Krishnapatnam Port Company Limited

Development of Phase-III at Krishnapatnam Port, Sri Potti Sriramulu Nellore Dist

Pre-Feasibility Report
December 2015

KRISHNAPATNAM PORT COMPANY LIMITED

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1. EXECUTIVE SUMMARY

1.1 Preamble

Krishnapatnam Port, a non-major port on the east coast of India in the state of Andhra Pradesh existing since 1825, is being developed by Krishnapatnam Port Company Ltd (KPCL) into an all-weather, deep water, multi-purpose port through Public Private Participation on BOST (Build Operate Share Transfer) concession basis in terms of a Concession Agreement entered into with GoAP during 2004. The Phase I & II developments of Krishnapatnam Port comprising of 17 berths with required marine infrastructure viz., breakwaters, navigational water ways and shore infrastructure like cargo handling equipment, cargo storage areas, roads and drains, railways, bridges, conveyors, pipelines, water supply, drainage, sewage treatment, power supply, area illumination, offices, operational, functional, welfare and control buildings, amenities, dust suppression measures, greenbelt, mangrove development, environmental measures etc. are under progress in a designated land area of Ha.1,240 (Ac. 3,064 acres) to cater to 72.3 MTPA of various types of cargo plus 3.3 MTEUsPA of container traffic in terms of the EC & CRZ Clearances accorded by the MoEF during 2006 & 2009 respectively for Phases I & II. About 70% of the planned port infrastructure is developed so far and development of balance planned infrastructure is under progress.

GoAP have sanctioned land to the extent of Ha.2,752 (Ac. 6,800) of land for the development of Krishnapatnam Port . Land required for the port development is being leased by the GoAP in terms of the Concession Agreement. GoAP have also been implementing the required rehabilitation and resettlement schemes in the project affected villages. KPCL is augmenting the same under its CSR initiatives.

1.2 External Road and Rail Connectivity

A dedicated 23 Km long four lane road connectivity (feasible to widen to 6 lanes) from Krishnapatnam Port to the National Highway No. 16 has been formed by the GoAP as an external infrastructure. A 19.40 Km long electrified double line rail connectivity from Krishnapatnam Port connecting to the to the National Rail Grid near Venkatachalam Station has been formed by a JV of RVNL, KPCL, GoAP & NMDC.

1.3 Need for Phase III Development

During the past decade, India is experiencing a rapid growth in economic development. As per the Maritime Agenda of Ministry of Shipping, Indian ports, which have a capacity to handle cargo traffic of about 1,240.4 MTPA by 2012, have to plan and augment to a capacity level of 2,600 MTPA by the year 2016-17 and 3,100 MTPA by 2019-20. To cater to the projected increase in traffic volumes, augmentation of the port infrastructure is essential and development of India's ports and trade related infrastructure will continue to be critical to sustain the success of accelerated growth of Indian economy. Krishnapatnam Port is also called upon to augment the cargo handling capacity commensurately.

According to traffic forecast studies undertaken by Krishnapatnam Port duly engaging reputed consultants, the cargo handling through Krishnapatnam Port by 2025-26 would be of the order of 226 MTPA of various types of cargo plus 5.5 MTEUsPA of container cargo as against the port capacity being developed as approved during the Phase I & II developments i.e., 72.3 MTPA of various cargo plus 3.3 MTEUsPA of container cargo. To cater to the projected traffic demand, the capacity of Krishnapatnam Port is to be augmented to handle 154 MTPA of various cargo (218-72.3=145.7) plus 2.2 MTEUsPA by 2025-26 by developing 20 number of berths plus 3 number of Single Buoy Moorings (SBMs), along with required marine and land based infrastructure catering to loading / unloading, storage and multimodal transshipment of cargo systems during the envisaged Phase III development in an area of Ha. 1512 (Ac.3736) of land being leased by GoAP.

1.4 Planning considerations

Utmost care is taken to maintain the environmental compatibility and sustainable development.

The infrastructure requirements have been evolved keeping in view the relevant BIS codes of practice and applicable norms. As the port infrastructure is dependent upon the design ship sizes, duly reviewing the pattern of ships now being deployed on marine transportation routes for similar cargo, ships on order and ships calling at the port etc., the design ship sizes to be followed for various cargo have been arrived at.

The design vessel sizes considered are 380,000 DWT for bulk cargo and 18400 TEU / 14000 TEU for container cargo respectively. In respect of coal, the major commodity among dry bulk cargo, four berths are intended to cater to 380,000 DWT ships. Design and construction of such designated berths will be undertaken to cater to 380,000 DWT vessels. However, the dredging of navigable waterways will be limited to cater to 180,000 DWT ships initially. Based on the demand for deployment of such vessels required widening and deepening of the navigable water ways to cater to 380,000 DWT vessels would be undertaken.

