layout

The total quantity of dredged material has been estimated as 9,96,954 m^3. 10% of the dredged material quantity may be utilized, after stabilization, as reclamation. So, the required reclamation quantity of 1,04,000 m^3 can be met with from dredged material and demolished material. The area proposed for reclamation is shown in **Figure-2.4**.The utilizable dredged material shall be dumped at the existing dumping site of Cochin Port.

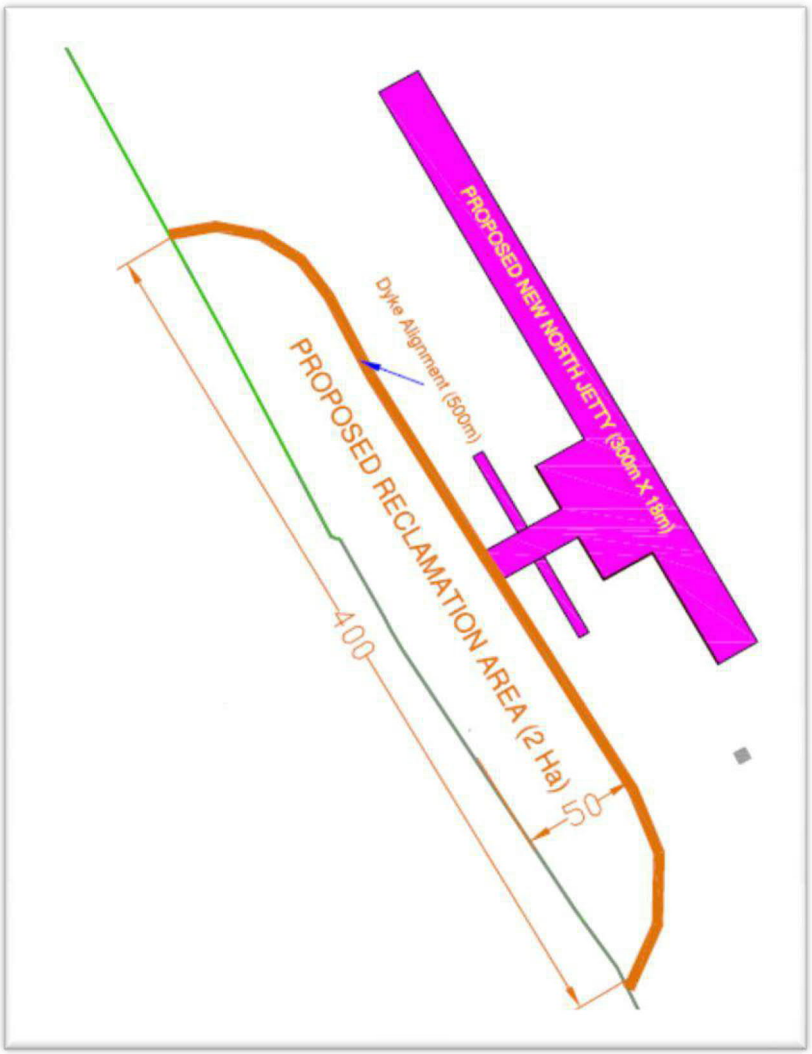


Figure- 2.4 Proposed Reclamation Area

Physical model studies were carried out in the existing Physical model of Cochin Port to evolve suitable configuration for the proposed reclamation. The model simulations for the configuration confirm that the better and streamlined flow conditions will prevail in the Ernakulam Channel as well as around the

proposed development. Some modifications may be required in incorporating the existing Slipway in the south into the proposed transition. The transitions provide additional area for developing berthing space in addition to improving the flow conditions.

2.7 HTL/LTL DEMARCATION

The proposed project envisages the demolition and reconstruction of North Jetty, with some associated facilities in 2 ha of the area to be reclaimed as a part of the project. All the project components with in Kochi Naval base area, which falls in CRZ-II as per the Coastal Regulation Zone (CRZ) notification of January 2011. Project specific HTL/LTL demarcation for the project site has been done by National Hydrographic Office, Dehradun, Uttarakhand. The project layout has been superimposed on HTL/LTL map. The HTL /LTL Report prepared by National Hydrographic Office, Dehradun, along with CRZ maps is enclosed as Annexure-II.

CHAPTER- 3

ENVIRONMENTAL BASELINE STATUS

CHAPTER- 3

ENVIRONMENTAL BASELINE STATUS

3.1 GENERAL

The assessment of baseline environmental setting is an essential component of any EIA study. Based on the "Scoping Matrix", various parameters to be covered for assessment of baseline environmental setting are identified. Assessment of environmental impacts due to demolition and reconstruction of North Jetty Kochi Naval Base requires a comprehensive and scientific consideration of various environmental aspects and their interaction with natural resources, namely, physico-chemical parameters i.e. meteorology, air quality, noise quality, land use and water quality, biological parameters i.e. terrestrial flora and fauna, marine flora and fauna, fish species, etc. and socio-economic parameters i.e. demography, occupational profile, etc.

