Final Feasibility Report for Development of POL Berth at Vasco Bay, Mormugao Port, GOA

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EXECUTIVE SUMMARY

1.1 Introduction

The Mormugao port located in Goa is a premier iron ore exporting port on the west coast of India. Mormugao Port is one of the oldest ports of India. Also it has the advantage of being a natural port. The Government of India declared it a "Major Port" in 1963. Port literature reveals a positive relationship between existence of a port and overall development of the region. Portuguese navigators founded the sea route to India to expand their commerce and trade. Historians say the pre-Portuguese trade of Goa was mostly horses, betel, areca, calico, fine muslin, rice, velvets, satin, damask and items of china ware, and during the Portuguese rule of 451 years it was spices and a wide variety of other items.

This port lies midway between the ports of Mumbai and New Mangalore. The port was commissioned in 1885 and is one amongst the 12 major ports of the country. Mormugao Port, ever since its inception as a seventh Major Port of India in 1963, constantly strives to be totally customer-centric organization consistently delivering Value-Plus services to all its clients by offering faster turnaround times, lower costs to port users, being adaptable to every requirement and consistently offering customers quality and reliable services. As a result Mormugao Port Trust plays a key role in the growth of the trade and also the region's economy.

The Mormugao port at present has the following facilities and is managed by the Mormugao Port Trust (MPT):

1. General Cargo handling
2. Iron Ore Exporting / Mooring Dolphins
3. Coal Handling
4. Steel Handling
5. Barrage Handling
6. Liquid bulk handling
7. Break Bulk Cargo Handling and
8. Ship Repairing Yard

Excellent facilities, high productivity, streamlined administration, and a dedicated workforce all go towards making this Port one of the most efficient Port in the Indian subcontinent. With all these attributes, Mormugao Port has tremendous potential to cater to the needs of trade and industry and to contribute to the economic development of the Nation.

Figure-1.1: Mormugao Port

1.2 Objective of the Study

Mormugao Port envisages development of terminals with the most effective and economical arrangement that would be viable under the conditions prevailing and consistent with site conditions. Existing conditions at Mormugao Port and Vasco Bay were established during project inception and through numerous subsequent field studies.

The nature of terminal facility to be established has been identified in the Sagarmala Development of Master Plan for the Mormugao Port prepared for Ministry of Shipping during February 2016. Accordingly, the assignment to prepare feasibility report on the technical and financial aspects has been awarded to Aarvee Associates, Hyderabad by Mormugao Port for the project "Development of berthing facilities for POL and Coastal Cargo".

This study for the Developments also considered the earlier reports / documents prepared for MPT for the development of the Vasco Bay by different agencies covering the period from 1999 to 2016.

1.3 Traffic Analysis

The following table illustrates the traffic growth in the next 25 years.

Table-1.1: Traffic Analysis

In Million Tonnes

Mormugao Port Trust Cargo Handled during the past 5 years and projections thereof																	MTPA
Year		Liquid Cargo		Coking Coal		Thermal Coal		Steel (HRC)		Iron ore		Fertilisers		Container cargo		Other cargo	Total
2011-12		1.37		5.67		1.16		0.38		29.37		0.09		0.25		0.71	**39.00**
2012-13		1.04		6.61		0.77		0.79		7.42		0.08		0.25		0.78	**17.74**
2013-14		0.86		7.52				1.20		0.05		0.18		0.23		1.70	**11.74**
2014-15		1.07		6.57		2.00		1.63		0.75		0.22		0.31		2.16	**14.71**
2015-16		1.06		7.81		3.73		0.84		3.96		0.22		0.35		2.81	**20.78**
2016-17	2%	1.08	5%	8.20	5%	3.92	5%	1.24	5%	4.16	1%	0.22	5%	0.37	5%	2.95	**22.45**
2017-18	2%	1.10	5%	8.61	5%	4.11	5%	1.30	5%	4.37	1%	0.22	5%	0.39	5%	3.10	**23.51**
2018-19	2%	1.12	5%	9.04	5%	4.32	5%	1.37	5%	4.58	1%	0.23	5%	0.41	5%	3.25	**24.63**
2019-20	2%	1.15	5%	9.49	5%	4.53	5%	1.44	5%	4.81	1%	0.23	5%	0.43	5%	3.42	**25.80**
2020-21	2%	1.17	5%	9.97	5%	4.76	5%	1.51	5%	5.05	1%	0.23	5%	0.45	5%	3.59	**27.03**
2021-22	2%	1.19	5%	10.47	5%	5.00	5%	1.58	5%	5.31	1%	0.23	5%	0.47	5%	3.77	**28.33**
2022-23	2%	1.22	5%	10.99	5%	5.25	5%	1.66	5%	5.57	1%	0.24	5%	0.49	5%	3.95	**29.68**
2023-24	2%	1.24	5%	11.54	5%	5.51	5%	1.74	5%	5.85	1%	0.24	5%	0.52	5%	4.15	**31.10**
2024-25	2%	1.27	5%	12.12	5%	5.79	5%	1.83	5%	6.14	1%	0.24	5%	0.54	5%	4.36	**32.60**
2025-26	2%	1.29	5%	12.72	5%	6.08	5%	1.92	5%	6.45	1%	0.24	5%	0.57	5%	4.58	**34.16**
2026-27	2%	1.32	5%	13.36	5%	6.38	5%	2.02	5%	6.77	1%	0.25	5%	0.60	5%	4.81	**35.81**
2027-28	2%	1.34	5%	14.03	5%	6.70	5%	2.12	5%	7.11	1%	0.25	5%	0.63	5%	5.05	**37.53**
2028-29	2%	1.37	5%	14.73	5%	7.03	5%	2.23	5%	7.47	1%	0.25	5%	0.66	5%	5.30	**39.34**
2029-30	2%	1.40	5%	15.46	5%	7.39	5%	2.34	5%	7.84	1%	0.25	5%	0.69	5%	5.56	**41.25**
2030-31	2%	1.43	5%	16.24	5%	7.75	5%	2.46	5%	8.23	1%	0.26	5%	0.73	5%	5.84	**43.24**
2031-32	2%	1.46	5%	17.05	5%	8.14	5%	2.58	5%	8.64	1%	0.26	5%	0.76	5%	6.13	**45.33**
2032-33	2%	1.48	5%	17.90	5%	8.55	5%	2.71	5%	9.08	1%	0.26	5%	0.80	5%	6.44	**47.53**
2033-34	2%	1.51	5%	18.80	5%	8.98	5%	2.84	5%	9.53	1%	0.26	5%	0.84	5%	6.76	**49.84**
2034-35	2%	1.54	5%	19.74	5%	9.43	5%	2.98	5%	10.01	1%	0.27	5%	0.88	5%	7.10	**52.26**
2035-36	2%	1.58	5%	20.72	5%	9.90	5%	3.13	5%	10.51	1%	0.27	5%	0.93	5%	7.46	**54.80**
2036-37	2%	1.61	5%	21.76	5%	10.39	5%	3.29	5%	11.03	1%	0.27	5%	0.98	5%	7.83	**57.46**
2037-38	2%	1.64	5%	22.85	5%	10.91	5%	3.45	5%	11.58	1%	0.27	5%	1.02	5%	8.22	**60.26**
2038-39	2%	1.67	5%	23.99	5%	11.46	5%	3.63	5%	12.16	1%	0.28	5%	1.08	5%	8.63	**63.20**
2039-40	3%	1.72	5%	25.19	5%	12.03	5%	3.81	5%	12.77	1%	0.28	5%	1.13	5%	9.06	**66.30**
2040-41	3%	1.77	5%	26.45	5%	12.63	5%	4.00	5%	13.41	1%	0.28	5%	1.19	5%	9.52	**69.55**

1.4 Conceptual Plan

1.4.1 Development of berthing facilities for handling POL Cargo

Covering the period 1999-2000 to 2012-2015 and documentation in possession of port, several alternatives for the layout of berths were put forth and analyzed for the optimum utilization of Vasco Bay. The proposal for the development of the berth and

other facilities in Vasco Bay has been prepared keeping in view of the fishing community who depends on fishing for their livelihood and hence the development planned would not restrict movement of their boats in and out of sea.

The Port has 7 nos. of cargo handling Berths, 5 nos. of barge Berths and 6 mooring dolphins, 1 new cruise terminal along the break water and 1 mole Berth along mole to handle Liquid bulk cargo, iron ore, coal/coke, general cargo and POL products. Berths No. 1, 2 & 3 have been leased out on long term basis (25 years) to a private party who has set up a modern ship repair facility. Berths No. 5, 6 & 7 are operated on BOOT basis. During the current year, the Port handed over Berths No 8 & 9 to the private operators for redevelopment on PPP basis.

Based on the traffic projection and the availability of Berths in the port, it is proposed to develop one berth for handling POL cargo.

1.5 Design Vessel for Berth

The design vessel size for the POL Berth is considered to be Panamax Vessel.

The vessel size for POL cargo is considered as 85,000 DWT with the following ship characteristics:

LOA	-	260m
Beam	-	38.1m
Draft	-	14.0m

1.6 Proposed POL Berth

The POL berth is proposed to be provided with the following components:

- ✓ Jetty head for accommodating marine unloading / loading arms, Piping and pumping systems
- ✓ Berthing dolphins for berthing of vessels
- ✓ Mooring dolphins for mooring of vessels
- ✓ Fenders and mooring bollards for safe berthing and mooring of ships
- ✓ Sufficient dredged depth
- ✓ A security wall separating Fisheries harbour from the POL / Coastal Cargo Berth.

A service platform of 40m x 20m (jetty head) with two berthing dolphins of 15m x 12m on either side with sufficient no. of mooring dolphins (3 nos. of 12 m x 12 m on either side) has been proposed. The jetty head will be installed with marine loading & unloading arms for various POL products to be handled. The object of proposing the POL berth adjacent to the coastal berth is to leave out eastern space of Vasco Bay for developing fishery harbour and related ancillary facilities. This berth is proposed parallel and opposite to berths 10 & 11.

As regards the slip distance between the existing berths 10 & 11 and the proposed coastal and POL berths, the same is governed by the beam of the largest vessel to be handled. The PIANC guidelines stipulate a distance of 7B (B refers to Beam of the vessel) for such, two ships berthing pier configuration. Taking the largest beam to be closer to 40m, a slip of 300m is found adequate so that Port will have sufficient eastern space of Vasco Bay for developing fishery harbour, related ancillary facilities and for future developments.

1.7 Requirement of Dredging

At present, the water depth at the proposed berth area (POL berth) is (-) 2.5m (average). The Dredge depth of (-) 15.00 is proposed to be maintained in front of berth. The dredging quantity is about 5 lakhs cu m. Out of the total dredge material about 75% is considered to be suitable for reclamation.

The balance dredged material after reclamation and the unsuitable dredged material will have to be disposed of in the designated spoil ground to be earmarked by Mormugao Port. The type of dredging to be done and the type of dredger to be deployed shall be decided on the basis of the soil profile as per the documents available and further investigations / studies.

1.8 Project Block Cost

The total capital block cost estimate for the project to be developed is as under:

Table-1.2: Block Cost

Rs. in CR

Sl. No	Item of Work	Estimated block Capital Cost of POL berth
1.	Civil Works	67.33
2.	Mechanical Works	6.00
3.	Electrical Works	1.50
4.	Dredging	12.50
	Total (1+2+3)	87.33
5.	Add: Detailed Engineering & Project Supervision @5%	4.37
	Contingencies @ 5%	4.37
6.	Cost of Wreck Removal	**10.00**
	Grand Total (excl. IDC)	**106.07**
7.	IDC	10.31
	Grand Total	**116.38**

1.9 Financial Analysis

The capital cost indicated in the Chapter-VIII for POL berth has been considered for financial analysis.

1.10 Project Implementation Schedule

The project implementation period including the detailed engineering from the date of award of work is estimated at 24 months.

1.11 Financial Returns

The FIRR of the Project at Base case is 9.95% and even in the least case of sensitivity gives 4.26% and hence financially viable to be taken up through internal resources.

CHAPTER-2

INTRODUCTION

2.1 Mormugao Port

The Mormugao Port, one of the oldest Ports of India which is a leading Major Port on the west coast of India was commissioned in 1888. This Port is located at the entrance of Zuari estuary at latitude 15° 25' N and longitude 73° 47' E. The Port was declared as the Major port in July 1964 under the Major Port Trusts Act 1963, and has grown by leaps and bounds over the last 50 years. It was the only premier Iron Ore handling Port in India for decades. After the ban on Export of iron ore from India, the Port has diversified its activities by handling other commodities including containers. Mormugao Port is an excellent natural harbour protected by a breakwater on the west. Over the years, the Port has developed a deep draft channel (-) 14.4m CD. It has well connected rail and road network. Although the port had lost lot of its iron ore cargo and had to face the minimum cargo handling of 11.74 millions in 2013-14, slowly it started regaining the cargo by way of coal, general cargo, POL and Containers during the last two years and is poised to witness the growth in the next couple of years.

The Location of Mormugao Port in the State of Goa is shown below.

Figure-2.1: Location

CHAPTER-3

EXISTING FACILITIES

3.1 Overview

The present cargo handling capacity of Goa Port is 47.35 MTPA. The Port has 7 nos. of cargo handling Berths, 5 nos. of barge Berths and 6 mooring dolphins, 1 new cruise terminal along the break water and 1 mole Berth along mole to handle Liquid bulk cargo, iron ore, coal / coke, general cargo and POL products. Berths No. 1, 2 & 3 have been leased out on long term basis (25 years) to a private party who has set up a modern ship repair facility. Berths No. 5, 6 & 7 are operated on BOOT basis. All the other Berths are operated by the Port till recent past. During the current year, the Port handed over Berths No 8 & 9 to the private operators for redevelopment on PPP basis.

During the year 2015-16, the Port handled traffic of 20.78 million tonnes as against 14.71 million tonnes handled during 2014-15. The traffic comprised of 5.41 million tonnes of Exports and 15.37 million tonnes of imports. The traffic of 20.78 million tonnes handled during 2015-16 was inclusive of 11.54 million tonnes Thermal / Coking coal and 1.06 million tonnes of Liquid bulk (including 0.56 million tonnes of POL). The other cargo includes iron ore / pellets, limestone, bauxite, steel coils, pig iron and container cargo. The Port has also handled imports of wood chips, which is a major raw material for the paper industry.

3.2 Approach Channel

The approach channel of the port comprises of an outer channel 5200m long and an inner channel 2300m long and is 250m wide. The harbour basin has two turning circles of 480m diameter each.

The outer channel is dredged to 14.4m CD. The inner channel and the turning circle are dredged to (-) 13.1m CD. The channel is one way navigation channel. The details of Approach Channel are as follows:-

Length of Outer Channel	:	5.2km
Length of Inner Channel	:	2.3km

Width Channel	:	250m
Depth	:	14.4m to 13.1m below chart datum
Turning Basins	:	2 nos. of 480m diameter
Tidal Range	:	Springs -2.3m/ Neaps-1.0m

The port has already awarded the contract for deepening the channel to 19.8m CD to enable handling of cape size ships.

3.3 Breakwater

The port has 522m long breakwater aligned slightly east of north at the western end of the port/berthing facilities. A Mole of 270m length runs from the tip of the breakwater in easterly direction. The breakwater and the mole give protection to the berths from W and NW waves during the monsoons.

3.4 Berthing Facilities

The location plan of the berths is shown below:

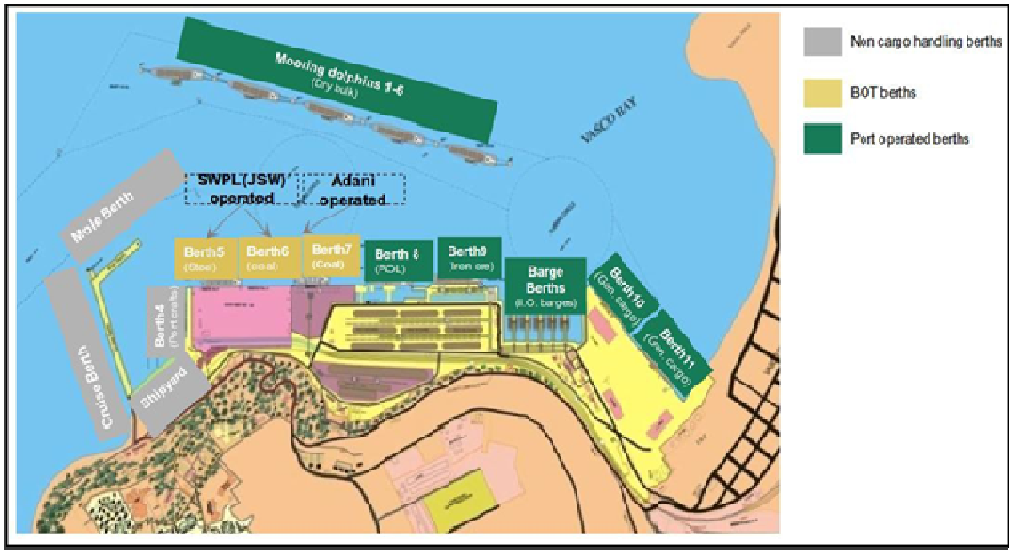


Figure-3.1: Existing Berthing Facilities

The details of all the berthing facilities are provided in the following table:

Table-3.1: Berth Wise Details

Berth No	Type of Berth	Designed / Depth (m)	Quay Length (m)	Planned for Maximum Size of Vessel	
				Length Overall	DWT Approx.
1, 2 &3	Shipyard	-	-	-	-
4	Non-Cargo berth	8	194	190	-
5	General Cargo	13.1	210	190	50,000
6	General Cargo	14.1	240	225	70,000
7	Coal Cargo	14.5	300	300	1,60,000
8	Liquid Bulk	13.1	116/ 298*	260	1,25,000
9	Iron Ore	14.1	222/ 357.5*	335	2,75,000
10	General Cargo	13.1	250	225	55,000
11	General Cargo	13.1	270	225	65,000
-	Non-Cargo Berth New Cruise Terminal (along the breakwater	9.50	450	-	-
-	Mole Berth (along the mole)	9.50	250	200	-
-	Between Mooring Dolphins no.1&2	14.1	340	225	70,000
-	Between Mooring Dolphins no.2&3	14.1	340	225	70,000
-	Between Mooring Dolphins no.3&4	14.1	340	225	70,000
-	Between Mooring Dolphins no.4&5	14.1	340	225	70,000
-	Between Mooring Dolphins no.5&6	14.1	340	225	70,000
-	East of Mooring Dolphins no.1	12.8	-	-	-

*Length between extreme mooring dolphins

3.5 Road Connectivity

Mormugao Port is connected with all major towns of not only Maharashtra and Karnataka, but the rest of India as well via the following National and State Highways;-

- NH17 (Panvel-Panaji-Mangalore-NH47 Junction in Kerala)
- NH17A (Cortalim-Mormugao)
- NH17B (Verna-Vasco)
- NH4A (Panaji-Belgaum)

All-important destinations in India whether on the North, West or East could be accessed through any one of the above mentioned Highways as shown below.