Similarly, feasibility of developing a two lane approach channel upto harbor entrance has been established and the second lane of the approach channel shall eventually cater to container vessels.

The deployment of berths planned / being developed during Phases I & II is reviewed in the context of the envisaged Phase-III development for suitable relocation / re-designation of berths to achieve cargo compatibility and integration with sustainable environmental considerations.

1.5 Infrastructure Proposals of Phase III Development

The Phase III development of Krishnapatnam Port is proposed contiguous to the ongoing Phase I and Phase II developments to optimally utilize the land and water front earmarked by the GoAP for the Master Plan development of the port.

The Phase III development planned in an area of Ha.1512 (Ac.3736) broadly comprises the following:

A. 20 Berths and 3 SBM's within Port Limits (to cater to 154 MTPA of various types of cargo plus 2.2 MTEUsPA of container cargo)

- 7 berths to handle 88 MTPA of coal,
- 6 berths to handle 14 MTPA of general cargo (Fertilizer, agri-products, granite, edible oil, lube oil, barytes and others),
- 4 berths to rationalize the berths being developed in Phase II and to handle 2.2 MTEUsPA of container cargo,
- 3 berths to handle 25 MTPA of liquid cargo (POL, LNG, LPG & crude oil) and
- 3 SBMs to handle 27 MTPA of liquid cargo comprising of 18 MTPA of crude and 9 MTPA of products.

Berths for general cargo, dry bulk cargo and container cargo are proposed in the north dock, the north-west dock, the south dock and the west dock along with required backup areas for cargo storage / warehouses and other pertinent infrastructure. Berths for liquid cargo berths are proposed on the leeside of the south & north breakwaters and SBMs in deep waters within the port limits. It is also proposed to develop 2nos Dry Docks with Fitting out Wharfs to cater to repairs of other needs of the Ports crafts, Coast Guard and commercial vessels.

It is proposed to relocate the container terminal contemplated during Phase-II in the south port area to the west port area on account of environmental considerations, compatibility of cargo handling and efficient road and rail connectivity. Accordingly, cargo handling at the berths has been designated (**Table 5.17**).

B. Cargo Storage Areas:

Storage facilities in an area of Ha.925 ha (Ac.2286), for the additional traffic volumes of various cargo envisaged.

C. Dredging & Reclamation

Dredging in soft soils of approximately 63 million cum for achieving required depths of navigable waterways viz.,

i. widening and deepening of the existing outer approach channel to a width of 300 m wide with a dredge depth of (-) 27.9 m CD to cater to VALEMAX vessels
ii. forming 190 m wide second lane outer approach channel with a dredge depth of (-) 18.9 m CD
iii. widening & deepening of 1st turning circle to 620 m diameter and (-)26.7 m CD
iv. widening and deepening of 2nd turning circle near the west dock to 680 m diameter and (-)18.1 m CD
v. at various berths and maneuvering areas to required depths varying from (-) 15.0 m CD to (-) 24.7 m CD.

Out of the 63 million cum of total dredging to be undertaken for the Phase–III, it is proposed to use about 29 million cum for reclamation of port lands and the balance 34 million cum of dredge material is proposed for disposal at the dumping ground identified in Phase II beyond (-) 20 m contour.

D. Straightening of Khandaleru Creek

Straightening of Khandaleru Creek by forming a straight cut across the existing sand bar in Khandaleru Creek near the west port for development of west dock and thereafter reclaim the meandering north and south arms of the creek by about ha.46 to serve as back space required for the berths.

E. Shore Protection wind ward of the South Breakwater

To conserve the areas windward of the existing south & north breakwaters, it is proposed to undertake necessary protection works to withstand incident waves and reclaim the accreting areas to a uniform level by utilizing the dredged sand. Further, product pipe lines, control houses and safety installations essential required for handling cargo of the LNG / LPG / POL berths as well as break water maintenance facilities are also proposed to be accommodated in the same areas. The extent of reclaimed area between the proposed protection works from the kink of the south breakwater up to the shore is Ha.16.00 (Ac.40). The length of the Shore protection from the kink to the outfall point of the breakwater is about 1300 m. Similarly the extent of reclaimed area between the proposed protection works from the curve at the north breakwater trunk head up to the shore is Ha.16 (Ac.40). The length of the Shore protection from the curve near the trunk head to the outfall point of the breakwater is about 1050 m. The reclaimed area lying beyond the safety zone for the liquid berths would also be used for accommodating other essential infrastructure control and safety installations & allied infrastructure including breakwater maintenance yard. A layout showing the proposed shore protection is enclosed as **Drawing No. KP/PH-III/PFR/07 and 08 respectively.**

F. Replacement of the Existing Mangroves

Existing mangroves within the project area shall be replaced at suitable areas in the proximity of the port.