As a part of the EIA study, a large quantum of related secondary data as available with departments like Forest, Fisheries, Revenue, etc. has been collected. Field surveys were conducted for primary data generation on various aspects including ambient air quality, water quality, noise, marine ecology, landuse pattern, etc.

The major portion of the study area is under water. In such settings, impacts likely to occur as a result of project construction and operation are expected to be occurring mainly on water front i.e. on marine environment. Thus, as a part of the EIA study, appropriate emphasis has been given to marine environment. As a part of the EIA study, the baseline status has been ascertained for the following aspects:

- Meteorology
- Geology
- Oceanographic conditions

- Bathymetry
- Land use pattern
- Ambient air quality
- Ambient noise level
- Marine water quality
- Terrestrial Flora, Fauna
- Marine Ecology
- Socio-economic Aspects

3.2 METEOROLOGY

Rainfall: The average annual rainfall is reported as 3228.3 mm, and most of which is received in the period from May to October under the influence of south-west monsoons. June and July are the wettest months of the year, accounting for more than 50% of the annual rainfall. On an average, there are 131.9 rainy days in a year. The average monthly rainfall and rainy days recorded at IMD station Cochin is summarized in Table 3.1. The rainfall as received in various months of the year is depicted in Figure-3.1.

Table- 3.1: Monthly Rainfall for the India Meteorological Department (IMD) Station at Kochi

Month	Rainfall (mm)	No. of Rainy days
January	21.9	1.0
February	22.9	1.4
March	35.3	2.3
April	124.0	7.5
May	395.7	12.9
June	720.7	23.4
July	897.2	24.2
August	367.8	19.43
September	289.4	15.3
October	302.3	14.4
November	175.1	8.1
December	48.3	2.0
Total	**3228.3**	**131.9**

Source: India Meteorological Department

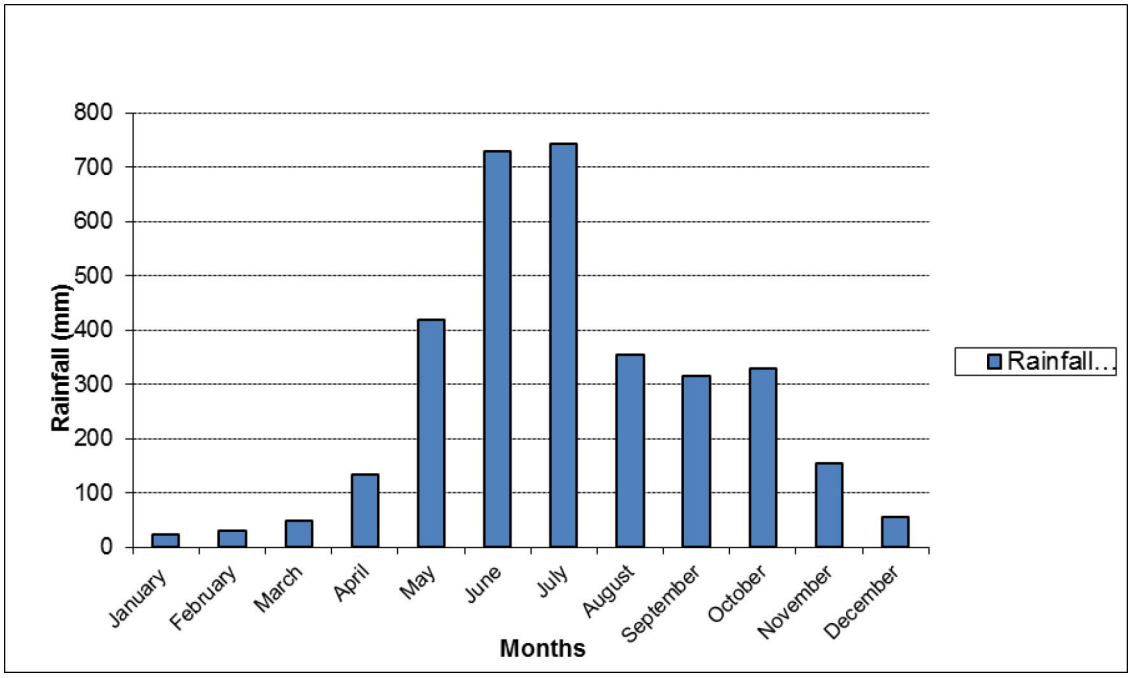


Figure-3.1 Month wise Rainfall Variation in Project Area

Temperature: The average monthly maximum and minimum temperatures recorded at IMD station Kochi is presented in Table 3.2. The mean monthly maximum temperature ranged from 30.5°C in August to 33.9°C in April and the mean monthly minimum temperature ranged from 19.3°C in January to 22.6°C in May. The month-wise temperature variations are depicted in Figure-3.2