Figure-3.2: Road Connectivity to Mormugao Port

NH17B passes along the port and have significant influence on Port Traffic movement. The port presently has 3 gates i.e. Gate-1, Gate-2 and Gate-9. Presently Gate-1 and Gate-9 are in use. Major vehicular movement is from Gate-9, whereas Gate-2 is mainly used for the commuters using light vehicles. The location of these gates is shown below.

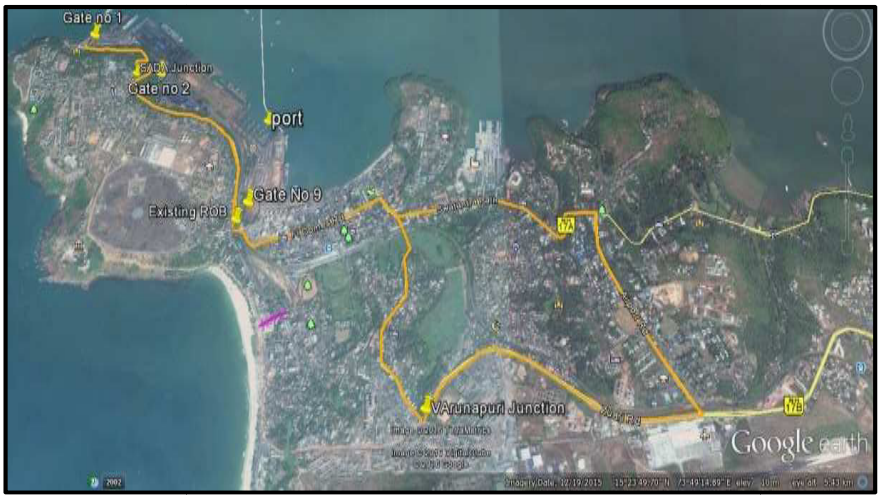


Figure-3.3: Locations of Entry/Exit Gates at Mormugao Port

3.6 Rail Connectivity

The Broad gauge railway system of the port serves the general cargo berths. Port Railway system is connected to south western railway through which it is also linked to Konkan Railway. Both these railway together facilitate easy access to the port

from any part of the country through the vast network of broad gauge railway system.

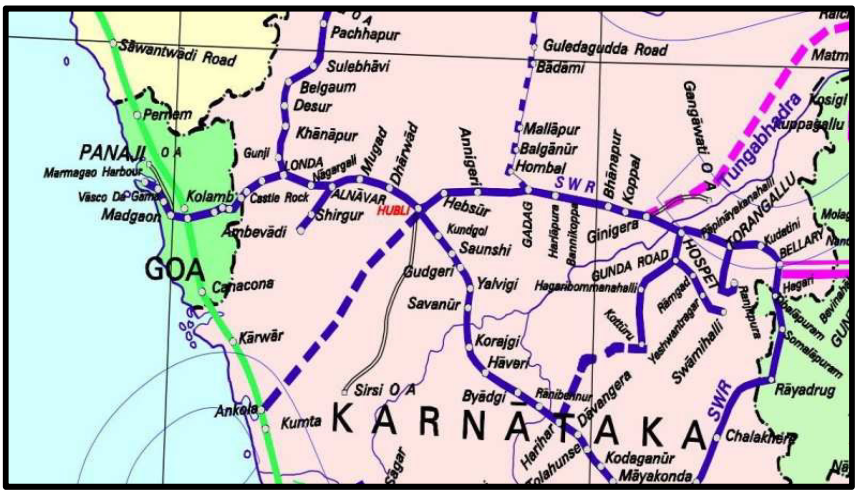


Figure-3.4: Rail Connectivity to Mormugao Port

The following Table 3.2 shows the Rail Routes details:

Table-3.2: Rail Route

Route No	Rail Route	Traffic Diversion
1.	Vasco–Majorda–Madgaon–Loliem–Manglore	South (along the coast)
2.	Vasco–Majorda–Madgaon–Kulem–Castle Rock–Londa – Belgaum – Miraj	East & North bound traffic
3.	Vasco–Majorda–Madgaon–Kulem–Castle Rock–Londa – Dharwad – Hubli – Hospet – Bellary	East & South East bound
4.	Vasco – Cansulim – Verna – Mapusa – Pernam –Ratnagiri – Mumbai	West (along the coast)

Vasco da Gama, the nearest railway station, is connected to the Port Trust Railway system from the south by double tracks which pass through the port rail gate. Also, in south of the port, there is a railway engine yard and workshop complex belonging to the Port Trust Railway. This complex has short tracks for placing of wagons and locomotives. Within the Port Trust Rail gates,a spur track serves Berth 10 and Berth 11. Inside the port area there are presently five tracks dedicated to receipt and dispatch (R&D) of single rakes. From the R&D lines, two lead tracks extend north for Berth Nos. 5A & 6A. These leads serve three tracks of 450m for loading coal and steel coil. The port has taken up the work of augmenting the capacity of rail

infrastructure within the port. Additional lines will now be laid in the R&D yard. Separate rail infrastructure facilities have been planned for Berth Nos 5A & 6A includes six (6) lines for Berth Nos 4, 5, 6 & 7 and one (1) line behind Berth 10 and planning two additional lines for berths no. 8 & 9.

3.7 Fishing Jetty Area

Towards the east of Berth-11 in the Vasco Bay, on the south side shore, a small temporary fishing jetty is available and the entire Vasco Bay is being used for fishing activities.

CHAPTER-4

VASCO BAY DEVELOPMENT

4.1 Background

The Board of Trustees of Mormugao Port Trust, acting through the Ministry of Shipping, Govt. of India represented by the Chairman, Mormugao Port Trust proposed to take up various capacity addition and modernization projects in Vasco Bay area over the next five years as part of the Port development under the Sagarmala Project.

The Sagarmala project envisages transforming existing ports into modern world class ports and developing new top notch ports based on the requirements. It also aims to efficiently integrate ports with industrial clusters, the hinterland and the evacuation systems through road, rail, inland and coastal waterways. This would enable ports to drive economic activity in coastal areas. Further, Sagarmala aims to develop coastal and inland shipping as a major mode of transport for the carriage of goods along the coastal and riverine economic centers. It would provide efficient and seamless evacuation of cargo both import and export and domestic sectors, thereby reducing logistics costs with ports.

The consultancy service for this project is to prepare a detailed feasibility report followed by FEED document for the following two projects, identified under Sagarmala Scheme of Port Development in Vasco Bay.

(i) Development of berthing facilities for POL and Coastal cargo.
(ii) Development of Fisheries Jetty, Passenger Jetty and Port Craft jetty.

Mormugao Port envisages development of terminals with the most effective and economical arrangement that would be viable under the conditions prevailing and consistent with site conditions. Existing conditions at Mormugao Port and Vasco Bay were established during project inception and through numerous subsequent field studies.

The nature of terminal facility to be established has been identified in the SagarmalaDevelopment of Master Plan for Mormugao Port, (AECOM report – Feb

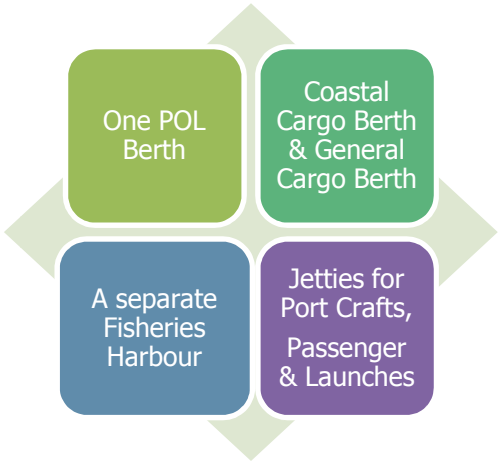
2016 prepared for Ministry of Shipping/Indian Ports Association) taking into consideration of cargo types to be handled in the proposed facilities. While examining the development options for Vasco Bay, various options like berth construction for General / Coastal Cargo, POL and accommodating fishing activities, Passenger vessel and berthing facilities for Port Flotilla are studied. The study on the developments also considered earlier reports like the Master Plan prepared by Howe (India) Private Limited; a feasibility report submitted by Frederic.R.Harris India Private Limited in 1998 on the development of Vasco Bay covering the period 1999-2000 to 2012-2015 and other geotechnical reports and documentation in possession of MPT.

Several alternatives for the layout of berths were put forth and analyzed for the optimum utilization of the Vasco Bay. The different parameters considered were the ease of maneuverability of ships, sufficient back up area through reclamation, effective capital dredging, type and quantity of cargo handled and connectivity.

In the Vasco Bay, the major activities are fishing related. There is one small temporary fishing jetty east of Berth-11 and fishing activities take place in this area.

The total development of Vasco Bay will not be possible unless the existing fishing jetty is shifted. The fishermen were strongly resisting all attempts of MPT to develop Vasco Bay, fearing that this development will affect their livelihood. The Government of Goa, on the demand by the fishing community, took efforts and approached the Mormugao Port to develop an exclusive fisheries harbour. The proposal for the development of the berth and other facilities in Vasco Bay has been prepared keeping in view of the fishing community who depends on fishing for their livelihood and hence the development planned would not restrict movement of their boats in and out of sea. It will not be desirable for the Port operations to co-exist with fishing activities as there are security concerns. MPT being an ISPS compliant port, have to necessarily address the security problems posed by the movement of fishing trawlers close to its operational water areas. There is a demand from fishing community to the Govt. of Goa for providing a separate fisheries harbour in the Vasco Bay.

Under this scenario, the Ministry of Shipping under Sagarmala Scheme proposed to develop in the Vasco Bay,



4.2 Vasco Bay

Vasco Bay forms the northern limit of Vasco da Gama town and lies to the east of existing port facilities. The shore line is a degraded sand beach that is used for informal haul-out and storage of small fishing boats/canoes. This beach is approximately 850m long with the western-most end occupied by a small commercial fish landing jetty. The eastern end of the beach terminates at a small temple and crematorium. Adjacent to the crematorium, there is a drainage outfall that collects storm water from Vasco da Gama town and discharges in to the Bay. A small headland, owned by the Indian Navy, forms the eastern boundary of Vasco Bay and separates the area from the mouth of the Zuari River and the larger Mormugao Bay.

Figure-4.1: Vasco Bay Project Area | Source: MPT

The figure above illustrates the Vasco Bay project area relative to the existing Port cargo terminals.

The Mormugao Port Trust limits include the entire Zuari River estuary up to Zuari Bridge of which Vasco Bay is a part. This limit extends to the sea wall behind the

beach to the south and otherwise fifty yards beyond the high tide line along the shore. South of the project area (as limited by the seawall), is the territory of the city of Vasco da Gama. On the east of the project area is a prominent headland under the control of the Indian Navy. The other significant feature found in this area is a major storm water drainage channel for the city of Vasco da Gama. The existing slums and encroachments along Vasco Bay must be relocated to another area to facilitate optimum development of further port facilities.

4.3 Inland Waterways

The State of Goa has an excellent system of inter connected and navigable inland waterways for transporting iron ore from mines to Mormugao Harbour for export. The river system in Goa consist of the rivers Mondovi, Zuari, Tiracol, Chapora, Talapona, Sal, Galgibaga rivers. The rivers Mondovi and Zuari are navigable for as much as 60km inland from their mouths and are mainly utilized for movement of iron ore by barges to the Port. Almost all iron ore (98%), handled at the port is transported to the port through barges on waterways.

4.4 Hinterland to Vasco Bay

It is proposed to address a hinterland around 150km radius from Vasco Bay. This defined hinter land is being surveyed in terms of connectivity, present and future industrial scenario, traffic and demand assessment. Although presently MPT's hinterland extends up to Bellary–Hospet region, the cargo generated from these areas is served through the existing berths.

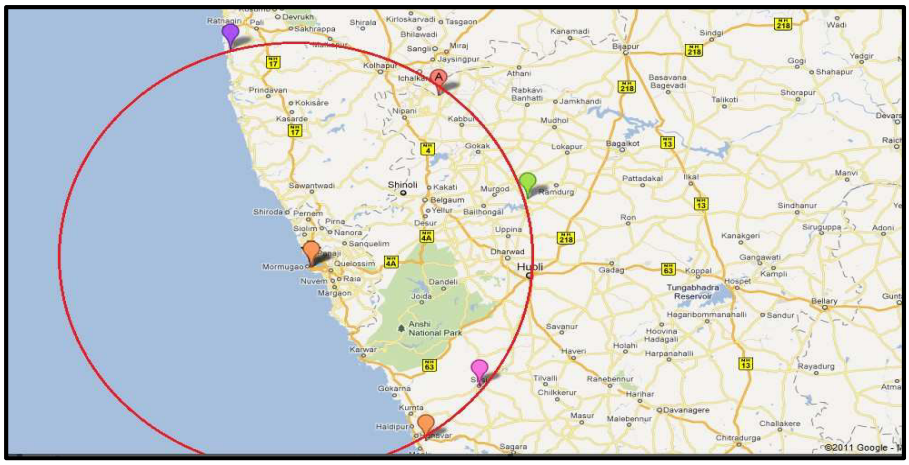


Figure-4.2: Hinterlands | Source: Mir projects and consultants

4.5 Vasco Bay Alternatives

Over the past about 14 years, multiple alternative layouts have been developed for Vasco Bay. For the most part, these layouts have concentrated on maximizing the berthing and the backup area capacity with no consideration to market demand or construction phasing. However, two significant planning documents/alternatives had been developed by F.R.Harris(2000) and Halcrow(2007) that include consideration of market demand and demand-driven phasing. In the meantime, many of the port needs have changed and priorities have shifted. Therefore, a third alternative had been developed. The primary differences include reduction in POL demand and an expansion of the MPT port territory.

4.5.1 Alternative-I: F.R. Harris Plan (2000)

Although limited to a smaller portion of Vasco Bay, the F.R.Harris November 2000 development plan resembles many of the subsequent layouts with a broad reclaimed land area flanked by berthing on both sides.

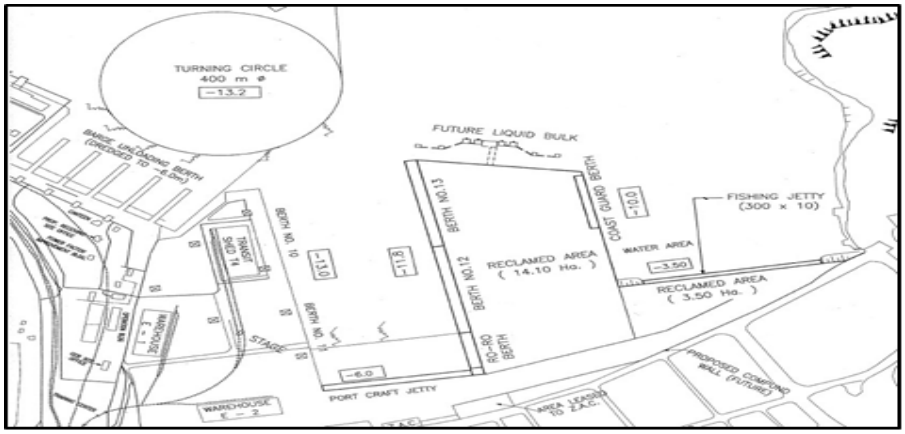


Figure-4.3: Alternative-I | Source: F.R.Harris India Pvt. Ltd

However, extension of the port territory to the east had presented opportunities that were not available at the time this alternative was prepared and use of this area for commercial fishing was no longer recommended.

4.5.2 Alternative-II: Halcrow Plan (2007)

The Halcrow Business Plan prepared for MPT in March 2007 has moved the focus of reclamation to the eastern side of Vasco Bay with an initial finger pier parallel to Berth-11.

Alternative II provides for low cost development early in the process with the higher level of investment occurring later, as cargo demand increases. However, the ultimate utility of a finger pier is very limited and the Navy and Coast Guard have expressed the need for about 150m of backland behind their berths. Additionally the port and Navy uses will require high security and good highway access. Therefore, this alternative was no longer recommended.

Figure-4.4: Alternatives-II | Source: Halcrow Report

4.5.3 Alternative-III: MIR Combined Plan

Using the market study and the functional requirements as a guide, a third alternative was developed that combined, aspects of previous Vasco Bay layouts with improved site access, phasing and land utilization.

The planned relocation of commercial fishing activities away from the marine cargo port, together with increased MPT jurisdictional territory, allowed for layout improvements that are designed to follow market need and still provide expand ability and flexibility.