G. Changes in Water Bodies

Four ephemeral drains exist in the development area; one of them serving as an agricultural drain and the rest as drainage path for the defunct salt pans. The agricultural drain would be diverted and maintained with the proposed culvert CED1. A culvert “CED 2” is proposed for one drain in the south which is crossing the port boundary and meeting the Buckingham Canal. The other two local drains would be reclaimed along with salt pans and the fish ponds except the part of one drain being maintained with suitable placed pipe lines for tidal exchange to the 9 acres of mangrove being protected.

H. Bridges

Development of Road Bridge RB22 & Rail Bridge RB-11, Relocation of Road Bridge RB-7 & Railway Bridge RB10 is proposed on the Khandaleru Creek. Two road bridges (RB21 & RB 23) & one Road Bridge – cum - Flyover (RB12) are proposed on Buckingham Canal. Two Road Bridges (RB19 & RB20) on the diverted drain / creek, Relocation / Modification of the existing bridge (EX1) on Upputeru creek as a Rail-Cum-Road Bridge are also proposed. Strengthening of 3 existing bridges / culverts on Buckingham Canal (RB16, RB17, RB18) to integrate the Port’s operational area separated by creek system and to facilitate faster deployment of heavy duty trucks and railways for transport of cargo to / from port and hinterland as well as reduce smoke emissions from cargo trucks are also proposed. Apart from the above, to ensure free movement of cargo five flyover bridges / grade separators on important road and rail crossings are proposed and are marked as F4-F8.

I. Operational Control Buildings

Development of 10 operational control buildings - Two near corners of North dock (CB-1 & CB-2), One along western end of the Northern Arm (CB-3), Two near corners of the North-West dock (CB-4 & CB-5), four on the corners of the Western Dock (CB-6,CB-7,CB-8 & CB-9) and one near western end of the Southern berthing front (CB-10).

J. Jetty's for Port Crafts, Coast Guard Vessels and Repair Dry Docks

Development of Jetty's to a length of 800 m for the port's crafts along with a jetty of 200 m long for the vessels of the Indian Cost Guard's vessels & crafts are proposed on the south side. A repair dry dock of 150 m length, 40 m width and 12.0 m depth (with (-)9.5 m sill level at entrance) with 200 m long repair quay is proposed at the west end of the south dock near the above jetty's for the repairs and maintenance works of the above vessels.

Also proposed for development is a dry dock facility of 335 m long, 65 m wide and 15.0 m depth (with (-)12.5 m sill level at entrance with 250 m long repair quay close to the northern breakwater at the beginning of the east quay of the northern dock. The proposed dry dock is foreseen for the repairs and maintenance works of the vessels of the mid-size sector of Handy to Panamax size plus a local market share of small ships size of up to 150m length.

Other Facilities

- Augmenting of the navigational aids including Transit Towers and harbour craft along with Pilot Boarding Jetty's / Facilities at the Breakwaters and at West Dock.
- Augmenting the services like roads, railway lines, fly overs / grade separators on major road and rail crossings, surface drainage, water supply lines, and electrical power supply including power lines, erection and commission of additional transformers, electrical switch gear instrumentation and area illumination.
- Augmenting the utilities like operational and disaster management & control buildings, administrative and functional buildings, electrical substations, workshops and repair shops, truck parking.
- Augmenting the environmental protection works like dust suppression systems, truck wash areas, STP and greenbelt.
- Augmenting the welfare and amenity facilities like rest places, dispensaries, canteens, safety appliances etc.
- Development of green pastures on the beaches for aesthetic upgradation.

1.6 Review of Land use Plan

Out of Ha.2752 (Ac.6800 acres) of land sanctioned by GoAP for the development of Krishnapatnam Port, an extent of Ha.1240 ha (Ac. 3064) of land is designated for Phase I and Phase II development. In addition to the above, the water body of about Ha. 133.6 (Ac.330 acres) where mangroves exists and development of mangroves as directed by MOEF during the Phase II development shall be retained intact.

Phase III development is now proposed in an area Ha.1512 ha (Ac.3736) of land.

1.7 Estimated Capital Cost of Phase III, Viability, Project Implementation Period

The estimated cost of development of the infrastructure envisaged during Phase III is **Rs. 12,256.00 Crores**. The project implementation period is 48 months after receipt of required statutory approvals. It is expected to yield 12 to 14% IRR on the investment, which is acceptable.

1.8 Environmental Aspects

Krishnapatnam Port is accredited to ISO 9001:2008 Quality Management Systems, ISO 14001:2004 Environmental Management Systems, ISO 18001:2007 Occupational Health and Safety Management Systems, ISO 28000:2007 Supply of Chain Security Management Systems.