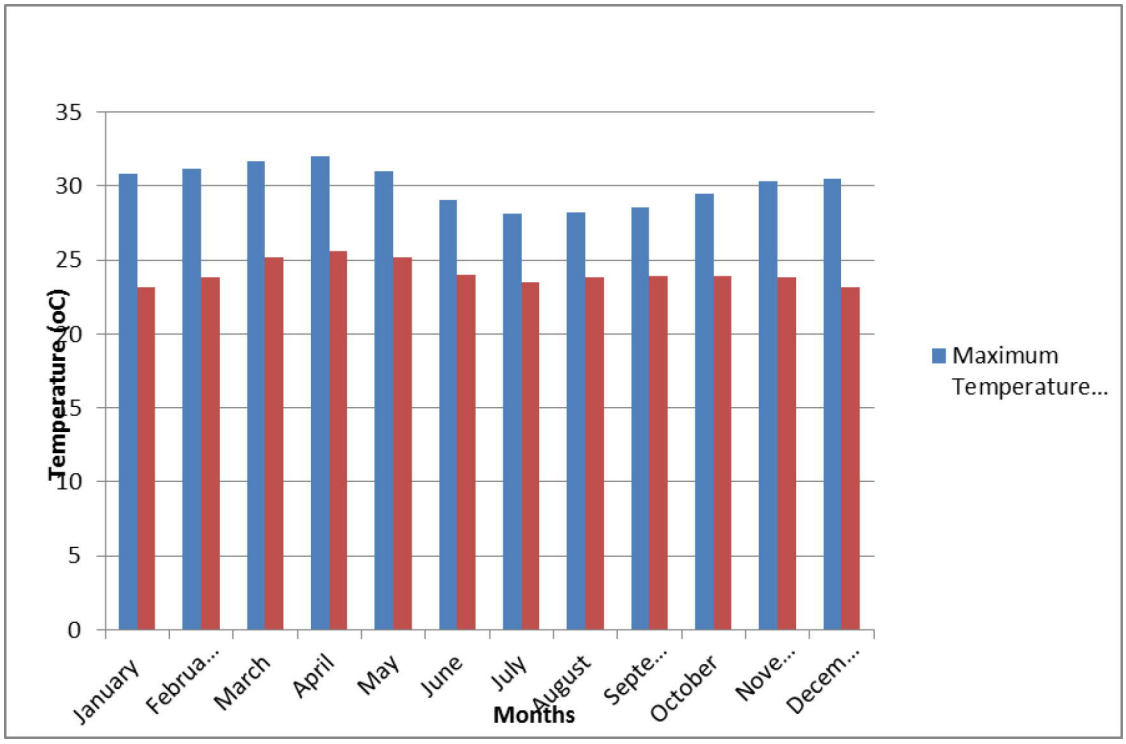


Figure-3.2: Month wise Temperature Variation in Project Area

Table-3.2: Average monthly maximum and minimum temperatures at IMD station Kochi

Month	Temperature (°C)	
	Maximum	Minimum
January	33.1	19.3
February	33.3	20.7
March	33.8	22.6
April	33.9	22.5
May	33.5	22.6
June	31.9	22.1
July	31.0	21.8
August	30.5	22.0
September	31.0	22.3
October	31.9	22.2
November	32.6	21.5
December	32.9	19.8
Mean	**34.4**	**18.9**

Source: India Meteorological Department

Humidity: The relative humidity is generally high throughout the year, with highest during south-west monsoon months. With the retreat of south-west monsoons, there is a marginal decrease in humidity. The lowest humidity is observed for the period from January to March. The average monthly relative humidity data recorded at Kochi IMD station is given in Table-3.3. The month wise humidity variations are given in Figure-3.3.