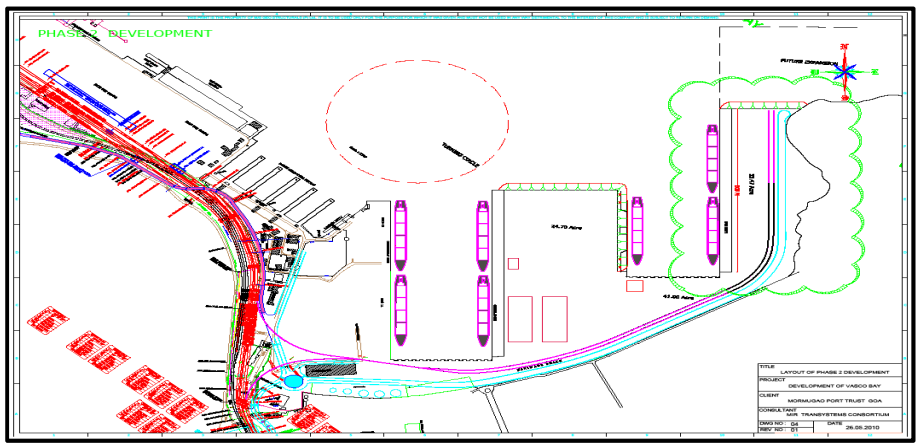


Figure-4.5: Alternative-III | Source: MIR Projects

However, this alternative was also not recommended.

4.5.4 Alternative-IV: MIR Plan

Based on the discussion of port officials and navy, the Indian navy had expressed their desire to have a dedicated berth in Vasco Bay for which they were willing to share the cost of initial development.

Accordingly, Alternative-IV was analyzed. MPT's specific requirements were also kept in mind while finalizing this alternative.

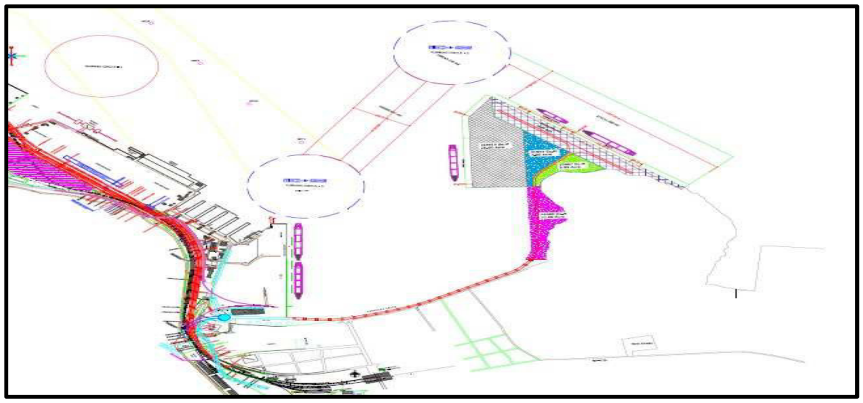


Figure-4.6: Alternative-IV | Source: MIR projects

However, this alternative was also not recommended.

4.5.5 Alternative-V: MIR 2013 (MIR Projects and Consultants)

In this alternative provisions were made for general cargo berth two (2) nos., provision for fishing activities, provision for berthing of fishing boats and fishing activities and provision of navy and coast guard berths. However, considering the further developments and other issues, this alternative also could not be processed.

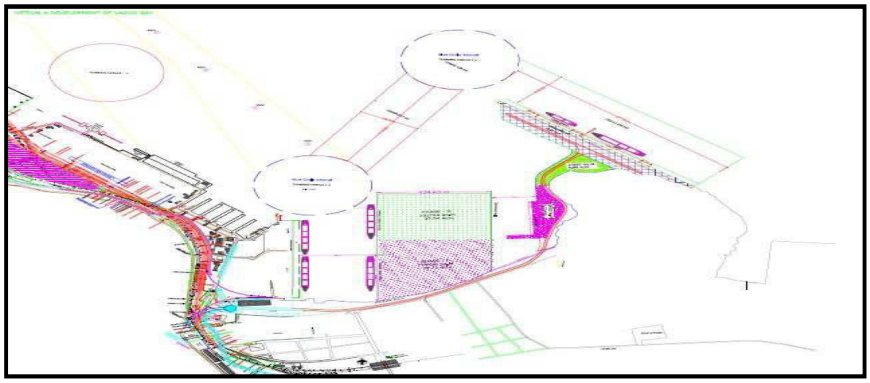


Figure-4.7: Alternative-V | Source: MIR projects

4.5.6 Alternative-VI: AECOM Report (2016)

Under Sagarmala Scheme of Port Development, in 2016, AECOM India Pvt. Ltd. proposed a layout incorporating the provisions for POL berth, Coastal Cargo berth, Fish landing centre with required facilities and passenger vessel berthing facilities.

Figure-4.8: Alternative-VI | Source: AECOM Report

Due to the proposed redevelopment of the Berth-8, for handling bulk and break bulk cargo, it is required to build a new berth for handling liquid cargo. There is also a requirement to develop the coastal cargo berth along with passenger vessel berth and the fishing jetties. It is proposed to develop all these facilities towards the east side of Berths No. 10 & 11.

4.5.7 Proposals Discussed

The consultant submitted a Preliminary Report on 30th August, 2016 for the following two projects at Vasco Bay.

(i) Development of berthing facilities for POL and Coastal cargo.
(ii) Development of Fisheries Jetty and Passenger Jetty.

which consists of two layout options i.e. Option - I & Option - II.

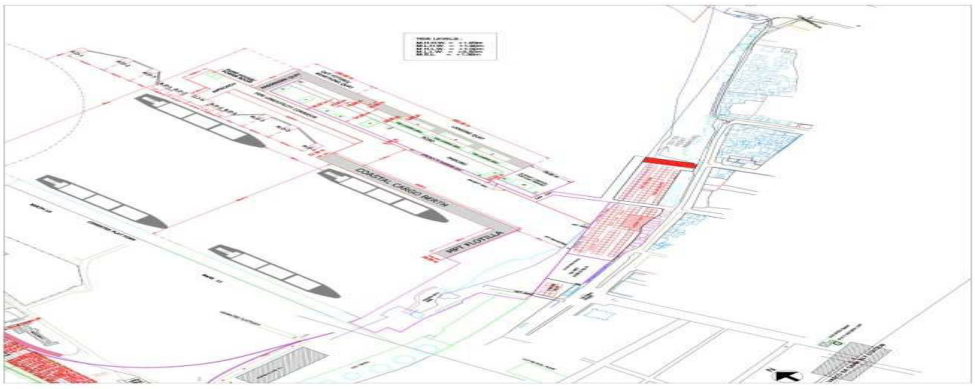


Figure-4.9: Option-I

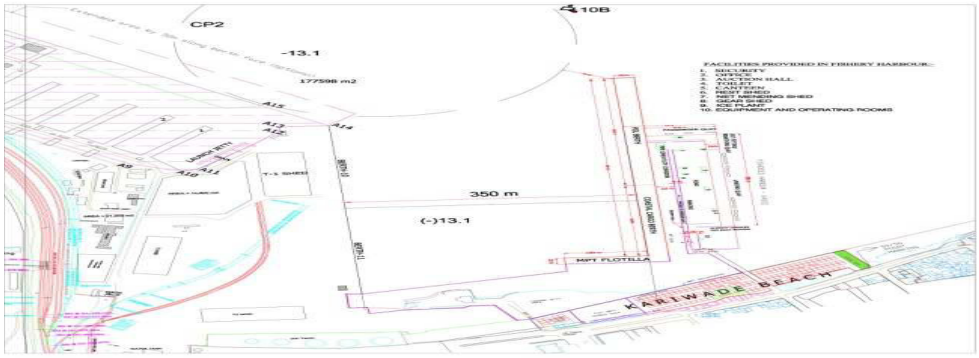


Figure-4.10: Option-II

A discussion on the above Preliminary report with Port officials was held on 14th & 15th September, 2016 and accordingly the Preliminary Report in two parts comprising, the first part for the development of Fisheries harbour including Passenger Jetty and the second part for the development of POL/Multipurpose/ Coastal Cargo berth in conventional type, in straight line, perpendicular to the shore and Port Flotilla berth were submitted to MPT in the month of October'2016.

4.6 Present Proposal

Later, after discussions with MPT officials on 8th & 9th November, 2016, in December 2016 and January 2017, keeping in view of the area constraints and the financial considerations, it has been proposed to develop initially One berth / jetty for handling POL Cargo with Berthing Dolphins, Mooring Dolphins and Jetty Head, keeping provision for developing one more berth towards south of the proposed Jetty and earth retaining structure on the south side in future. The Fisheries Harbour is proposed on the east side of the proposed facilities by the MPT. The layout of the proposal is as shown below.

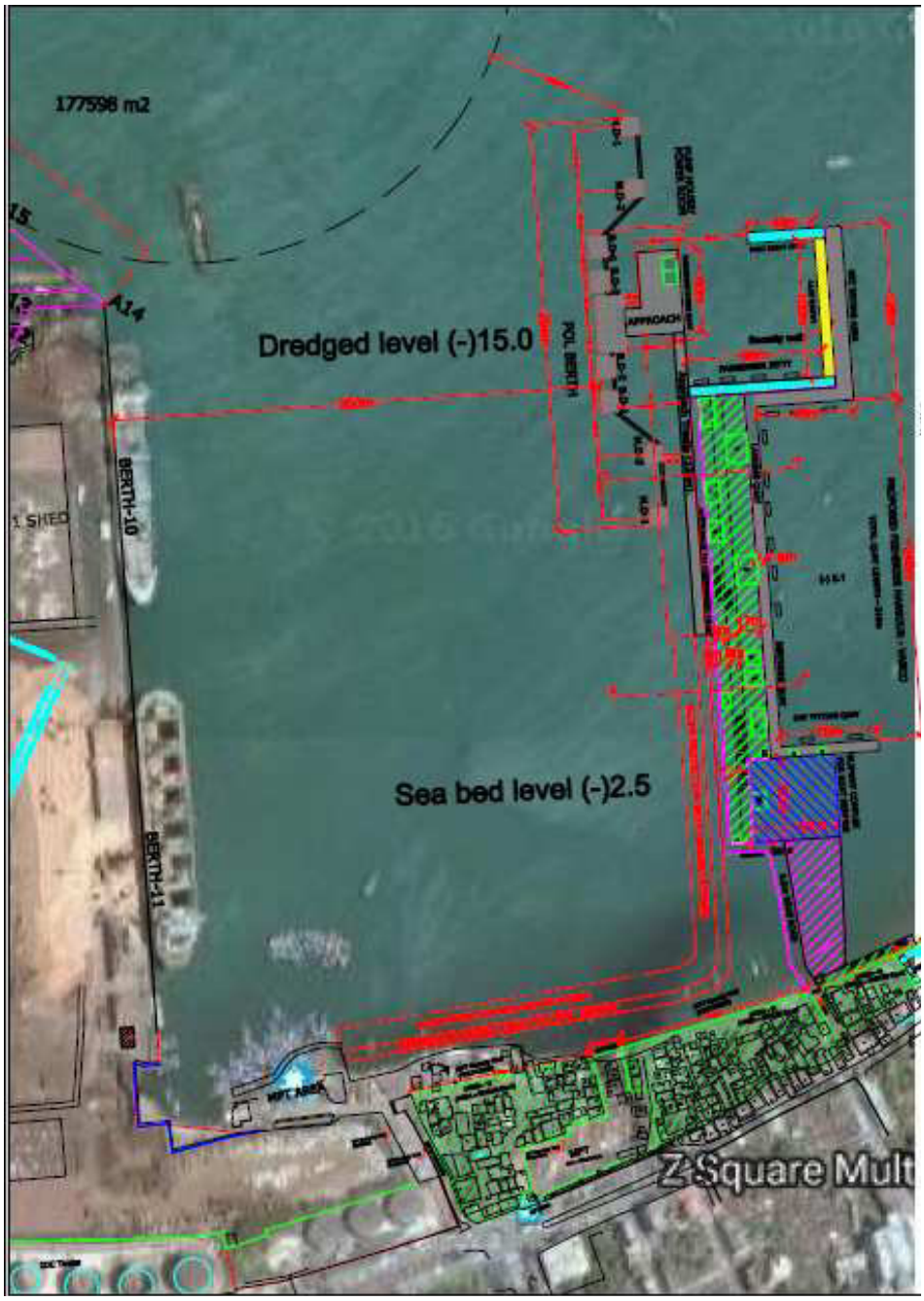


Figure-4.11: Proposed Layout Plan

CHAPTER V

ENVIRONMENTAL DATA

5.1. General

The Port of Mormugao has a 250m wide channel that is 5.2km long in the Outer Channel and 2.3km long in the Inner Channel. Channel depths range from 14.1m in the Inner Channel to 14.4m in the Outer Channel.

The maximum fully laden vessel draft that can be accommodated within the harbour at all stages of the tide is 13.4m allowing for under keel clearances. However, vessels are sometimes loaded upto 13.1m draft, departing only on the high tide.

In the region of Berth Nos 10 and 11, the design channel and turning basin depth is 13.1m. Berth 10 is currently maintained at 12m and cannot be deepened considering the berth structure. Berth 11 is maintained at 13.1m, but is designed for a future 14.1m depth.

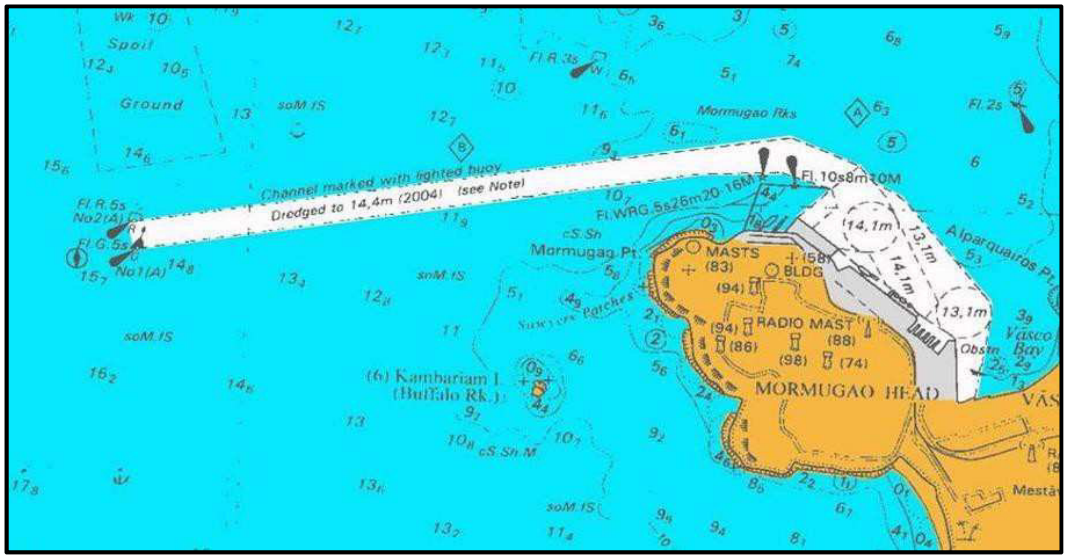


Figure-5.1: MPT Navigation Chart| Source: Indian National Hydrographic Office Chart #IN4 2022

During the monsoon season, allowable vessel drafts must be reduced by 1.0 to 1.5m to accommodate increased vertical ship movement and ship maneuvering safety issues. The existing channel will serve the proposed berths at Vasco Bay. However, capital dredging will be required to provide access to the proposed berths at Vasco Bay from the Channel.

5.2. General Physical Environment

The existing Berth Nos. 10 and 11 are the southernmost berths of Mormugao Port Trust. The Vasco Bay is just immediately east of these two berths. The Vasco Bay is currently used for general anchorage of the commercial fishing fleet with a small fishing jetty.

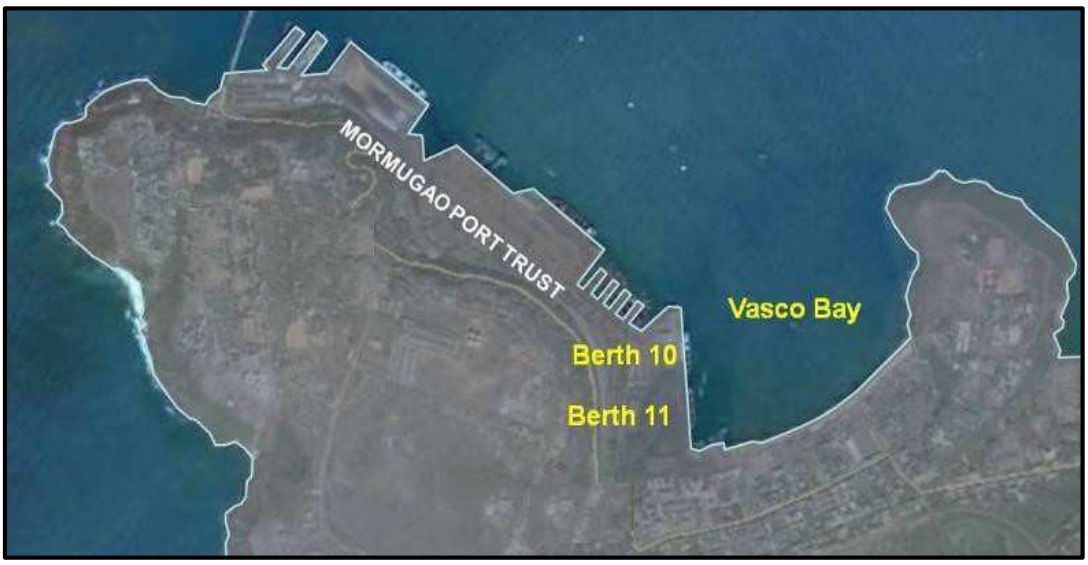


Figure-5.2: Berth Nos 10 & 11 and Vasco Bay | Source: MPT

General physical conditions, including marine navigation, hydrographic survey, geotechnical investigation and environmental conditions of the site have been evaluated and documented in previous reports. Field investigations for seabed engineering and oceanographic surveys, geotechnical investigations and mathematical studies were carried out in Vasco Bay during April 1997 to September 1998 in connection with the study of detailed feasibility studies for Vasco Bay development. Therefore, no new primary data was considered necessary for this feasibility analysis.

5.3. Topographical Condition

Mormugao Port is located on the estuary of the River Zuari. The Mormugao headland adjoining the Harbour is in the form of an elevated plateau; the height varies from 20m to 60m. As the area is flanked by hills or the urban city area of Vasco da Gama, back land is limited for development of Port. Even for the Vasco Bay development entire back up area has to create through reclamation.