Table- 3.3: Monthly average relative humidity for the IMD Station at Kochi

Month	**Relative humidity (%)**	
	At 8.30 hrs	**At 17.30 hrs**
January	73	61
February	76	64
March	75	67
April	77	71
May	82	75
June	89	82
July	91	84
August	89	82
September	86	79
October	84	78
November	81	72
December	75	64
Average	**82**	**73**

Source: India Meteorological Department

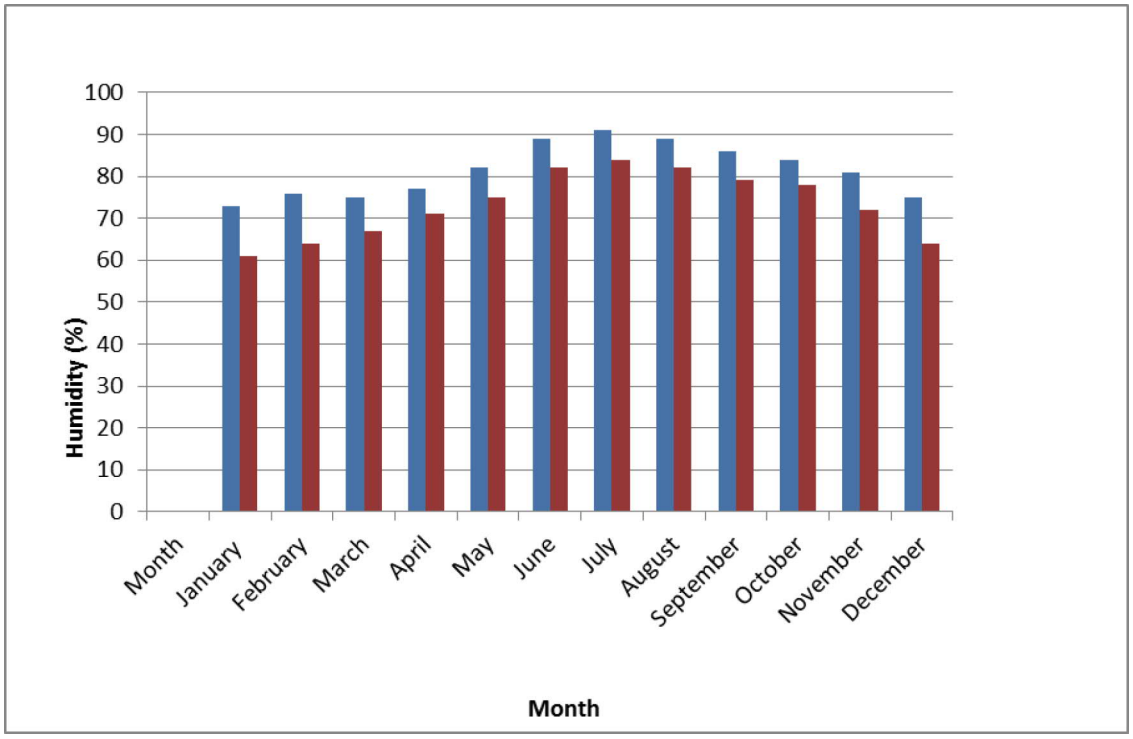


Figure-3.3: Monthwise Humidity Variation Project Area

3.3 GEOLOGY

The study area is a part of Kochi region. This forms a part of the peninsular India, which is considered seismically highly stable (Zone-III). The underlying geological formations of the area are mostly alluvium followed by granite gneiss of Archaean age. The major rock type within Archaeans is the biotite-granite-gneiss. The typical composition of this formation is essentially quartz and feldspar with variable amounts of biotite. The biotite granite is a gray or whitish rock, medium to coarse grained in texture. Dark gray, foliated gneiss occurs are also observed in the study zone. The gneiss strata is found to dip in various directions. Around Muvattupuzha and Thodupuzha, the dips are found to be between east and north-east, the most general direction being east-northeast.

Laterite is found, almost extensively forming low flat-topped ridges and hills, covering the Archaeans, between the Western Ghats and the Arabian Sea. The laterite is formed by the decomposition of In-situ rocks. The entire western part of the study zone is covered by the recent sediments. All along the coast, geological formations are of recent origin, which date back to early tertiary period. The sedimentary formations along the coastal plains are of recent and sub-recent formations. The coastal stretches that are overlain by recent and sub-recent alluvial deposits consist of sands, sandy clays, clays and carbonaceous clays. The alluvial formations of coastal plains extend as a narrow stretch of low lying land between the sea and the extensive back water system, running almost parallel to the coast. The width of the land regions varies from a few meters to few kilometers.

3.4 BATHYMETRY

The Bathymetry has been studied from National Hydrographic Office, India, Chart 2045 (Refer Figure-3.4). The width of Ernakulam Channel at the project site is 650 m. The seabed contours in the study area i.e. in the Ernakulam Channel vary from 0m to 4 m. In general, all the depth contours trend parallel to the shore. The Ernakulam channel in front of the study area is dredged to 8.0 m depth. The seabed slopes gently in the offshore region and is about 1 in 500-600. The coast experiences littoral drift, as anywhere else but there is a phenomenon of formation of the mud banks. The mud banks are not stationary and have a tendency to move in the coastal region.