5.4. Meteorological Data

5.4.1. Temperature

Mean dry bulb temperature varies from 24.3°C (all temperatures expressed in degrees Celsius) in January to 29.8°C in May. The mean daily maximum temperature varies from 27.8°C in August to 31.5°C in May and the mean daily minimum temperature from 21.4°C in January to 26.9°C in May. The annual average daily maximum and minimum temperatures are 29.5°C and 23.7°C respectively.

5.4.2. Rainfall

The average annual rain fall in Mormugao is 2,611.7mm and the average number of rainy days in a year is 100. During June to September, Mormugao receives 89% of the annual rainfall.

5.4.3. Wind

The mean wind speed varies from 2 on Beaufort scale in November (3.4 to 5.4m/sec) to 4 (5.5 to 7.9m/sec) in July, the annual mean wind speed being 13.6km/h. In an average year, there are 316 days with wind speed varying from 0 to 3 on Beaufort scale (0.0 to 5.4m/sec) and 48 days with winds scaling 4 to 7 on Beaufort scale (5.5 to 17.1m/sec), and one calm (0.0 to 0.2m/sec) day. The predominant wind direction changes with the time of the year. During June to September wind direction is from West and South West and during the remaining period the direction is from North East and East South East.

5.5. Marine Conditions

5.5.1. Wave Height and Harbour Tranquility

A number of wave observations have been made at and around Mormugao harbour at different times, including both ship observations and those made from shore and the measured wave height by installing a wave rider buoy. Extreme wave conditions at the harbour entrance will occur mainly during the monsoon period. The wave analysis indicated that the yearly average probability of offshore waves exceeding

the height of 2 m would be greatest from the west or south west.

Table-5.1: Offshore Wave Probability

Direction	Exceed ance HS=2.0 M
SW	4.7%
W	4.5%
NW	0.4%

Source: Howe India Ltd.

Frederic.R.Harris during their master plan study in 1997 carried out further wave climate analysis based on wave observation made during the period 1961 to 1980 from the are abound by Latitude 13°N to 16°N and Longitude 70°C to 74°E. The propagation of waves from deep water to harbour entrance was studied by means of are fraction analysis, there by taking into consideration refraction, shoaling, breaking and bottom friction. It is found that waves between SW and NW do not affect the tranquility condition in the harbour. The probability of exceeding a specific wave height from a given direction (SW, W or NW) is expressed as a percentage in the following table:

Table-5.2: Deep Water Wave Climate

Hs	1.0m	2.0m	3.0m	4.0m	5.0m	6.0m
SW	12.2%	8.7%	4.7%	2.2%	0.8%	0.3%
W	22.0%	14.4%	8.1%	3.6%	0.7%	-
NW	9.6%	2.5%	0.7%	0.3%	-	

Source: F.R. Harris

Due to refraction, shoaling, and breaking, the wave direction and wave height will change while traveling from deep water to the harbour entrance. Generally the waves from NW turn W NW by refraction. Waves from W and NW reduce in height. All wave conditions higher than Hs=4m are reduced by breaking.

Table-5.3: Operational Wave Climate at Harbour Entrance

Hs	1.0m	2.0m	3.0m	4.0m
SW	12.2%	8.7%	4.7%	2.2%
W	21.0%	13.6%	7.4%	3.0%
NW	8.4%	2.0%	0.6%	0.2%

Source: MPT

5.5.2. Tides

The tide prevailing at Mormugao harbour is mainly semi-diurnal exhibiting two high and two low waters in a tidal day. The mean tidal variations of the order of 1.6m at spring tides and 0.7 m at neap tides. The Chart Datum (Mean Low Water) is 4.8449m below the principal Bench Mark established by the port and is the datum used for all depths in this report. Based on this datum and Indian Naval Hydrographic Chart No.2020 the tide levels are as follows:

- Higher High Water at Spring Solstices +2.3m
- Mean Higher High Water (MHHW) +1.9m
- Mean Lower High Water (MLHW) +1.8m
- Mean Higher Low Water (MHLW) +1.0m
- Mean Lower Low Water(MLLW) +0.5m
- Mean Sea Level(MSL) +1.3m

5.5.3. Currents

The current in the region outside the sheltered harbour have been found to be generally less than one knot (51.44cm/sec), during fair weather season and are mainly caused by tidal flow. Within the sheltered harbour, indicated currents strengths are of the order of 30 to 40cm/sec. The maximum current velocity was observed as 68cm/sec. During heavy monsoon rains the current pattern is altered from that during the fair weather season but the current strengths do not get altered appreciably.

5.5.4. Hydrographic Information

The general hydrographic characteristic of the harbour regions available from a number of sources like Indian Naval Hydrographic Chart Nos.214, 2020, 2022 and 2078, as well as Admiralty Chart No.74 covering the Mormugao harbour and its approaches. As part of the earlier field investigations in Vasco Bay hydrographic and seismic surveys were carried out during April-May 1998 by Elcome Surveys Pvt. Ltd.

5.5.5. Bathymetry

Bathymetry details indicate that the seabed over a major portion of the surveyed

area is generally smooth. Natural water depth (not including the dredged channel) increases gently from 4m along the eastern boundary to 8m near the harbour entrance, 3.5 km to the west.

In the western part, however, the water depths are extremely irregular, with depths increasing to more than 11m, while rocks outcrops are found within the northern boundary. The depths within Vasco Bay between the eastern headland and the existing cargo Berth11 are generally less than 3.5m below chart datum (mean low water).

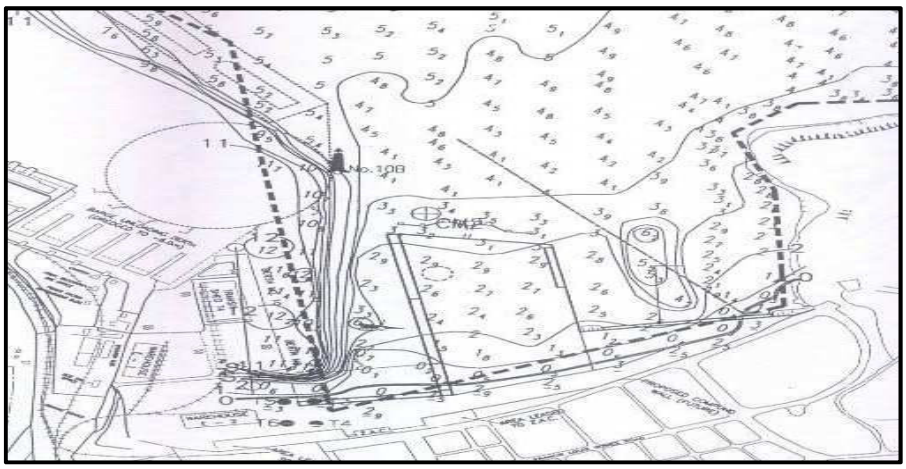


Figure-5.3: Vasco Bay Soundings (meters) | Source: Fredrick R. Harris India Pvt. Ltd.

5.5.6. Seabed Features

The seabed exhibits an even low to medium level of reflectivity, indicative of silty clays, with a few patches of higher reflectivity probably caused by accumulation of coarser sandy aggregates. Linear scars, presumed to have been caused by dragging anchors, are scattered within the area. The area to be dredged within Vasco Bay has been found to be free from rocky patches or course materials, although debris due to jetties on and wrecks are found on the other part of the surveyed area.

The sub bottom profiler records in Vasco Bay shows two main units. The upper most layer varying in thickness between 15 m in south and 24m in the northern portion, interpreted to be made of silty clay, very soft clay at the top and becoming stiffer with depth. The acoustic basement, beyond which the acoustic signals do not penetrate, is an irregular surface, separating unit one above from unit two below and is interpreted to be the top of the weathered bedrock. Boreholes drilled in the area

indicate the occurrence of laterite (highly weathered basalt) at approximately 16-18m below the seabed matching the position of reflector.

5.6. Subsoil Information

Mormugao Port trust has been carrying out geotechnical investigation from time to time within the port during its growth. Before construction of Berth Nos 10 and 11, borehole investigations were conducted at that location which is close to the present development area. Geotechnical investigations were carried out in Vasco Bay during April–October 1997 by Fugro-Knd Geotech Ltd. The locations of the boreholes drilled in Vasco Bay and surrounding are shown in the Frederick. R. Harris report 2000. Boreholes BH1 to BH32 carried out during 1997 and boreholes BH52 to BH65 done prior 1997, fall in the new development area.

The seabed is generally covered by soft sand, silty sand and silty clay with saturated densities in the order of 1,600kg/m 3, above water. At few places, these abed are covered with dense to very dense, silty, and fine to medium sand. Each borehole was tested for soil support strength using the Standard Penetration Test (SPT), General characteristics of the soil strata based on site investigations at Vasco Bay are as follows:

Table-5.4: SPT Soil Density Characteristics

Stratum	Thickness	Soil Type	N-value
Top layer	8-10m	Loose silty sand	N=0to5
Next layer	~10m	Medium to Dense sand	N=15to30
Bottom layer	Beyond 24-32m	Weathered to Hard rock	N>100

Source: MPT

This indicates that pile could be founded at about 25/33m below the existing seabed level. The resulting total pile length would vary from 30m to 38m from the founding level to the cut of level to provide a wharf surface of +4.5m above chart datum.

5.7. Past Environmental Studies

With increasing environmental concerns, handling and storage of POL and other Cargo in large quantity is a challenge to the port. The Environmental studies in the

Port have been carried out as follows for various developmental projects.

- Primary EIA Study for development of Waterfront West of Breakwater at Mormugao Port, Goa by WAPCOS
- Studies for Hydrodynamics and Siltation for Deepening of Approach Channel at Mormugao Port by CWPRS in Feb 2015.

5.8. Environmental Aspects

Based on the past study, few environmental aspects are summarized below:

5.8.1. Noise

It can be observed from the Wapcos report that the day time equivalent noise level ranged from a minimum of 43.2 dB (A) to a maximum of 44.5 dB (A). The night time equivalent noise level ranged from a minimum of 34.9 dB (A) to a maximum of 36.0 dB (A). The day and night time equivalent noise level at various sites located close to residential areas were compared with Ambient Noise Standards and were observed to be well below the permissible limit specified for residential area.

5.8.2. Air Quality

Ambient air quality monitored at various locations by WAPCOS from December 2007 to March 2008. It is observed that the average concentration of SPM at various stations ranged from 133 to 176 mg/m3. The highest SPM level observed was 176 mg/m3.

The average concentration of RPM at various stations monitored ranges from 55.4 to 61 µg/m3 were below the prescribed limits for limit of 60 µg/m3 specified for industrial, residential, rural and other areas.

It is observed from the report that, the average concentration of SO2 at various stations in the study area was much below the prescribed limits of 50 mg/m3 specified for industrial, residential, rural and other areas. The highest SO2 concentration of 13.2 µg/m3 was observed at station near Project site, which is again well below the prescribed limit of 80 µg/m3 specified for residential, rural and

other areas.

It can be seen from the table that during the study period, average NOx concentration at various sampling stations ranged from 9.3 to 14.4 µg/m3.

5.8.3. Water Quality

As per the Wapcos report, the temperature of surface and bottom water samples ranged varies from 25.0 - 25.6ºC and 24.5 to 25.0ºC with a difference of less than 1ºC between the surface and bottom waters.

The pH of seawater at surface water samples ranged from 8.3 to 8.4, while in bottom water samples, it ranged from 8.1 to 8.2. The variation in pH is within normal limits.

The variation in salinity in surface water samples ranged from 33.2 to 33.9 ppt. The salinity is marginally higher in bottom water samples. This phenomenon indicated mixing of surface and bottom waters. The salinity levels observed in the project area is typical of that observed in coastal area.

The DO level in surface and bottom water samples ranged from 6.0 to 6.7 mg/l, 5.2 to 5.6 mg/l respectively. The DO levels indicate the absence of pollution sources.

The BOD values in surface and bottom water samples ranged from 3.7 to 4.1 and 3.2 to 4.6 mg/l respectively.

5.8.4. River Discharge

As Mentioned in the CWPRS report, it could be seen from the figure that the flood discharge in Mandovi River is about 4-5 times high as compared to the Zuari River. The maximum river discharges in Mandovi and Zuari rivers have been observed as about 4000 m^3/s and 970 m^3/s respectively. The average discharges in Mandovi and Zuari River are about 1000 m^3/s and 250 m^3/s respectively.

5.8.5. Fisheries

Goa has a coastline of 104 km and 48 fishing villages situated along the coastline.

The fishing season in Goa generally commences from the middle of August and lasts up to mid-May. About 25% of the total marine fish production of Goa is contributed by traditional fishing whereas the balance, i.e. 75% of the total marine fish production is contributed by mechanized fishing. The Vasco fishing centre is situated within the Mormugao port limits, opposite to Berths 10 & 11. The landings of marine fish at Vasco bay is more than 20,000 tonnes/year. The major fish species landing at the Vasco Bay includes mackerels, oil sardines, silver belly, soles, caranx, prawns, etc.

5.9. Environmental Impact of Dredging and Reclamation

5.9.1. Dredging and Disposal

The potential environmental effect due to dredging arises because of the dredging process itself and also due to the disposal of the dredged material. During the dredging process, effects may arise due to the excavation of sediments at the bed, loss material during transport to the surface, overflow from the dredger whilst loading and loss of material from the dredger and/or pipelines during transport.

The extent to which maintenance dredging and/or disposal might affect marine features highly varied and site specific, depending upon a number of factors shown below:

- Factors influencing the potential effects of capital dredging and disposal
- Magnitude and frequency of dredging activity
- Method of dredging and disposal
- Quantity of dredging
- Size, density and quality of the material
- Area of Dredging - Intertidal Zone/offshore
- Background levels of water and sediment quality, suspended sediment and turbidity
- Oceanographic parameters
- Seasonal variability and meteorological conditions, affecting wave conditions and freshwater discharges
- Proximity of the marine feature to the dredging or disposal activity

- Presence and sensitivity of animal and plant communities (including birds, sensitive benthic communities, fish and shellfish)

The potential impacts of dredging and disposal can be summarized as follows:

- Removal of sub tidal benthic species and communities
- Short-term increases in the level of suspended sediment can give rise to changes in water quality which can affect marine flora and fauna, both favourably and unfavourably, such as increased turbidity and the possible release of organic matter, nutrients and or contaminants depending upon the nature of the material in the dredging area.
- Settlement of these suspended sediments can result in the smothering or blanketing of sub tidal communities and/or adjacent intertidal communities, although this can also be used beneficially to raise the level of selected areas to offset sea level rise or erosion (short-term impact v long-term gain).
- The impact of dredged material disposal largely depends on the nature of the material (inorganic, organically enriched, and contaminated) and the characteristics of the disposal area (accumulative or dispersive areas).

The evaluation of the environmental effects of dredging and disposal must take account of both the short-term and long-term effects that may occur both at the site of dredging or disposal (near field) and the surrounding area (far field).

In addition to the environmental effects that may occur as a direct result of dredging and disposal activities, we must also consider the environmental effects that may occur as a result of the physical changes to bathymetry and hydrodynamic processes that dredging makes. These changes can be summarized as follows:

- Alterations to coastal or estuary morphology, for example alteration of sediment pathways and changes to siltation patterns, which may affect coastal habitats and species in addition to marine ones
- Alterations to water currents and wave climates, which might affect navigation and conservation interests, and
- Reduction or improvement of water quality.

5.9.2. Reclamation

Reclamation can have adverse effects on the marine environment on a local or regional scale. Reclamation mainly influences the coastal and near-shore marine habitats, e.g., sandbanks, estuaries, mudflats, salt marshes and halophytic habitats, as well as species occurring in these habitats. Marine habitats are permanently lost where land is reclaimed from the sea. As the present proposed reclamation area is inside the Mormugao Port, the marine habitat will not be affected. As Mormugao port is an operational port and due to continuous vessel movements, the marine habitat is not found in the manoeuvring area.

Reclamation impacts could be changes in coastal currents, increased noise and reduced air quality during the construction phase as well as adverse effects on benthos organisms and habitats from sand extraction, elevated fine silt concentrations.

Land reclamation in coastal areas may have a significant effect on local ground water systems as well. Following reclamations water tables rise and the salt water – fresh water interface moves seaward. An unintended advantage is an increase in fresh ground water resources because the reclaimed land can be an additional aquifer and rain recharge takes place over a larger area. It can be assumed that the impacts of land reclamation activities might have parallels to the impacts of disposal of dredged sediment. In both cases materials are deposited on the seabed.

Impacts of disposal of dredged sediments that are relevant to land reclamation activities include:

- Possible chemical disturbances
- Habitat alterations due to a change in sediment structure (i.e. grain-size). Complexity and community structures would change due to the deposition of fine grained sediment on coarser grained natural sediment
- Burial and smothering of the benthic community caused by enhanced sedimentation due to the disposal of sediment

- Local and temporal re-suspension of sediments, causing increased turbidity. High turbidity results in low levels of transmitted light and can negatively affect the functioning of light-dependent organisms.
- Increased turbidity can be both caused by natural processes such as storm events and tides, and human activities, e.g. the disposal of dredged sediment at sea;
- Possible increase in suspended particulate matter concentrations as large amounts of sediments are brought into suspension.

5.10. Environmental Monitoring

Monitoring of environmental parameters is of enormous importance to ascertain the status of environment during project construction as well as operation. The knowledge of baseline environmental condition the monitoring programme help to gauge any deterioration in environmental conditions due to operation of the project, to enable taking up timely and suitable mitigatory steps to safeguard the environment. Monitoring is of paramount importance as control of pollution since the effectiveness of control measures can only be determined by monitoring. Hence, regular monitoring programme of the environmental parameters is essential to take into account the changes in the environmental quality.

CHAPTER-6

TRAFFIC ANALYSIS AND PROJECTION OF CARGO

6.1 General

The Maritime sector in India comprises of Ports, Shipping, Ship building, Ship repair and Inland Water Transport Systems. India has 12 Major Ports and about 200 non-Major Ports. Indian Shipping Industry has over the years played a crucial role in the transport sector of economy. Approximately 95% of the country's trade by volume and 68% by value are moved through Maritime transport. Therefore, the Ports and harbours and their efficient working are the main focus of the Shipping Ministry of Government of India.

6.2 Performance of the Major Ports during the past Two years

6.2.1 Cargo Handled

The Major ports and the non-major ports together handled about 1052 million tonnes of cargo during the year 2014-15. The 12 Major ports handled 581.344 million tonnes of cargo in 2014-15 and 606.374 Million tonnes in the year 2015-16 achieving a growth rate of 4.31%. The major commodities handled in 2014-15 and 2015-16 are POL, Coal, Containers, Fertilisers, Iron ore, Timber, Granite, Limestone, Edible oils, other dry / break bulk cargo.

The cargo handled by Major Ports during the past 2 years is as under:

Table-6.1: Traffic Handled by 12 Major Ports

Sl. No	Port	2014-15	2015-16	% age growth
1	Kolkata (incl Haldia)	46.292	50.195	8.43
2	Paradip	71.011	76.386	7.57
3	Visakhapatnam	58.004	57.033	(-) 1.67
4	Kamarajar (Ennore)	30.251	32.206	6.46
5	Chennai	52.541	50.058	(-) 4.73
6	VOC (Tuticorin)	32.414	36.849	13.68
7	Cochin	21.595	22.099	2.33
8	New Mangalore	36.566	35.582	(-) 2.69
9	Mormugao	14.711	20.776	41.23
10	Mumbai	61.660	61.110	(-) 0.89

Sl. No	Port	2014-15	2015-16	% age growth
11	JNPT	63.802	64.029	0.36
12	Kandla	92.497	100.051	8.17
	Total	**581.344**	**606.374**	**4.31**

6.3 Cargo Handled by Mormugao Port Trust

6.3.1 Cargo composition of the Traffic

Mormugao port has traditionally been one of the leading iron ore exporting port of India. Owing to the Supreme Court's ban on iron ore exports from Goa and subsequent restrictions on iron ore exports, the volumes handled by Mormugao have fallen sharply. Today, the port is set to diversify into other commodities as well as containers.

Mormugao Port handled 15.37 MMTs of Imports and 5.41 MMTs of Export cargo in 2015-16 totaling to 20.78 MMTs and registered a growth rate of 41.2% compared to the traffic of 14.7 million tonnes handled during 2014-15. The growth rate of 41.2% registered by the port during 2015-16 is the **highest among major ports.** The cargo handled during the last 5 years is as follows:

Table-6.2: Imports & Exports

In Million Tonnes

Sl. No	Cargo	2011-12	2012-13	2013-14	2014-15	2015-16
I.	**IMPORTS**					
A.	**Liquid Cargo**					
1	POL	0.92	0.82	0.52	0.57	0.56
2	Phosphoric acid	0.33	0.16	0.24	0.36	0.37
3	Caustic soda, Liquid ammonia, Sulphuric acid, Edible oil	0.12	0.06	0.10	0.14	0.13
	Total Liquid Cargo	**1.37**	**1.04**	**0.86**	**1.07**	**1.06**
B.	**Fertilizers**					
1	Muriate of Potash	0.09	0.08	0.15	0.21	0.19
2	DAP / Urea			0.03	0.02	0.03
	Total Fertilizers	**0.09**	**0.08**	**0.18**	**0.23**	**0.22**
C.	**Other General Cargo**					
1	Coking Coal	5.67	6.61	7.52	6.57	7.81

Sl. No	Cargo	2011-12	2012-13	2013-14	2014-15	2015-16
2	Thermal Coal	1.16	0.77		2.00	3.73
3	Pet coke Raw	0.16	0.18	0.35	0.43	0.60
4	Wooden chips			0.39	0.39	0.58
5	Lime stone	0.15			0.11	0.56
6	Iron ore / pellets	0.16			0.15	0.39
7	Container cargo/Tare weight	0.16	0.14	0.11	0.14	0.21
8	CP Coke, Bauxite, Met Coke, Nickel products, Machinery, Iron & Steel, Bentonite, Miscellaneous, Sugar	0.19	0.25		0.30	0.21
	Total Other Gen Cargo	7.65	7.95	8.37	10.09	14.09
	TOTAL IMPORTS	**9.11**	**9.07**	**9.41**	**11.38**	**15.37**
II.	**EXPORTS**					
A.	**Ores & Allied products**					
1	Iron ore & Pellets	29.21	7.42	0.05	0.60	3.57
2	Bauxite		0.07	0.15	0.27	0.21
	Total Ores & Allied products	29.21	7.49	0.20	0.87	3.78
B.	**General Cargo**					
1	HR steel coils	0.38	0.79	1.20	1.63	0.84
2	Granite	0.05	0.19	0.36	0.30	0.31
3	Pig Iron			0.27	0.26	0.31
4	Container cargo/Tare weight	0.09	0.11	0.12	0.17	0.14
5	Granite, Iron & Steel, Maize, Miscellaneous, Pig iron, Sugar, Wheat, Calcined Alumina, CP Coke	0.16	0.09	0.19	0.10	0.03
	Total General Cargo	0.68	1.18	2.14	2.46	1.63
	TOTAL EXPORTS	**29.89**	**8.67**	**2.33**	**3.33**	**5.41**
	GRAND TOTAL	**39.00**	**17.74**	**11.74**	**14.71**	**20.78**

It is seen from the above table that the dry bulk cargo traffic (export + import) was 18.19 million tonnes in 2015-16 constituting 88% of the total traffic. The share of break bulk cargo including container was 7% and that of liquid cargo was 5%.

Further, analysis of traffic through put during the past 5 years indicates that the peak traffic handled was 39.00 MMTs in 2011-12 and the traffic declined to its lowest in 2013-14 which was 11.74 MMTs. Mormugao Port steadily started growing with an increase of 25% in 2014-15 and 41% in 2015-16. The growth trend during the past two years indicates that the Port may gain the past glory slowly with the commodity shift from Iron ore exports to Coal imports.

Further, there is decrease in the Liquid cargo from 1.37 MMTs in 2011-12 to 1.06 MMTs in 2015-16 and almost no growth during the past 3 years. Presently, the Liquid cargo is being handled at Berth Nos 8, 10 and 11.

6.3.2 Overseas / Coastal Traffic

The share of Coastal traffic in the overall traffic is about 8.3% in 2014-15 and 5.3% in 2015-16 as seen from the table below:

Table-6.3: Coastal Traffic

In '000 tonnes

	2014-15			2015-16		
	Overseas	**Coastal**	**Total**	**Overseas**	**Coastal**	**Total**
Imports	10,697	684	11,381	14,636	733	15,369
Exports	2,793	537	3,330	5,039	368	5,407
Total	13,490	1,221	14,711	19,675	1,101	20,776
%age to Total	**91.7**	**8.3**	**100.0**	**94.7**	**5.3**	**100.0**

Source: MPT

6.3.3 Commodity-wise Coastal Cargo

The commodity-wise coastal cargo handled by MPT during the past 2 years is as under:

Table-6.4: Commodity

In '000 tonnes

S. No	Cargo	2014-15	2015-16
1	POL (Product)	571	559
2	Thermal Coal	9	
3	Iron Ore	391	210
4	Iron ore pellets	49	
5	Others		
a	Coking Coal		68

S. No	Cargo	2014-15	2015-16
b	Raw Pet coke		41
c	Container Cargo	22	74
d	Bentonite		4
e	Hot Rolled Coils	179	145
	Total	**1221**	**1101**

Source: MPT

6.4 Number of vessels handled and their sizes

The number of vessels called at MPT and their sizes together with the broad commodities handled are given below:

Table-6.5: Vessels & Sizes

Year		Liquid Bulk	Dry Bulk	Break Bulk	Containers	Others	Total
2013-14	Vessels	113	145	96	42	18	414
	DWT ('000 MTs)	3934	10566	3163	690	308	18661
	Avg DWT (MTs)	34814	72869	32948	16429	17111	45075
2014-15	Vessels	126	206	118	69	26	545
	DWT ('000 MTs)	4261	14347	4238	639	209	23694
	Avg DWT (MTs)	33816	69645	35913	9255	8036	43475
2015-16	Vessels	138	282	89	96	29	634
	DWT ('000 MTs)	4697	20449	2450	1458	306	29361
	Avg DWT (MTs)	34036	72514	27528	15187	10552	46311

Source: IPA & MPT Annual Administrative Report – Statement – XVII

6.5 Port Performance Parameters

The performance indicators of the Mormugao port during the last 2 years are as under:

Table-6.6: Performance

S. No	Commodity	No of Vessels	Cargo Handled (MTs)	Avg TRT (days)	Avg PBWT (days)	Avg output per ship berth day (MTs)
	2014-15					
1	POL (Products)	64	571,144	1.85	0.46	6634
2	Other Liquid Bulk	62	495,007	1.73	0.76	8800
3	Iron ore	8	267,035	3.41	1.36	10415
4	Coking Coal	89	6,355,586	6.86	4.22	28323
5	Thermal Coal	33	1,853,410	4.64	2.36	25438

6	Fertilizers (Finished)	14	226,392	5.4	1.59	4339
7	Other Dry Bulk	40	1,529,152	6.95	2.50	9232
8	Steel Products	93	1,656,891	4.37	1.05	5505
9	Other Break Bulk	24	284,751	6.49	1.25	2292
10	Containers	69	254,882	1.86	0.63	3086
11	**All Commodities**	**496**	**13,494,250**	**4.15**	**1.68**	**11,332**
	2015-16					
1	POL (Products)	73	559,110	1.56	0.36	6567
2	Other Liquid Bulk	65	488,658	2.05	1.07	8154
3	Iron ore	9	578,257	5.36	0.70	14039
4	Coking Coal	101	7,325,147	6.07	3.67	31723
5	Thermal Coal	58	3,563,475	4.63	2.62	31885
6	Fertilizers (Finished)	13	223,152	5.19	0.71	3936
7	Other Dry Bulk	55	1,938,050	4.18	1.29	12475
8	Steel Products	59	869,853	4.34	1.14	4753
9	Other Break Bulk	30	332,448	6.24	1.33	2297
10	Containers	96	286,285	1.28	5.98	3001
11	**All Commodities**	**559**	**16,164,476**	**3.65**	**35.91**	**13,885**

Source: MPT Admin Report Statement XVIII. Passenger vessels not considered in the above table. Double counting of Vessels handled by mechanical and Conventional methods excluded by MPT.

6.6 Port Capacity to Handle Cargo

(a) MPT at present has the following berths and its capacity assessed as on 31st March 2015 is as under:

Table-6.7a: Port Capacity (Present)

Berth No.	Particulars	Cargo Handled	Capacity (MTPA)
1, 2, & 3	Leased to WISL	Ship Yard	
4	Non cargo Beth	Berthing Port Crafts	
5	Break Bulk Berth	Steel Products	1.02
6	Coal Berth	Coking Coal	8.94
7	Coal Berth	Thermal Coal	8.94
8	Liquid Berth	POL & Liquids	1.84
9	Barge Berth	Iron ore	7.67
10	General Cargo Berth	Break bulk/Container	1.92
11	General Cargo Berth	Break bulk/Container	1.02
	Mooring Dolphins	6 Nos	10.00
	Transhippers	3 Nos	6.00
	Total		**47.35**

(b) MPT further as on 31st March 2016 re-assessed its capacity on the cargo type as under:

Table-6.7 b: Port Capacity (Re-Assessed)

S. No.	Cargo Type	Capacity (MTPA)
1	POL & Other Liquid Cargo	1.50
2	Iron Ore	27.50
3	Coal / Coke	8.94
4	Break Bulk / Gen Cargo	10.85
	Total	**48.79**

6.7 Berth Occupancy

The details of Berths and occupancy of the berths are as under

Table-6.8: Berth Occupancy

Berth No	Cargo Handled	Length (mtrs)	Designed/ Actual Depth (m)	%age of Occupancy		
				2013-14	2014-15	2015-16
5	Break Bulk	210	14.10	53	41	36
6	Coal / coke	240	14.10	74	80	86
7	Coal / coke	300	14.10		13	20
8	Liquid Bulk	50	13.10	30	26	26
9	Iron ore (MoHP)	*222	14.10	24	47	75
10	General Cargo	250	13.10	64	81	67
11	General Cargo	270	13.10	88	79	68

Length between extreme mooring dolphins is 357.50 | Source: IPA/MPT

6.8 Traffic Analysis and Projections

6.8.1 Liquid Cargo

a) Petroleum products

The country's Refining capacity increased from 187.4 million tonnes in 2010-11 to 219 million tonnes in 2014-15. Public sector accounts for 135 million tonnes including Joint Ventures and balance by Private Refineries. The crude oil production had remained stagnant since 2010 at 37.461 MMT. The Indian refineries consumed around 223 million tonnes of crude oil of which about 189 MMT is met through imports and balance through indigenous production. The capacity of the Refineries is likely to increase to about 290 million tonnes by the 2025.

The production of petroleum products is at 221.136 MMT in year 2014-15 as against 220.756 MMT achieved in 2013-14, showing a marginal increase of about 0.17%. During the year 2014-15, the consumption of petroleum products in India was 165 MMT registering a growth of 4.15% as compared to consumption of 158 MMT during 2013-14. In addition, about 18 million tonnes of LPG was consumed in 2014-15

During 2014-15, the imports of petroleum products were 20.423 MMT which showed an increase of 22.16% compared to 16.718 MMT of petroleum products imported during 2013-14. The exports of petroleum products during 2014-15 were 63.928 MMT showing a decrease of 5.80% compared to the exports of 67.864 MMT of 2013-14.

As per the Sagarmala report prepared by MOS, the demand for petroleum products is expected to grow to anywhere between 275 MMTPA and 295 MMTPA, depending on the growth scenario that materializes. The 'gradual recovery' scenario envisages GDP growth at 6.1% per annum, which would result in a growth of over 4.7% per annum in demand for petroleum products, to reach 273 MMTPA by 2025. As against this, under the 'growth renewal' scenario with a 7.2% per annum expected growth in GDP, domestic demand for petroleum products is expected to grow at 5.3% per annum, to reach 288 MMTPA in 2025.

The Working Group on Ports and Shipping for the National Transport Development Policy Committee (October 2011) has adopted a growth rate of 4% for POL during 2017-18 to 2029-30.

b) Projections for Petroleum products

As per the 12th Five Year Plan, capacity addition in the refineries till 2022 in MTPA is anticipated as under,

- New refinery at Cuddalore 6 MTPA and Kakinada 15 MTPA in 2015,

- Bina refinery 7.5MTPA & 1.5 MTPA in 2016 & 2017 respectively,

- Chennai Refinery 15 MTPA in 2020,

- Mangalore 3.75 & 5 MTPA in 2021 & 2022 respectively.

It is clear that no capacity creation / enhancement plan is expected either in Goa or in any port nearby. There is going to be an expansion of 8.750 MTPA at Mangalore by the year 2022 for which there is a dedicated port with SBM facility. Hence, there is no possibility of crude handling at the port.

The master plan report prepared by TATA consultancy in March 2015 has considered the following projections for MPT for POL.

Table-6.9: Projections (March 2015)

In Million Tonnes

	2020	2025	2030	2035
POL including LPG	0.48	0.52	0.57	0.62

The Sagarmala report prepared by AECOM in February 2016 has considered the following projections for Mormugao port for POL.

Table-6.10: Projections (February 2016)

In Million Tonnes

	Current	2025	2030	2035
Base	0.6	0.8	1.0	1.7
Optimistic		0.8	1.1	1.9

The Sagarmala report prepared by MOS in July 2016 has adopted the following projections for Mormugao Port:

Table-6.11: Projections (July 2016)

In Million Tonnes

	Current	2020	2025	2035
Base	0.6	1.0	1.5	2.2
Optimistic		1.0	1.8	2.7

The growth in POL traffic during the past 3 years and the trends indicate that there may be annual growth of 1 to 2% during the next few years due to the demand position of hinterland of Goa port. The following table indicates the growth in various scenarios.

Table-6.12: Growth Rate

	Optimistic	Realsitic	Pessimistic
Year 1 to 10	3%	1.5%	1%
Year 11 to 20	3%	2%	1.5%
Year 21 to 30	3%	2%	2%

Adopting a growth rate of 1.5% & 2% being the realistic growth, the projections for POL have been firmed up as under:

Table-6.13: Projections for POL

In Million Tonnes

	2015-16	2020	2025	2035
POL including LPG	0.56	0.60	0.64	0.75

a) Other Liquids

The port handled about 0.5 million tonnes of traffic of other liquid cargo comprising phosphoric acid, Caustic soda, liquid ammonia and edible oils in 2015-16. The Sagaramala report July 2016 had considered a forecast of 0.7, 0.8 and 1.3 million tonnes for 2020, 2025 and 2035 respectively and the growth Rate considered was 5%. However as is stated above, the growth trends during the past 3 years indicate a realistic growth of about 1.5 to2% only during the next 30 years. Accordingly, the other liquid cargo traffic projections are reckoned as under.

Table-6.14: Other Liquids Handled

In Million Tonnes

	2015-16	2020	2025	2035
Other Liquids	0.50	0.53	0.58	0.69

b) Total Liquid Cargo

Table-6:15: Total Liquid Cargo

In Million Tonnes

	2015-16	2020	2025	2035
Total Liquids	1.06	1.13	1.22	1.44

6.9 Need for a Dedicated POL / Liquid Handling Berth

Presently Liquid cargo is handled at Berth Nos. 8, 10 and 11. Berth 8 handles various liquid cargoes viz. Caustic soda, Furnace oil, HSD, Liquid Ammonia, Motor Spirit, Palm oil etc. These products are received in smaller tankers with low parcels sizes. The unloading is done with ship's pumps and hence the average productivity at this berth is very low i.e. about 9000 TPD only. The capacity of the berth is stated to be

2.2 MTPA with about 70% occupancy. The berth occupancy of this berth in 2014-15 and 2015-16 is only 26%.

Berth 10 and 11 handle Liquid cargoes like Aviation oil, HSD, Furnace Oil, LSHF, Kerosene and Phosphoric acid etc. The above cargo is besides the General cargo which is predominantly handled at these berths. The total cargo handled at these berths in 2015-16 is 2.64 MMTs. The Berth occupancy of these berths in 2014-15 is 81% & 79% and in 2015-16 it is 67% & 68% respectively. Going by the norms, these berths are over utilized in 2014-15 and nearly utilized optimally in 2015-16. By releasing the Liquid cargo handling from these berths the utilisation / occupancy can be at optimal and can be utilized for handling other general cargo.