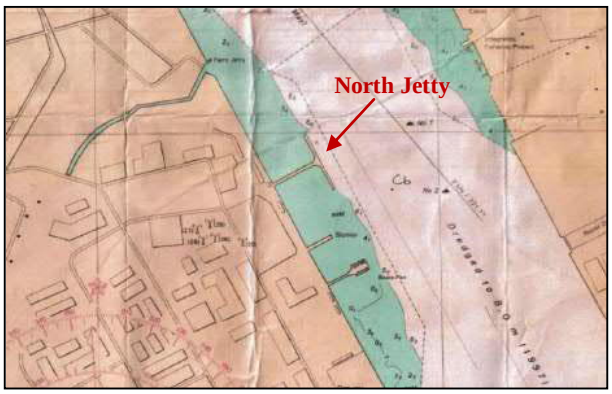


Figure-3.4 Extract of Naval Hydrographic Chart 2045

3.5 OCEANOGRAPHIC CONDITIONS

3.5.1 Tide data

Cochin experiences semi diurnal tides. The tidal levels as per Naval Hydrographic Chart No.2004 are as follows:

Highest Astronomical Tide (HAT)	+1.30m
Highest High Water Level (HHWL)	+1.20m
Mean High Water Spring (MHWS)	+0.92m
Mean Low Water Spring (MLWS)	+0.80m
Mean Sea Level (MSL)	+0.582m
Mean High Water Neap (MHWN)	+0.60m
Mean Low Water Neap (MLWN)	+0.30m
Lowest Low Water Level	+0.20m
Lowest Astronomical Tide (LAT)	-0.20m

The above levels are with respect to Cochin Port's Chart Datum, which is approximately the level of Lowest Astronomical tide. Tides in the area are semi-diurnal type with an average tide range of 0.6 m.

3.5.2 Waves

The wave climate is governed by the south-west monsoons when wave action can be strong with prevailing wave direction from north-west to south-west. Deep water (15m) wave observation in the past indicate the significant wave heights of 4 m, 2 m and 1 m at the water depths of 10 m, 5 m and 2 m respectively, the predominant wave direction being west.

Wave action inside the Ernakulam Channel is insignificant because of narrow entrance between Cochin Gut and Fort Cochin and the configuration of the land. Generally calm conditions prevail throughout the year except during the times of extreme wind action.

3.5.3 Currents

The currents along the coast of Cochin consists of tide, wave and wind induced components. As per observations the maximum current velocities at the Cochin Gut during the non-monsoon periods is of the order of 3 knots, which could increase to as high as 5.5 knots during the monsoon periods. Inside the Ernakulam Channel the current velocities are low, of the order of 0.5 knots only, with directions varying at different locations.

3.5.4 Littoral Drift

The littoral drift influenced by the monsoon is southwards during south–west monsoon period and northwards during non–monsoon period. Though this contributes to the siltation in the approach channel, it has no direct impact in the Ernakulam Channel.

3.5.5 Tidal Streams

The maximum rate of the ebb stream at springs throughout the year is from 2 to 3 knots and at Neaps from ½ to 1 ½ knots.

- Ebb Stream Springs 2 - 3 knots
- Ebb Stream Neaps ½ to 1 ½ knots
- Flood Stream Springs 1 ½ - 2 knots
- Flood Stream Neaps ½ to 1 ½ knots

Both streams run for considerable time after the predicted times of High and low water, for about 2 hours on the flood and 2 - 3 hours on the ebb. After heavy inland rains the ebb stream may run continuously for many days, while the flood stream enters the harbour under the surface ebb.

3.6 LANDUSE PATTERN

The land use pattern of the study area, i.e. the area within 10 km radius of the project site has been studied based on the satellite data for the study area. The IRS, P6-LISS IV FMX digital satellite data has been procured from National Remote Sensing Agency (NRSA), Hyderabad for assessing the landuse pattern of the study area. The raw satellite imagery has been processed using ERDAS IMAGINE software. The signals of satellite imagery were verified by performing ground truthing and then final classification of satellite imagery was done. Based on this classification, landuse pattern of the Study Area was obtained. The FCC and the Classified imagery of the Study Area are enclosed as Figures 3.5 and 3.6 respectively. The land use pattern of the study area based on the satellite data is given in Table-3.4.

Table- 3.4: Landuse pattern of the Study Area

Category	Area (ha)	Percentage of the total study area
Open vegetation	7237	23.04
Dense vegetation	1120	3.57
Mangrove	1419	4.52
Barren land	4227	13.46
Water body	13951	44.41
Exposed area	128	0.41
Settlement	3333	10.61
Total	31416	**100**

It is evident from Table-3.4, that major landuse category in the study area is water body, which accounts for 44.41% of the study area. The other dominant landuse category is vegetation (26.61%), followed by barren area which accounts for about 13.46% of the total study area. Area under Settlements accounts for about 10% of the total Study Area. Mangroves constitute about 4.52% of the total study area.