Berth 8 and 9 are being handed over to a PPP operator for redeveloping and cargo handling due to which the POL cargo being handled at Berth 8 has to be shifted to other berths which is Berth10 and 11 only. As is stated above, Berth10 and 11 are being over utilized and hence there is no other alternative left for the port to develop a POL / Liquid cargo berth to handle the Liquid cargo. Otherwise the port may lose the cargo for want of berth. Due to the growth in the economy and the cargo traffic for MPT, it becomes essential construct a New POL Jetty towards East of Berth Nos 10 and 11. The Liquid jetty is non-polluting and hence shifting may not cause any public unrest.

As may be seen from the below Table 6:16, the Liquid cargo is set to a growth of more than 1.5 Million tonnes by 2038-39 and is poised to improve to the level of 1.74 Million Tonnes by the end of 2046-47. Hence there is an immediate need for another Liquid / POL Jetty in MPT. The optimistic situation will further enhance the traffic position and the necessity to utilise the berths for the optimal use.

The Traffic Projections in the Sagarmala, Development of Master Plan for Mormugao Port indicates that the POL may grow from the existing 0.6 MTPA to about 1.7 to 1.9 MTPA by 2035. This is besides the other Liquid cargo being handled by MPT. But the trends in the growth of hinterland and the incentives on the use of LNG in the near future, it is considered that the growth in POL traffic may be more or less straight line. The demand for other liquids/acids etc is also showing variations over the years and hence it is considered that the growth may be linear in nature over the next 10

to 30 years.

Table-6.16: Traffic Projections for Liquid Cargo

in Million Tons

S.No	Year	Growth	POL	Caustic Soda	Liquid Ammonia	Phosphoric Sulphuric Acid	Edible Oil	Total
1	2017-18		0.57	0.01	0.08	0.38	0.04	**1.08**
2	2018-19	1.5%	0.58	0.01	0.08	0.38	0.04	**1.10**
3	2019-20	1.5%	0.59	0.01	0.08	0.39	0.04	**1.11**
4	2020-21	1.5%	0.60	0.01	0.09	0.39	0.04	**1.13**
5	2021-22	1.5%	0.61	0.01	0.09	0.40	0.04	**1.15**
6	2022-23	1.5%	0.62	0.01	0.09	0.41	0.04	**1.16**
7	2023-24	1.5%	0.62	0.01	0.09	0.41	0.04	**1.18**
8	2024-25	1.5%	0.63	0.01	0.09	0.42	0.04	**1.20**
9	2025-26	1.5%	0.64	0.01	0.09	0.43	0.05	**1.22**
10	2026-27	1.5%	0.65	0.01	0.09	0.43	0.05	**1.24**
11	2027-28	1.5%	0.66	0.01	0.09	0.44	0.05	**1.25**
12	2028-29	1.5%	0.67	0.01	0.10	0.44	0.05	**1.27**
13	2029-30	2.0%	0.68	0.01	0.10	0.45	0.05	**1.29**
14	2030-31	2.0%	0.69	0.01	0.10	0.46	0.05	**1.32**
15	2031-32	2.0%	0.70	0.01	0.10	0.47	0.05	**1.34**
16	2032-33	2.0%	0.71	0.01	0.10	0.48	0.05	**1.36**
17	2033-34	2.0%	0.72	0.01	0.11	0.49	0.05	**1.39**
18	2034-35	2.0%	0.74	0.01	0.11	0.50	0.05	**1.41**
19	2035-36	2.0%	0.75	0.01	0.11	0.51	0.05	**1.44**
20	2036-37	2.0%	0.76	0.01	0.11	0.52	0.06	**1.46**
21	2037-38	2.0%	0.77	0.01	0.11	0.53	0.06	**1.49**
22	2038-39	2.0%	0.78	0.01	0.12	0.54	0.06	**1.51**
23	2039-40	2.0%	0.79	0.01	0.12	0.55	0.06	**1.54**
24	2040-41	2.0%	0.80	0.01	0.12	0.56	0.06	**1.56**
25	2041-42	2.0%	0.82	0.02	0.12	0.58	0.06	**1.59**
26	2042-43	2.0%	0.83	0.02	0.13	0.59	0.06	**1.62**
27	2043-44	2.0%	0.84	0.02	0.13	0.60	0.06	**1.65**
28	2044-45	2.0%	0.85	0.02	0.13	0.61	0.06	**1.68**
29	2045-46	2.0%	0.87	0.02	0.13	0.62	0.07	**1.71**
30	2046-47	2.0%	0.88	0.02	0.14	0.63	0.07	**1.74**

CHAPTER-7

DEVELOPMENT OF BERTHING FACILITIES

7.1 General

At present, Liquid cargo is being handled in Berths No 8, 10 & 11. Port has now proposed for allocation of this Berth-8 for handling multipurpose cargo and Berth-10 & 11 exclusively for handling general cargo. In this situation, there is a need for establishing new berthing facilities for handling POL cargo in Mormugao Port. This has been envisaged in the latest report on Sagarmala – Development of Master Plan for Mormugao Port.

In the Vasco Bay, the major activities are fishing and related. There is one small fishing jetty east of Berth-11 and fishing activities take place in this area. There is resistance from the fishing community in development of the Vasco Bay by the Port fearing this will affect their livelihood. Govt. of Goa, on the demand by the fishing community, took efforts and approached the Mormugao Port to develop an exclusive fisheries harbour.

This has been envisaged in the latest report on Sagaramala - Development of Master Plan for Mormugoa Port in 2016 by AECOM India Pvt Ltd., including development of berthing facilities for POL, Coastal Cargo and Port Floatila Jetty. At present, the Port Flotilla is berthed in Berth-4. By providing a separate berthing facility for Port Flotilla, the other berths could be used for cargo handling. On the demand by the fishing community, the Govt. of Goa has approached the Mormugao Port to develop an exclusive fisheries harbour. Accordingly, the MPT will be submitting a Fisheries Harbour Proposal to the Govt. of GOA as proposed in the Layout finalized.

7.2 Project Planning Concept

The planning and design of the berthing structures for POL berth shall consider appropriate criteria for the operational factors.

Following shall be considered as a minimum,

- Cargo Volume
- Cargo Characteristics

- Vessel arrival conditions
- Vessel dimensional characteristics
- Unloading capacity
- Pilot and tug assistance
- Vessel motion during loading /unloading
- Sea state and prevailing wind speed and
- Safety clearances in the case of POL handling

Some of the above requires careful consideration both during design and operation for efficient use of the facility.

The above requirements will be useful in defining the operational limits of the Marine Terminal such as

- Limiting approach velocity of vessel
- Limiting Sea state for operations
- Tugs and capacity required
- Navigational requirements
- Mechanical facilities
- Emergency systems
- Ship to shore communication systems and
- Safe clearance from POL vessels

7.3 Planning for POL Berth

Port has proposed to allocate the existing berth no. 8 where presently petroleum products and other liquid cargoes like caustic soda, ammonia, molasses etc., for multipurpose terminal and hence, considering the future requirement of POL handling, there is a need for liquid handling berth. Accordingly, it is proposed to have a POL berth/Jetty of capacity 2 MTPA in the Vasco Bay. A Feasibility Report for Development of Vasco Bay has been prepared by MIR Projects and Consultants in September 2013 which specifies the design vessel size for POL cargo as 85,000 DWT by taking cognizance of the present sizes of the ships which arrive at the Port and future likely trend.

The vessel size for POL cargo is considered as 85,000 DWT with the following ship characteristics:

LOA - 260m
Beam - 38.1m
Draft - 14.0m

The POL berth is proposed to be provided with the following components

- Jetty head for accommodating marine unloading / loading arms, Piping and pumping systems,
- Berthing dolphins for berthing of vessels
- Mooring dolphins for mooring of vessels
- Fenders and mooring bollards for safe berthing and mooring of ship
- Dredged depth of (-)15.00m
- A security wall separating Fisheries harbour from the POL/Coastal Cargo Berth.

A service platform of 40m x 20m (jetty head) with two berthing dolphins of 15m x 12m on either side with sufficient no. of mooring dolphins (3 nos. of 12 m x 12 m on either side) has been proposed. The jetty head will be installed with marine loading & unloading arms for various POL products to be handled. The object of proposing the POL berth/Jetty adjacent to the coastal berth is to leave out eastern space of Vasco Bay for developing fishery harbour and related ancillary facilities. Both these berths are proposed parallel and opposite to berths 10 & 11.

As regards the slip distance between the existing Berths 10 & 11 and the proposed berth, the same is governed by the beam of the largest vessel to be handled. The PIANC guidelines stipulate a distance of 7B (B refers to beam of the vessel) for such, two ships berthing pier configuration. Taking the largest beam to be closer to 40m, a slip of 300m is found adequate so that Port will have sufficient eastern space of Vasco Bay for developing fishery harbour, related ancillary facilities and for future developments. However, a slip distance of 350m is proposed leaving a provision of about 25m for future expansion / strengthening of the existing Berths 10 & 11, if required for future development, after discussions with MPT officials.

A minimum ship to ship clearance of 90-100 m is to be maintained between the POL

vessel and the vessel to be berthed at Coastal Cargo berth. An approach of 8m width (Approach Trestle and Road) is proposed to connect with the jetty head to lay the transfer pipelines to be taken to the shore and also for transport purposes during installation and operation. Sufficient space has been proposed at the Northern end of the approach jetty for the installation of electrical facilities and firefighting appurtenances. The POL handling rate can be taken as 1000 tons per hour for all vessel sizes. When the jetty is to be designed for higher DWT vessels, the jetty configuration may be provided with additional mooring dolphins with suitable dredge depth in front.

The deck top level is maintained as +5.50m in uniform with that of Berths No 5, 6 & 7 as discussed and finalized during the meeting with MPT officials on 8th & 9th of November 2016. A security wall separating the activities of Fisheries harbour from the POL and Coastal Cargo berth is proposed with 3m high and top covered with spiral fence along the entire periphery of the fisheries harbour.

7.3.1 Structural Arrangement:

The jetty head, mooring dolphin and berthing dolphin will be of concrete structure with beams and deck slab supported on bored cast in situ RC piles. Each mooring dolphin will be supported on RC piles of 1200 mm dia (provisional) and the top deck slab of 2m depth (provisional). Each berthing dolphins will be supported by 12 RC piles of 1200 mm dia (provisional) and top deck slab of 2 m depth. The jetty head will be supported by RC piles of 1000 mm dia (provisional). The jetty head, mooring dolphin and berthing dolphins are connected by catwalk / walkway either by concrete or by steel platforms to provide access. Considering the marine environment, it would be preferable to go for catwalk by concrete on 1000 mm dia (provisional) RC piles spaced at 8mc/c approximate with 2 m width of walkway and 30 cm depth of slab.

An approach corridor / road way of width 8m is proposed (partially as trestle on piles and partially on the filled up earth east of Coastal cargo berth) connecting the southern portion of Vasco Bay with the proposed berth for movement of vehicles and routing of pipelines in duct. This approach trestle structure is of concrete with beam and deck slab supported on bored cast in situ RC piles of 1200 mm dia (provisional).

7.3.2 Berth facilities:

The berthing dolphins and the mooring dolphins will have the following facilities

- Fenders for berthing - berthing dolphins: 3 fenders on each berthing dolphin
- Bollards for berthing in mooring dolphins: 1 Bollard of 150 tons pull on each mooring dolphin
- Fire, Safety & Pollution Control system

POL Berth/Jetty plan is shown in Drawing No. I (Conceptual Plan).

7.3.3 Existing Liquid Cargo Handling Facilities

Existing liquid cargo handling facility at Mormugao Port, at Berths 8 & 10 has several facilities such as Storage tanks, connecting pipelines, booster stations etc. Liquid cargo handled at Goa Port is mostly import cargo. The Pipelines from the proposed POL Berth are to be connected to the existing storage facilities available in / around the Port area.

The table below shows the existing pipelines and storage facilities details for liquid cargo handled at Berths 8 & 10.

Table-7.1: Existing Pipelines at Mormugao Port

Pipe line No	Origin	Desti nation	Product	Pipeline Dia (")	Pipeline Area (Sqm)	Booster Station	Tank age Area (Sq)
Pipeline No 1	Berth 8	JRE Tanks	Petroleum	12	561.74	No Booster Station	1176.3
Pipeline No 2	Berth 8	Indian Molasses	Petroleum	12	423.72	No Booster Station	701.3
Pipeline No 3	Berth 8	Tanks		12	36.	No Booster Station	
Pipeline No 4	Berth 8	Ganesh Benzoplast Tank	Liquid Handling	12	575.00	Ganesh Benzoplast Booster Station (1)	20000
Pipeline No 5	Berth 8	ROB Baina	Petroleum	20	120.96 +1131.2	Zuari Indian Oil Tank Booster Station (2)	-
Pipeline No 6	Berth 8	Zuari Agro Chemical Tan	Ammonia	14	464.82	No Booster Station	6600
Pipeline No 7	Berth 10	Indian Oil Tank	Petroleum	16	-	No Booster Station	9981

Source: FFR for 1st Phase of MP provided by MPT

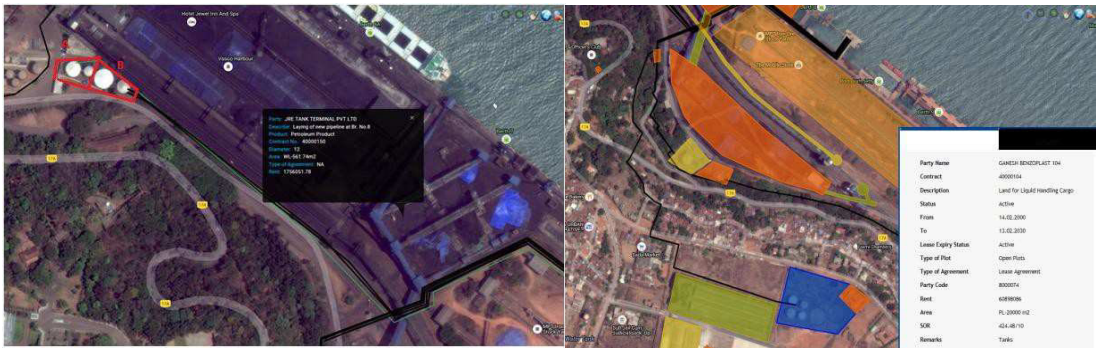
The table below shows the existing locations of storage tanks for the various liquid cargos handled at Berths 8 & 10.

Table-7.2: Existing Storage Tanks at Mormugao Port

Tank age	Pipeline No	Origin	Booster Station	Location	Tankage Area(Sq)	Approx. Pipeline Length (m)
JRE Tanks – Petroleum	Pipeline No 1	Berth 8	No Booster Station	South East of B.4	1176.3	990
Indian Molasses Tanks – Petroleum	Pipeline No 2	Berth 8	No Booster Station	South East of B.4	701.3	939
	Pipeline No 3	Berth 8	No Booster Station			
Ganesh Benzoplast Tankage – Liquid Handled	Pipeline No 4	Berth 8	Ganesh Benzoplast Booster Station (140.41 sqm)	South of B.9 7 Adjacent to FCI Godown	20000	1645
ROB Baina – Petroleum	Pipeline No 5	Berth 8	Zuari Indian Oil Tank Booster Station (250.0 sqm)	Booster Station at South of Adani Plot	-	2597
Zuari Agro Chemical Tank – Ammonia	Pipeline No 6	Berth 8	No Booster Station	Ammonia Storage Tank at South of Adani Plot	6000	904
Indian Oil Tank Petroleum	Pipeline No 7	Berth 10	No Booster Station	South East of B.11	9981	1194

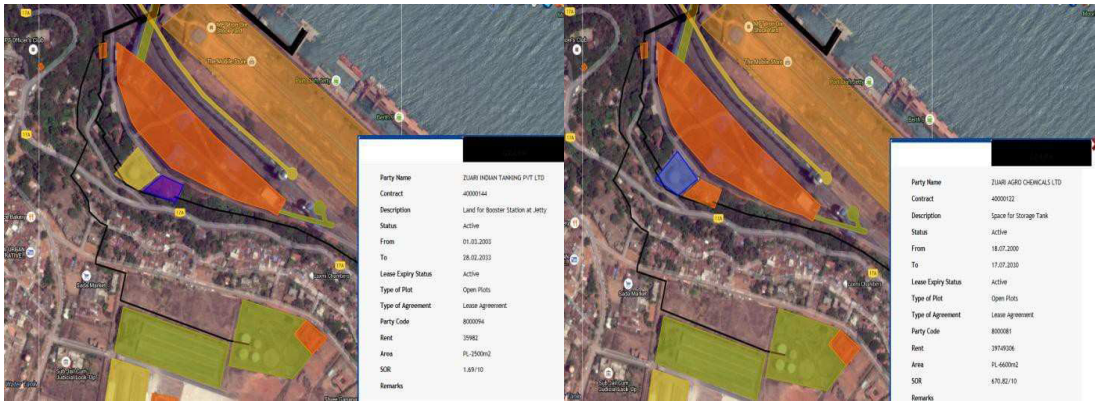
Source: FFR for 1st Phase of MP provided by MPT

Figure-7.1:
Location of JRE and Indian Molasses Tanks (Petroleum) & Ganesh Benzoplast Tanks



Source: TCEL Report 2015

Figure-7.2:
Location of Zuari Tanks Booster–Petroleum & Zuari Agro Chemical Tanks–Fertilizer



Source: TCEL Report 2015

Handling of Liquid Cargo at this proposed berth will require realignment of pipelines and the pipelines originating from Berth-8 will have to be connected to the proposed POL berth. POL storage tanks for JRE and Indian Molasses may require booster pumps owing to increasing length of pipelines from the proposed berth. The figure below shows the existing alignment of pipelines from Berth-8.