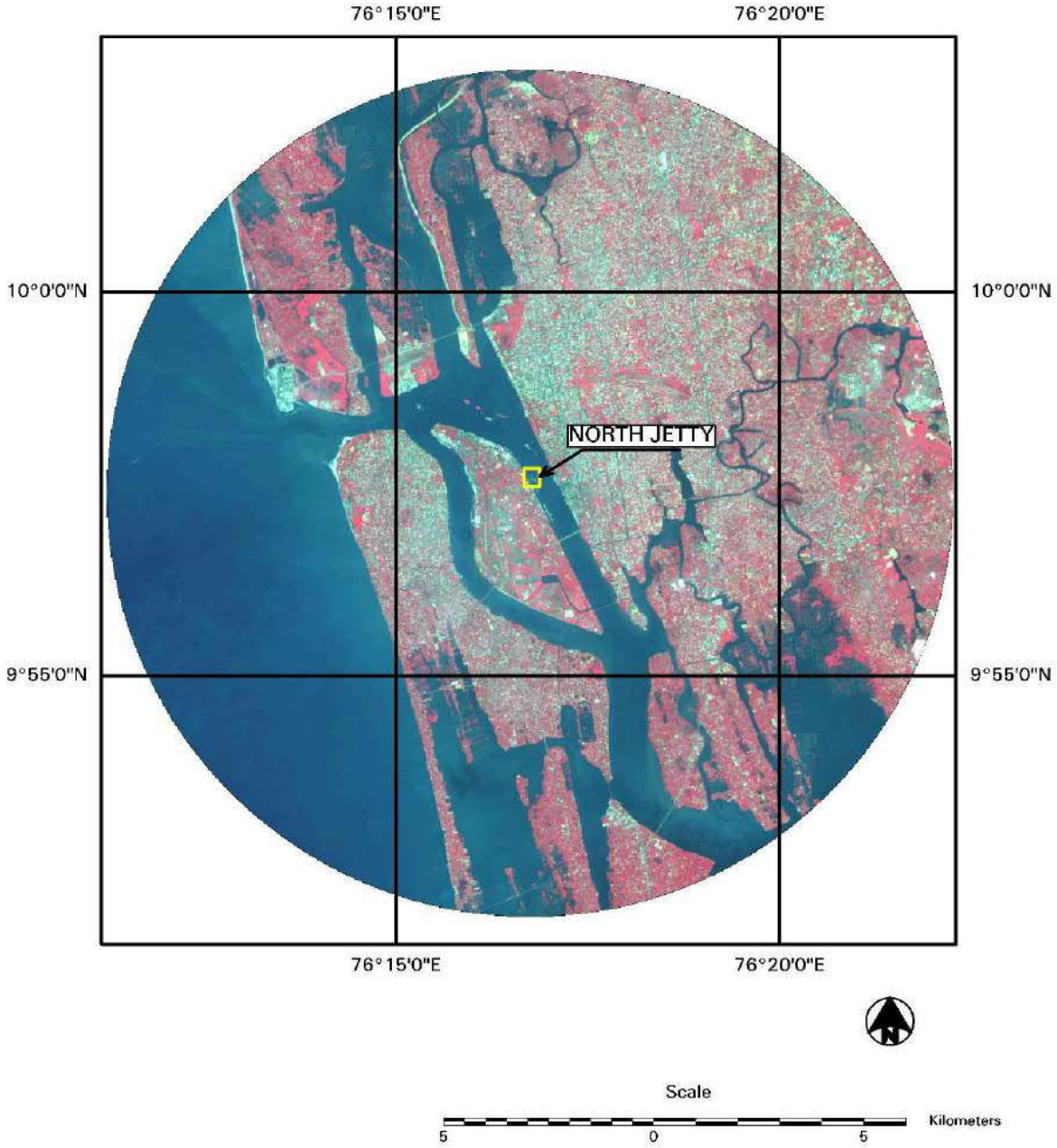


Figure-3.5: Satellite Imagery (FCC) of the study area

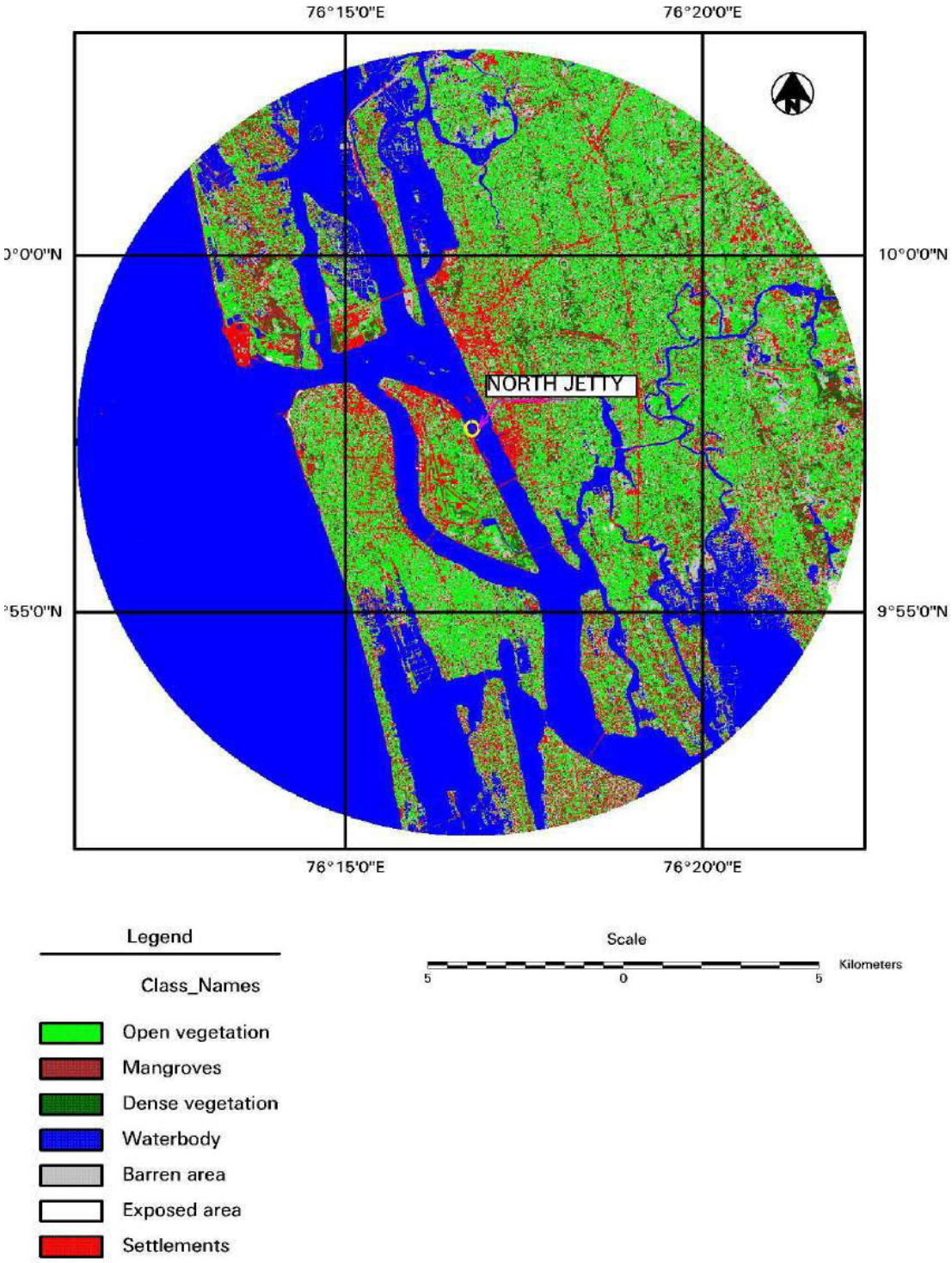


Figure-3.6: Classified imagery of the study area

3.7 AMBIENT AIR QUALITY

As a part of field studies, ambient air quality monitored at various locations in the study area by WAPCOS from 20th December 2013 to 20th March 2014. The ambient air quality monitoring was carried out with a frequency of two samples per week for twelve consecutive weeks at four locations in the study period. The parameters monitored as a part of the study are listed as below:

- Particulate Matter less than 10 microns (PM_{10})
- Particulate Matter less than 2.5 microns ($PM_{2.5}$)
- Sulphur dioxide (SO_2)
- Nitrogen dioxide (NO_2).

The location of ambient air quality monitoring stations is given in Table-3.5. The results of ambient air quality survey conducted during the study period are given in Tables-3.6. The ambient air quality standards specified by Central Pollution Control Board (CPCB) are enclosed as Annexure-III. The location of ambient air quality monitoring stations is shown in Figure-3.7.

Table- 3.5: Location of Ambient Air Quality Monitoring Stations

S. No.	Station Code	Location
1	AAQ-1	Near Project Site
2	AAQ-2	Near Nay Gate
3	AAQ-3	Near Boat Jetty at CPT
4	AAQ-4	Near Varsha Building at Kadavanthra

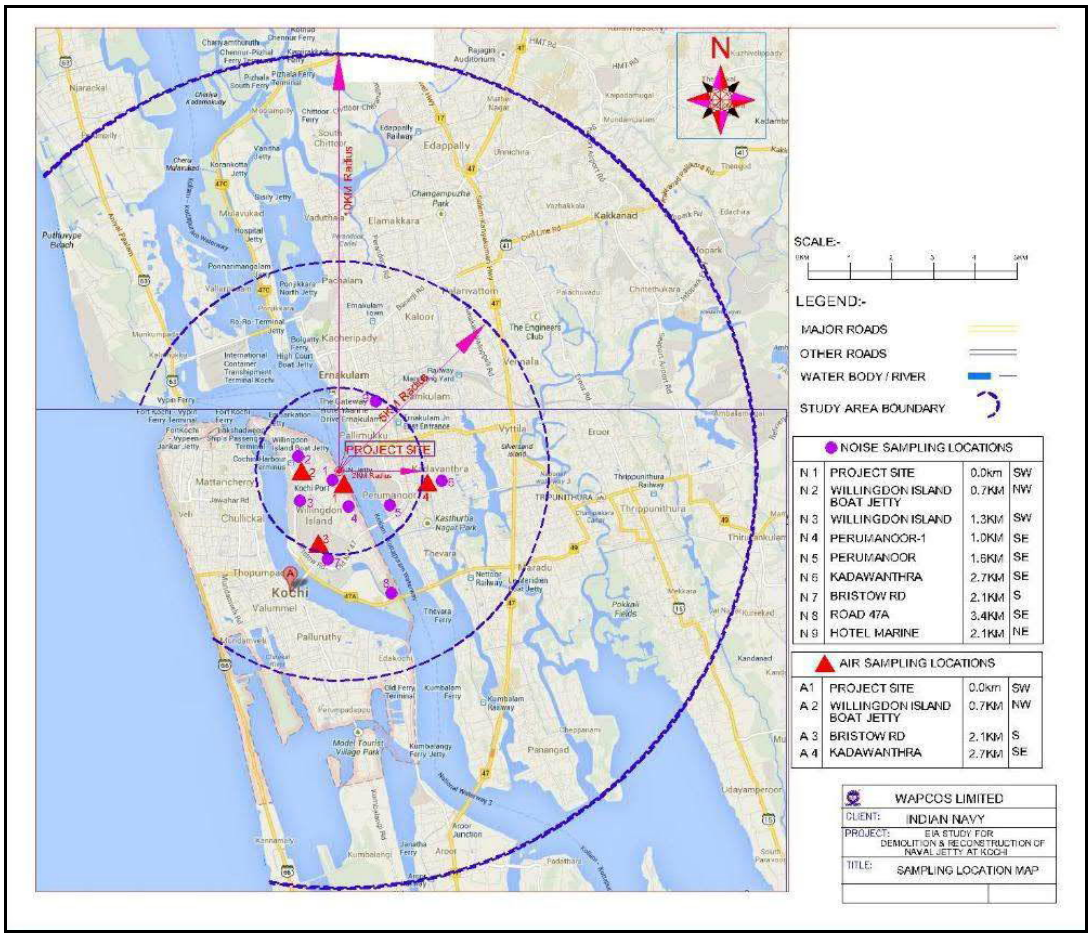


Figure-3.7: Ambient Air Quality monitoring stations

Table-3.6: Results of ambient air quality monitoring (Unit - µg/m^3)

S.No.	Date of Sampling	Parameter			
		SO_2	NO_2	PM_{10}	$PM_{2.5}$
Sampling Location - Near Project Site (AAQ1)					
1	30-31.12.2013	9.2	20.4	53.8	24.8
2	02-03.01.2014	9.6	21.3	56.1	25.9
3	06-07.01.2014	9.0	20.0	52.6	24.3
4	08-09.01.2014	9.4	20.9	55.0	25.3
5	13-14.01.2014	9.8	21.8	57.3	26.4
6	16-17.01.2014	10.2	22.7	59.6	27.5
7	20-21.01.2014	10.0	22.2	58.5	26.9
8	22-23.01.2014	10.5	23.3	61.4	28.3
9	27-28.01.2014	10.0	22.7	59.8	27.6
10	29-30.01.2014	10.4	23.6	62.2	28.7
11	03-04.02.2014	11.0	25.0	65.8	30.3
12	05-06.02.2014	10.7	24.3	64.0	29.5
13	10-11.02.2014	11.2	25.5	67.0	30.9