Figure-7.3: Existing Pipelines Originating from Berth-8

The tanks for various users are situated at different places around the port. There are total 6 pipelines originating from Berth-8 and 1 pipeline from Berth-10. The alignment shown in the figure is indicative only and for estimation purpose. The pipelines have to be realigned besides the existing pipeline along NH 17A and along the south edge of the Vasco Bay up to the proposed berth. However, alignment survey will be required during the execution stage. The alignment of pipeline for IOCL will also require realignment as it has its pipeline at Berth-10.

The pipelines in the berth area, approach corridor and along the south side shore of Vasco Bay, will be routed in underground trenches, both in PPP operator area and port area.

7.4 Dredging

At present, the water depth at the proposed berth area (POL berth) is (-) 2.5m (average). The Dredge depth of (-) 15.00 is proposed to be maintained in front of berth. The dredging quantity is about 5 lakhs cu m. Out of the total dredge material about 75% is considered to be suitable for reclamation.

The balance dredged material after reclamation and the unsuitable dredged material will have to be disposed of in the designated spoil ground to be earmarked by Mormugao Port.

The type of dredging to be done and the type of dredger to be deployed shall be decided on the basis of the soil profile as per the documents available and further investigations / studies. The two types of dredger proposed to be used are listed below.

7.4.1 Trailing Suction Dredger

This type of dredger is suitable for dredging loose sand and clay which is predominantly seen in the area to be dredged. A trailing suction hopper dredger (TSHD) trails its suction pipe when working, and loads the dredge spoil into one or more hoppers in the vessel. When the hoppers are full, the TSHD sails to a disposal area and either dumps the material through doors in the hull or pumps the material out of the hoppers. Some dredgers are equipped with automatic offloading using drag buckets and conveyors.

7.4.2 Cutter Suction Dredger

The Cutter suction dredger is used when presence of the hard soil in the profile is encountered. The cutter suction dredger is a stationary dredger equipped with a cutter device (cutter head), which excavate the soil before it is sucked up by the flow of the dredge pump(s). During operation the dredger moves around a spud pole by pulling and slacking on the two fore sideline wires. This type of dredger is capable to

dredge all kind of material and is accurate due to their movement around the spud. The spoil is mostly hydraulically transported via pipeline, but some dredgers do have barge-loading facilities as well. Sea going cutter suction dredgers have their own propulsion. Cutter power ranges from 50 kW up to 6000 kW, depending on the type of soil to be cut.

For the dredging operations in the Vasco Bay, it may be necessary to deploy both Cutter as well as Trailer suction dredgers.

From the review of the soil report, it is noted that gravelly soils are not met at the anticipated depths of dredging at the site. The soils are not observed to be calcareous nor cemented. It is anticipated therefore, that the rate of equipment wear and tear will be relatively low in the loose silty sand but may increase in compact soils. For underwater excavation, slopes of about 1 Vertical to 5 Horizontal or gentle slopes may be feasible.

7.5 Design Criteria for Structural Concrete Works

7.5.1 Design Loads

- DEAD LOADS comprising the self-weight of the structure plus superimposed loads of permanent nature shall be considered as per IS: 875 (Part-I) 1987.
- LIVE LOADS uniformly distributed load to be considered: 50 k Pa on the entire deck.

7.5.2 Crane Loads

The following vehicles and the corresponding loads shall be considered on the berth:

- 2 Gantry Crane with 48 m outreach

7.5.3 Seismic Loads

The seismic loads on the structures shall be computed in accordance with the seismic code of India IS: 1893 (Part I): 2002. Goa falls under Zone III with seismic zone factor 0.16, Importance factor 1.5 and response reduction factor 3. Coefficient depending on the soil foundation to be calculated as per fundamental time period of the structure. Horizontal seismic force coefficient shall be calculated accordingly.

7.5.4 Wind Loads

For calculating wind loads on the structure a basic wind speed of 39m/s as per code IS 875 (part 3) shall be used.

7.5.5 Mooring Loads

The bollard pull of 150 T shall be considered for the design of the structure.

7.5.6 Berthing Loads

The berthing load calculation shall be made as per IS 4651 (Part III)–1974 reaffirmed 2002 for the design vessel.

7.5.7 Berthing Energy

Considering the location of the berths from the wave tranquility point of view and the design ships to be handled at these berths, it has been assumed for the purpose of calculation of the berthing energy that the design vessel under fully loaded condition berths at an angular approach of 10° with a velocity 0.1m/s perpendicular to the berth. (Source IS 4651 Part III).

7.5.8 Fendering System

Considering the tidal range at the site and also the variation in the sizes of vessels to be handled at the jetty, the fender system is designed such that sufficient contact area between the hull of the ship and the fender face is ensured at all tidal levels, for all possible size of ships expected to be berthed at the jetty.

It is required to provide a suitable fender system, not only to absorb the design berthing energy of the vessel but also to keep the vessel's hull pressure below the limit of 40T/m².

7.5.9 Fender Reaction (Berthing Force)

Corresponding to the energy to be absorbed and the fender selected, the design reaction force has to be worked out.

Berthing Energy	94Tm

Fender	MNC1200G4
Berthing Force	1765Kn

In addition a longitudinal force equal to the 25% of transverse berthing force is also applied simultaneously on the fender point to account for the friction between the ship's hull and the fender.

7.5.10 Temperature Effects

A variation of 6 degrees (rise) and 6.1 degrees (fall) shall be considered for analysis.

7.6 Load Combinations and Analysis

The analysis is to be carried out using STAAD Pro package or equivalent. The load combinations are to be considered in the analysis as per IS: 4651 part IV - 1989 for limit state of collapse and serviceability.

Load combinations and partial safety factors have been considered as per IS: 4651 – Part IV 1989 Table 1.

7.6.1 Design

Maximum forces and moments are to be tabulated and percentage steel is obtained for piles and superstructure. Design of piles and superstructure is to be carried out using Limit State Method. Design shall be carried out considering soil parameters at structure location. The static capacity of the pile is derived based on IS 2911.

7.6.2 Slope Stability Analysis

Slope stability analysis shall include both circular and non-circular slips. The application of seismic acceleration shall be in accordance with the standard code of practice.

7.7 Material for Berth Construction

7.7.1 For Edge Structures -Grade

The following concrete grades for structural concrete shall be used. These grades have been chosen for durability and with reference to IS 456:2000.

7.7.2 Marine Structures

- Reinforced concrete pile M40
- Reinforced concrete retaining walls M40
- Reinforced concrete of deck including beams M40
- Precast concrete work M40

7.7.3 Reinforcement -Grade

All reinforcing steel to be high strength deformed CRS/TMT with minimum strength of Fe 500 conforming to IS 1786:2008.

7.8 Limiting Stresses

7.8.1 Limit State Design

Under Limit State Design in IS 456: 2000 with partial safety factor of material Ym=1.5 for concrete and Ym =1.15 for reinforcement.

7.8.2 Serviceability Limit State

Stresses in reinforcement under un-factored working loads shall be limited as necessary to ensure that modifications in reinforcement requirements during design to satisfy serviceability (crack width) requirements are minimal. Deflection due to all loads including creep and shrinkage should not exceed the limits as given in Clause 23.2 of IS 456:2000.

7.9 Minimum Requirements

Minimum reinforcement requirements shall be in accordance with IS 456:2000

7.10 Indian Standard Codes Referred for Civil Application

IS 4651(Part I to V)	Code of Practice for planning and design of Ports And Harbours
IS 2911 – 1980	Code of practice for Design and construction of Pile foundation
IS 875 – 1987	Code of Practice for Design Loads
IS 1893 – 2002	Criteria for Earthquake Resistant Design of Structures

IS 456 – 2000	Code of Practice for plain and reinforced concrete
SP – 16	IS - 456 - 1978
IS: 800 - 2007	Code of Practice for General Construction of Steel
IS 1786 - 2008	Specification for HSD steel bars and wires for concrete Reinforcement. (Third Revision)

7.11 Recommendations

In addition, the following recommendations are made

- To conduct full scale risk analysis or HAZOP study for the operation of POL vessel amidst the operation of other facilities in VascoBay
- To obtain Environmental and Forest department clearances for the proposed facilities in VascoBay.
- To conduct Mathematical / Physical model studies for tranquility and ship motion at berth.
- To take action for salvaging the ship wreck in the Vasco Bay before development of the proposed facilities.

CHAPTER-8

CAPITAL BLOCK COST ESTIMATE & IMPLEMENTATION SCHEDULE

8.1 Capital Cost

The total capital block cost estimate of the facilities to be developed is as under:

POL Berth (excl IDC) - **Rs. 106.67cr**

POL Berth (incl IDC) - **Rs. 116.38 cr**

The detailed block cost estimate is attached as ***Appendix- 8***

The summary breakup of the block cost estimate is given as under for the proposed berth: Table-8.1: Capital Cost

Rs. in Crore

Sl. No	Item of Work	Estimated block Capital Cost of POL Berth
1.	Civil Works	67.33
2.	Mechanical Works	6.00
3.	Electrical Works	1.50
4.	Dredging	12.50
	Total (1+2+3)	**87.33**
5.	Add: Detailed Engineering & Project Supervision @ 5% Contingencies @ 5%	 4.37 4.37
6	Cost of Wreck removal	10.00
	Grand Total (excl IDC)	**106.07**
7	IDC	10.31
	Grand Total (incl IDC)	**116.38**

8.2 Implementation Schedule

The project implementation period including detailed engineering from the date of Award of Work is estimated at 24 months for POL berth.

8.3 Phasing of Expenditure

The proposed phasing of expenditure as percentage age of capital cost is as under:4

1st Year 2017-18 = 45%

2nd Year 2018-19 = 55%

Appendix-8

Capital Block Cost Estimate for Developing POL Berth

Sr. No.	Description	Amount Rs. Lakhs
A	**Cost of Jetty & Allied works**	
1	Jetty Head (40 m x 20 m)	800.00
2	Mooring Dolphins (12 m x 12 m)	748.80
3	Berthing Dolphins (15 m x 12 m)	936.00
4	Catwalk Sub & Super structure	550.00
5	Service Platform (30 m x 40 m)	1,400.00
6	Pump house, Power Room & Control room	40.00
7	Pipe line corridor (800 m x 2 m Typ- Civil cost)	160.00
8	Approach Trestle (220 m x 8 m)	1,232.00
9	Fender	144.00
10	Bollard	20.00
11	Construction of compound wall (Height 3m using solid blocks with protective spiral fence)	63.75
12	Reclaimation of approach bund	61.25
13	Approach bund Slope protection with stone pitching over the geotextile layer (363 x 26)	377.52
14	Approach Road & Drain- 363 M	200.00
	Sub Total (A)	**6,733.32**
B	**Dredging**	
1	Berth side (POL-from existing bed level)	1,250.00
	Sub Total (B)	**1,250.00**
C	**Mechanical works**	
1	Fire fighting system , Pollution / Oil spill control, Communication & CCTV facilities	600.00
	Sub Total (C)	**600.00**
D	**Electrical works**	
1	Electrical & DG	150.00
	Sub Total (D)	**150.00**
	Total Cap-ex	**8,733.32**
E	**Pre-operative expenses**	
1	Project preliminaries such as pre project activities, survey, soil investigations etc @ 5%	436.67
2	Add Contingencies @ 5 %	436.67
	Sub Total (E)	**873.33**
F	ADD Wreck removal charges at Propsed POL area	1,000.00
	Sub Total (F)	**1,000.00**
	Grand Total (excl IDC)	**10,606.65**
G	Interest During Construction	1,031.50
	Grand Total (incl IDC)	**11,638.15**
	Say Rs. Cr	116.38

CHAPTER-9

FINANCIAL VIABILITY OF THE PROJECT

9.1 General

The Financial viability is a key determinant to commercial investment. A Project is considered viable, if it generates sufficient revenues during the project life to cover the investment and the operating cost and also gives sufficient returns on investment. To arrive at the financial viability, the traffic projections as indicated in the Chapter-VI and the capital cost of the project as indicated in Chapter-VIII are considered. The assumptions in broad are brought out hereunder:

9.2 Projected Traffic

The POL and other liquid traffic is considered to be handled at the new berth in view of the fact that Berth 8 and 10 where the said cargo was being handled, is proposed to be allotted to a private operator for redeveloping and handling the bulk cargo. Hence, the entire traffic is considered to be shifted to the new berth which otherwise would have been lost by MPT in the absence of a new berth. The Liquid cargo considered is as under:

Table-9.1: Project Traffic

In Million Tonnes

	2015-16	2020	2025	2035
POL	0.56	0.60	0.64	0.75
Other Liquids	0.50	0.53	0.58	0.69
Total	**1.06**	**1.13**	**1.22**	**1.44**

9.3 Capital Expenditure

The capital cost indicated in the Chapter-VIII for POL berth has been considered for financial analysis. During the period of 30 years of the operation of the berth, Mechanical equipments need replacement at the end of 15 years being the life norm and major repairs may be required to be undertaken for the civil structures at the end of 20 years. The present cost duly escalated @5% up to the year of replacement is considered for infusion in the respective years as cap-ex.

9.4 Revenue

9.4.1 POL Berth

The revenue earnings from the POL berth mainly consists of wharfage and berth hire charges. Hence the same is taken into consideration as per SOR of the Port. Other Vessel related charges are not considered for the viability analysis since the same are accrued to the port in general for the services rendered and the fact that the said services have the cost element. The present SoR is not escalated in respect of wharfage due to the fact that the charges are already on higher side as compared to other ports and there is no chance of increasing the SOR in the near future. No escalation is considered in the berth hire charges except for the fact that the US$ denominated rates are bound to increase by apx 1% yoy.

9.5 Annual Operation and Maintenance Cost

The annual operation and maintenance cost of the project is estimated based on TAMP 2008 Guidelines except for other expenses which is considered at 3.5% instead of 1% as per TAMP. This is due to the fact that the other expenses are mainly to meet the Salary & Overhead expenditure which is steeply increasing due to the pay revisions and pension liabilities. The key assumption for estimation of annual Operation and Maintenance expenditure are as follows. The O&M cost is assumed to escalate at 5% year on year.

9.5.1 Repairs & Maintenance Cost

As per norms specified in guidelines, the Repairs & Maintenance cost is estimated at 1% of civil assets cost and 2% of all mechanical and electrical equipment cost for berth handling Liquid cargo.

9.5.2 Power Cost for Illumination

As per norms specified in TAMP guidelines, the power consumption for illumination is taken at 24 units per annum per sq.mtr. It is assumed that a total area of about 22500 sq. mtrs will be required to be illuminated covering Jetty and trestle areas and the pipe line corridors on land and accordingly the power cost is estimated by

considering the average rate of Rs. 9 per unit with escalation at 5% p.a. (including demand charges etc.)

9.5.3 Fuel cost

POL Berth: No fuel cost.

9.5.4 Insurance

As per guidelines, the Insurance cost is estimated @ 1% of Gross fixed assets value.

9.5.5 Depreciation

Not considered for viability since the same is not cash cost.

9.5.6 License Fee

The License fee is to be considered based on the mode of development of this project i.e. either on PPP mode or through internal funding. For the purpose of the exercise, the license fee is not considered presuming it to be the port own berth.

9.5.7 Other expenses

As per norms specified in TAMP guidelines, other expenses are to be estimated @ 1% of the Gross fixed assets value in case of Liquid cargo berth. However, as aforesaid, the other expenses are considered at 3.5% of the Gross fixed assets to meet the ever increasing cost of Salaries & Wages and the related overheads.

9.5.8 Maintenance Dredging

Maintenance dredging cost is considered to be Rs.2.00cr p.a.

9.6 Financial Viability and Sensitivity Analysis

The Financial viability considering the 30 years life period of the project is worked out along with the sensitivity analysis to gauge the impact of increase in cost and reduction of revenue earnings on the viability of the proposal. The results of the analysis are presented below.

Table-9.2: Viability and Sensitivity Analysis

Sl. No.	Pre-Tax Project IRR	POL Berth
		IRR (%)
1	Base case	9.95%
2	Capital Cost up by 10%	8.68%
3	Revenue down by 10%	7.15%
4	Annual O&M Cost up by 10%	8.69%
5	Combined effect of Sl. no. 2, 3 & 4	4.26%

From the above, it is evident that The FIRR of the Project at Base case is 9.95% and in the least case of sensitivity gives 4.26%. Although the IRR works out to be lower at the base case, the project needs to be taken up to avoid diversion of Liquid cargo to other competing ports and to serve the hinterland of Goa. The other scenario in sensitivity analysis are only for academic purpose and does not arise due to the fact that the growth is considered at very realistic situation and no escalation in SOR considered. Hence for all practical purposes, the IRR at the base case at 9.95% shall prevail and it may be even more due to the incremental revenues that may arise on account of other vessel related charges.

Cash flow statements for the above analysis are given at Appendix-9.1 to 9.3.

9.7 Funding

The following options are available for the port for funding of this project.

a) Entire amount can be funded by the MPT. Since the cash reserves of MPT are not enough to take up the projects, the port may avail for intercorporate loans from the sister ports at a competitive price.
b) Avail Central Sector Scheme (CSS) financial assistance of Rs. 15 cr. (maximum as per GOI letter, dated 8th Aug 2016) for mechanization of the berth. Balance however has to be met either through internal resources or a combination of IR and Intercorporate loans.
c) Avail the funding through Sagarmala programme. However, the funding will be limited to 50% of the project cost. In this case, an SPV has to be formed for the revenue sharing between SDC and the MPT and through equity participation.

9.8 Conclusion

The project needs to be taken up to avoid diversion of Liquid cargo to other competing ports and to serve the hinterland of Goa. The port may explore the possibility of funding through Sagarmala programme since it is a highly essential project for the region of Goa.

Appendix-9.1

Mormugao Port Trust

Whargage / Vessel Related income - Liquid Cargo

Rs. Cr

S.No	Year	Wharfage	Berth Hire	Total Op Income
1	2017-18			
2	2018-19			
3	2019-20	18.36	3.62	21.98
4	2020-21	18.63	3.71	22.34
5	2021-22	18.91	3.81	22.73
6	2022-23	19.20	3.90	23.10
7	2023-24	19.48	4.03	23.52
8	2024-25	19.78	4.13	23.90
9	2025-26	20.07	4.24	24.31
10	2026-27	20.37	4.33	24.71
11	2027-28	20.68	4.43	25.11
12	2028-29	20.99	4.53	25.52
13	2029-30	21.34	4.69	26.03
14	2030-31	21.71	4.79	26.49
15	2031-32	22.07	4.93	27.01
16	2032-33	22.45	5.10	27.54
17	2033-34	22.83	5.25	28.07
18	2034-35	23.21	5.37	28.59
19	2035-36	23.61	5.53	29.13
20	2036-37	24.01	5.68	29.69
21	2037-38	24.41	5.86	30.27
22	2038-39	24.83	6.02	30.85
23	2039-40	25.25	6.21	31.45
24	2040-41	25.68	6.39	32.07
25	2041-42	26.11	6.56	32.67
26	2042-43	26.56	6.75	33.31
27	2043-44	27.01	6.93	33.94
28	2044-45	27.47	7.13	34.59
29	2045-46	27.93	7.33	35.26
30	2046-47	28.41	7.51	35.92

Appendix-9.2

Liquid Cargo Berth at Mormugao Port Trust

Operating Expenditure

S.No	Particulars	CC Rs Cr	Rate	% of CC or Amt	Amount Rs Cr
1	**Repairs & Maintenance Cost**				
a	Civil works	81.27		1%	0.81
b	Mechanical works	7.24		2%	0.14
c	Electrical works	1.81		2%	0.04
	Sub Total	**90.32**			**0.99**
2	**Power cost**				
	24 units per m2				0.49
	Jetty area	7500			
	Trestle & approaches	15000			
	Total area	**22500**			
	Rate per unit		9.00		
3	**Insurance**	90.32		1%	0.90
4	**Licence fee**	NA			
5	**Other Expenses**	90.32		3.50%	3.16
6	**Mtce dredging p.a**	13.13			2.00
	Total Operating Cost				**7.54**

Appendix – 9.3

Mormugao Port Trust

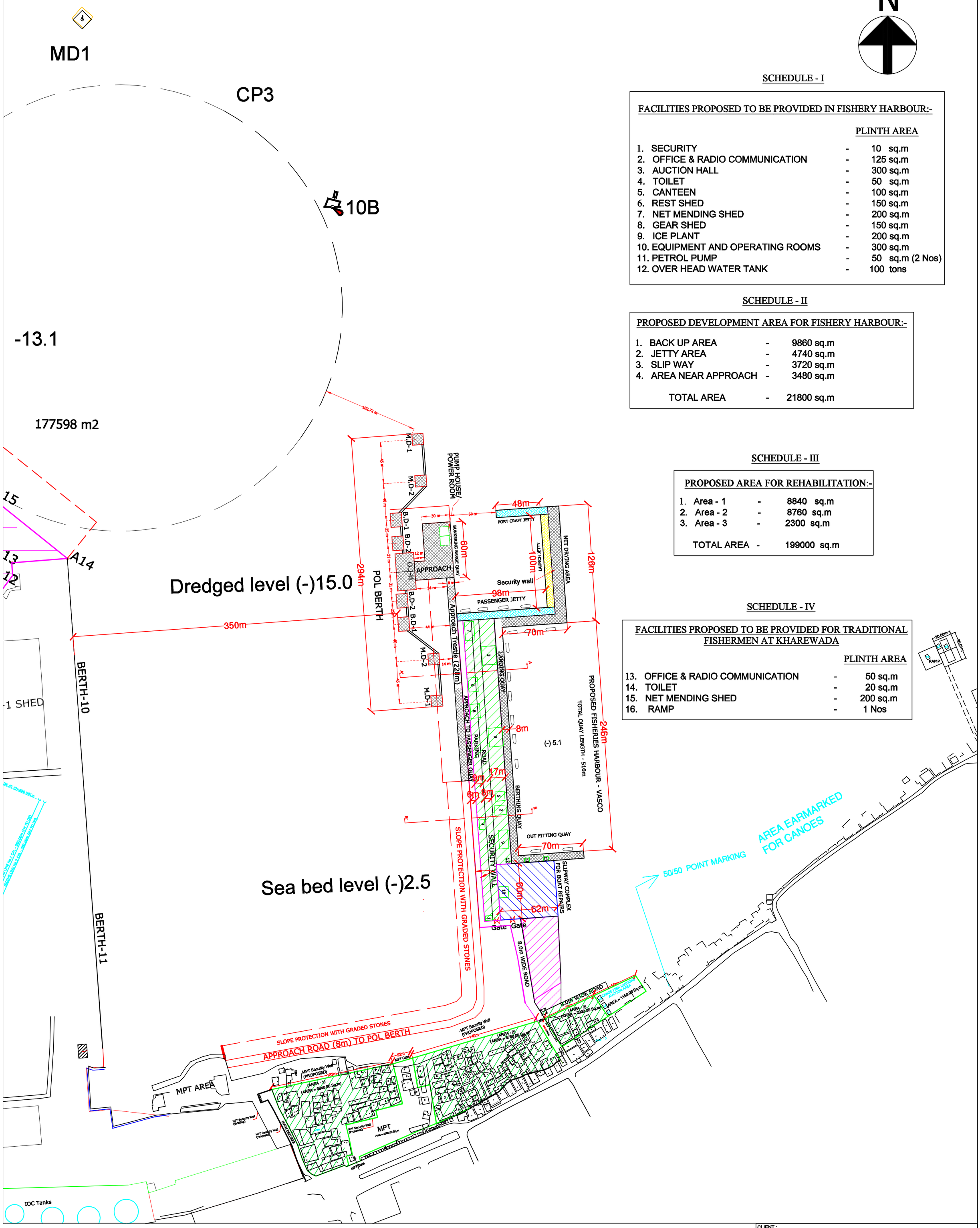
FINANCIAL FEASIBILITY - PROJECT IRR - POL / LIQUID CARGO JETTY

						Rs. Cr	9.95%	8.68%	7.15%	8.69%	4.26%
Year of Opn	F Y			Cap-ex	Total Revenue	O&M Exps 5% esc	Net Operation Cashflows	Sensitivity Analysis			
								Cap-ex +10%	Revenue -10%	O&M +10%	Combined Effect
1	2			3	4	5	6	7	8	9	10
1	2017	-	18	50.12			-50.12	-55.13	-50.12	-50.12	-55.13
2	2018	-	19	66.27			-66.27	-72.89	-66.27	-66.27	-72.89
3	2019	-	20		21.98	7.54	14.44	14.44	12.24	13.68	11.48
4	2020	-	21		22.34	7.92	14.42	14.42	12.19	13.63	11.40
5	2021	-	22		22.73	8.32	14.41	14.41	12.14	13.58	11.31
6	2022	-	23		23.10	8.73	14.37	14.37	12.06	13.49	11.18
7	2023	-	24		23.52	9.17	14.35	14.35	11.99	13.43	11.08
8	2024	-	25		23.90	9.63	14.27	14.27	11.88	13.31	10.92
9	2025	-	26		24.31	10.11	14.20	14.20	11.77	13.19	10.76
10	2026	-	27		24.71	10.62	14.09	14.09	11.62	13.03	10.56
11	2027	-	28		25.11	11.15	13.96	13.96	11.45	12.85	10.34
12	2028	-	29		25.52	11.70	13.82	13.82	11.26	12.65	10.09
13	2029	-	30		26.03	12.29	13.74	13.74	11.14	12.51	9.91
14	2030	-	31		26.49	12.90	13.59	13.59	10.94	12.30	9.65
15	2031	-	32		27.01	13.55	13.46	13.46	10.76	12.10	9.40
16	2032	-	33		27.54	14.23	13.32	13.32	10.56	11.89	9.14
17	2033	-	34	17.15	28.07	14.94	-4.02	-5.73	-6.82	-5.51	-10.03
18	2034	-	35		28.59	15.68	12.90	12.90	10.04	11.33	8.48
19	2035	-	36		29.13	16.47	12.67	12.67	9.75	11.02	8.11
20	2036	-	37		29.69	17.29	12.40	12.40	9.43	10.67	7.70
21	2037	-	38	10.00	30.27	18.16	2.12	1.12	-0.91	0.30	-3.72
22	2038	-	39		30.85	19.06	11.79	11.79	8.70	9.88	6.79
23	2039	-	40		31.45	20.02	11.44	11.44	8.29	9.44	6.29
24	2040	-	41		32.07	21.02	11.05	11.05	7.84	8.95	5.74
25	2041	-	42		32.67	22.07	10.61	10.61	7.34	8.40	5.13
26	2042	-	43		33.31	23.17	10.14	10.14	6.81	7.82	4.49
27	2043	-	44		33.94	24.33	9.61	9.61	6.21	7.17	3.78
28	2044	-	45		34.59	25.55	9.05	9.05	5.59	6.49	3.03
29	2045	-	46		35.26	26.82	8.44	8.44	4.91	5.76	2.23
30	2046	-	47		35.92	28.17	7.76	7.76	4.16	4.94	1.35
	Total			**143.53**	**790.12**	**440.60**	**205.99**	**191.64**	**126.98**	**161.93**	**68.56**
						FIRR	9.95%	8.68%	7.15%	8.69%	4.26%

Note	
1	At the end of 15 yrs, Mechanical equipments may require total replacement. Escalted cost is considered
2	Major repairs for civil structures are expected at the end of 20 yrs. Rs. 10 crs is considered for the same.

Annexure-1

Drawing-I CONCEPTUAL PLAN



SCHEDULE - I

FACILITIES PROPOSED TO BE PROVIDED IN FISHERY HARBOUR:-

		PLINTH AREA
1. SECURITY	-	10 sq.m
2. OFFICE & RADIO COMMUNICATION	-	125 sq.m
3. AUCTION HALL	-	300 sq.m
4. TOILET	-	50 sq.m
5. CANTEEN	-	100 sq.m
6. REST SHED	-	150 sq.m
7. NET MENDING SHED	-	200 sq.m
8. GEAR SHED	-	150 sq.m
9. ICE PLANT	-	200 sq.m
10. EQUIPMENT AND OPERATING ROOMS	-	300 sq.m
11. PETROL PUMP	-	50 sq.m (2 Nos)
12. OVER HEAD WATER TANK	-	100 tons

SCHEDULE - II

PROPOSED DEVELOPMENT AREA FOR FISHERY HARBOUR:-

1. BACK UP AREA	-	9860 sq.m
2. JETTY AREA	-	4740 sq.m
3. SLIP WAY	-	3720 sq.m
4. AREA NEAR APPROACH	-	3480 sq.m
TOTAL AREA	-	21800 sq.m

SCHEDULE - III

PROPOSED AREA FOR REHABILITATION:-

1. Area - 1	-	8840 sq.m
2. Area - 2	-	8760 sq.m
3. Area - 3	-	2300 sq.m
TOTAL AREA	-	199000 sq.m

SCHEDULE - IV

FACILITIES PROPOSED TO BE PROVIDED FOR TRADITIONAL FISHERMEN AT KHAREWADA

		PLINTH AREA
13. OFFICE & RADIO COMMUNICATION	-	50 sq.m
14. TOILET	-	20 sq.m
15. NET MENDING SHED	-	200 sq.m
16. RAMP	-	1 Nos

CLIENT : MORMUGAO PORT TRUST, GOA

PROJECT : PROPOSED POL & COASTAL CARGO BERTHS, FISHERIES HARBOUR & PASSENGER JETTY AT VASCO BAY

TITLE : GENERAL LAYOUT PLAN OF PROPOSED POL BERTHS, FISHERIES HARBOUR & PASSENGER JETTY

CONSULTANT :

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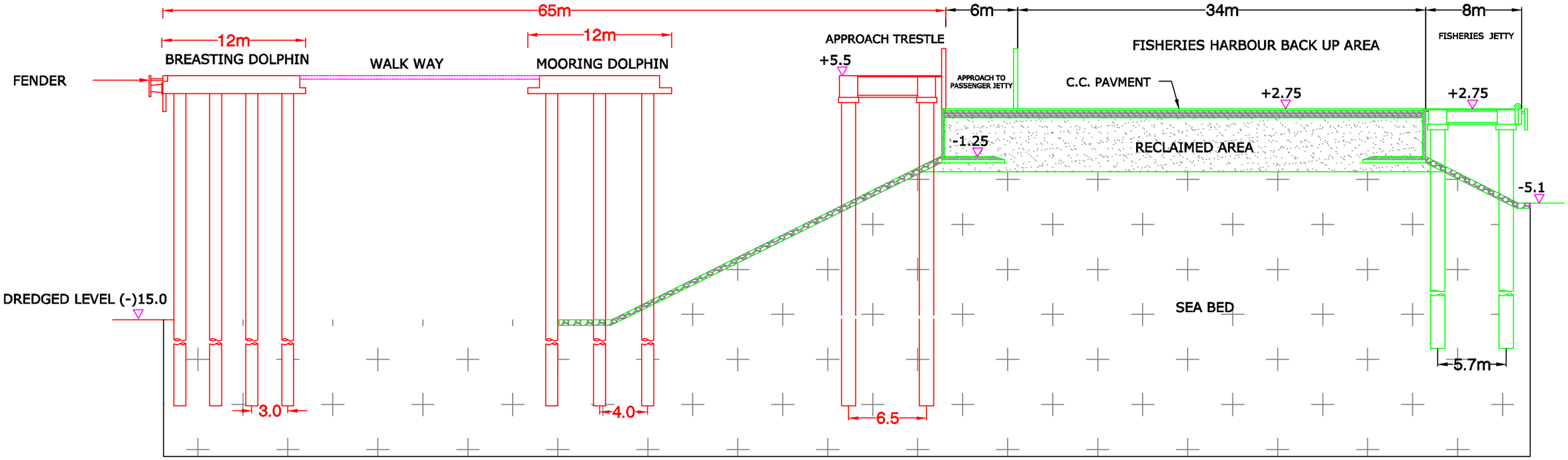
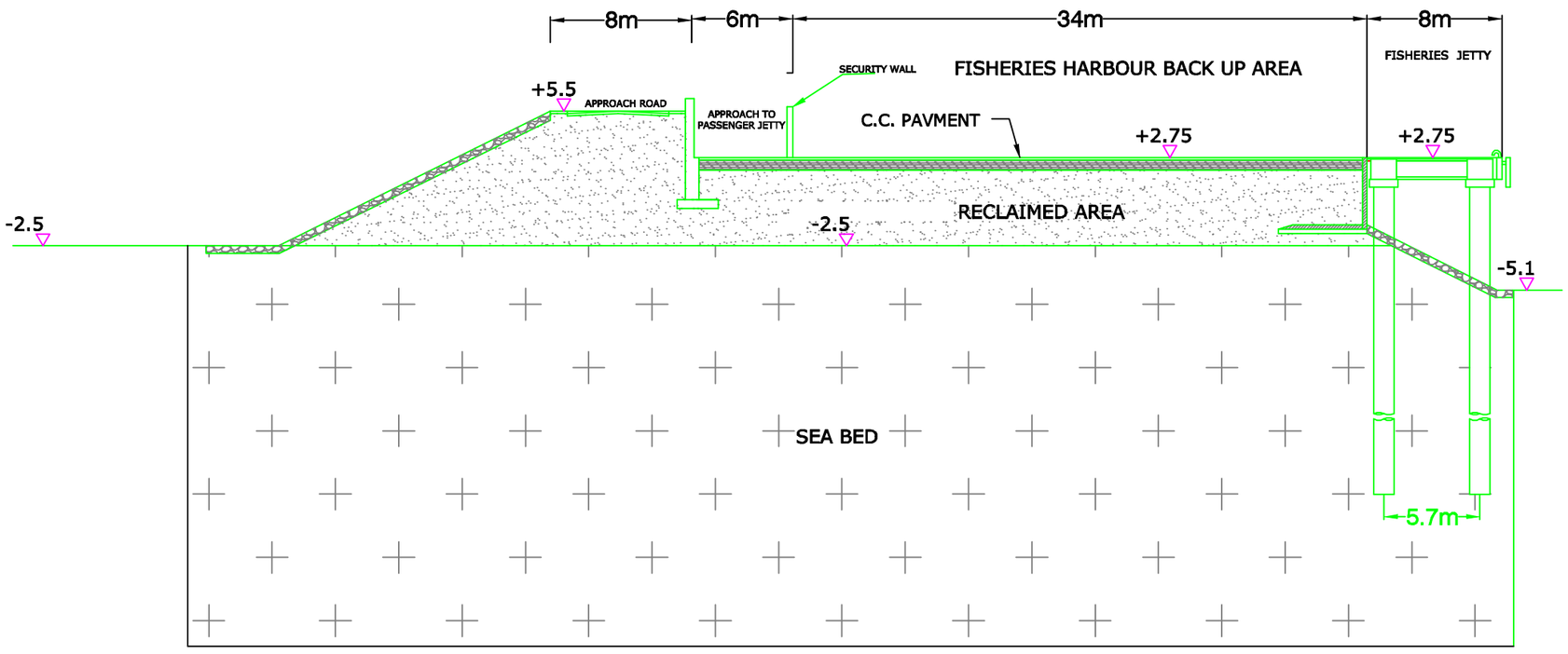
DRNO. AA/2002/MPT/GLPVB/R4	SHEET NO: 1/1	DRAWN BY: PBK
	ISSUED DATE: 19-01-2017	SHEET SIZE: A2

Annexure-2

Drawings-II TYPICAL CROSS SECTION



TYPICAL CROSS SECTION AT A-A'



TYPICAL CROSS SECTION AT B-B'

CLIENT :
MORMUGAO PORT TRUST, GOA

PROJECT : PROPOSED POL & COASTAL CARGO BERTHS, FISHERIES HARBOUR & PASSENGER JETTY AT VASCO BAY

TITLE : TYPICAL CROSS SECTION OF POL BERTH AND FISHERIES HARBOUR

CONSULTANT :

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