Environmental monitoring both during construction and operation phases is being carried by Krishnapatnam Port through an agency approved by the MoEF and accredited to the NABL to ensure compliance to the norms. Conditions laid down by the statutory authorities are being scrupulously complied. Periodical monitoring reports are being regularly submitted to the concerned statutory authorities. Krishnapatnam Port will be undertaking the envisaged Phase III project development, duly ensuring compliance to environmental standards, complying with all directions as may be issued by the statutory authorities and implement the Environment Management Plan (EMP) as outlined in the Environmental Impact Assessment (EIA) study being undertaken through an agency approved by the MoEF.

1.9 Social Benefits

The social benefits on account of the proposed Phase III development of Krishnapatnam Port would be as follows:

- Larger employment generation in the port and allied industrial establishments coming up in the region.
- Improvements to the existing roads and other infrastructure in the vicinity due to the development of the port.
- CSR initiatives of port such as housing, education, medical and health, vocational training for employment generation, women empowerment etc. would lead to faster sustainable social infrastructure development of the region
- Overall value addition to the quality of life in the region.

These social benefits will improve the living standards of the communities in the neighbourhood of the port as well as in the hinterland. The employment generation so far due to Krishnapatnam Port is about 7,000 numbers direct and 20,000 numbers indirect. This is likely to go up by about 3,500 numbers direct and 10,000 numbers indirect on account of envisaged Phase III development of the port in addition to the employment generation of Phase II.

Increased revenue would also accrue to the exchequer i.e. Central Government departments like Customs & Excise, Railways, Commercial Taxes and Income Tax etc. Additional revenues would also accrue to the state government of Andhra Pradesh by way of share of revenue and lease rentals as per the Concession Agreement. It is pertinent to mention that during the years 2013-14 and 2014-15 with traffic handling of about 25.2 MTPA & 40.74 MTPA by the port, the revenue accruals to the exchequer i.e. various governmental departments is about Rs. 2,340 Crores & Rs.3953 Crores respectively. The revenue to the exchequer would increase considerably with the projected traffic handling of 154 MTPA of various cargo plus 2.2 MTEUsPA of container traffic upon completion of the contemplated Phase III development.

2. INTRODUCTION

2.1 Identification of the Project and Project Proponent

Ports and harbours are the gateways for trade and commerce as well as transportation of larger volumes of goods across oceans internationally and along the coast. India has a coast line of 7,517 km and the state of Andhra Pradesh has a coast line of 972 km. This provides tremendous opportunity to implement new port projects in Andhra Pradesh and to attract a large share of India's growing sea-borne traffic. The Government of Andhra Pradesh (GoAP) is implementing new port projects through the Public Private Participation (PPP) mode and has entered into a Concession Agreement with Krishnapatnam Port Co. Ltd. (KPCL) for the development of Krishnapatnam minor port into an all-weather, deep water, multi-purpose port. The location of Krishnapatnam Port is given in **Drawing No. KP/PH-III/PFR/01.**

Phase I & II developments of the port in terms of the CRZ and Environmental Clearances accorded by the MoEF vide their orders dt. 26-7-2006 & 13-11-2009 and the CFE accorded by APPCB vide orders dt. 25-5-2004 & 8-5-2010 respectively are currently in progress in a designated land area of Ha.1240 (Ac.3064). Upon completion of the Phase II development, Krishnapatnam Port will have a capacity to handle 72.3 MTPA of various types of cargo plus 3.3 MTEUsPA of container cargo. Phase II layout under development is shown in **Drawing No.KP/PH-III/PFR/02**.

The GoAP vide its letter dt. 15-10-2007 sanctioned an area of Ha.2752 (Ac.6800) of land for the development of Krishnapatnam Port. Krishnapatnam Port has been accredited with international management systems viz: ISO 9001 (Quality Management), ISO: 14001 (Environmental Management), ISO: 18001 (OHSAS Management) and ISO: 26000 (Security Management). The port has also received several awards and accolades for its efficient operations.

The port operations are being undertaken as per CFO accorded by APPCB vide letter dt. 8.6.2009 and renewed periodically. The cargo handling at all the Indian ports i.e., both of the major ports under central government control and non-major ports in the maritime states being developed on PPP mode is continuously increasing in line with the predictions of the Government of India. The cargo handling at Krishnapatnam Port is also increasing correspondingly. Keeping in view the lead time required for development of additional infrastructure, it is considered necessary to initiate the proposal for Phase III Development of Krishnapatnam Port to cater to the traffic forecast up to 2025-26.

Based on the traffic forecast studies carried out through specialized agencies and the ports' own market survey as elaborated in the subsequent sections of this chapter, traffic projections for the Krishnapatnam Port by the year 2025-26 have been assessed as 226.0 MTPA of various types of cargo plus 5.5 MTEUsPA of container cargo.

2.2 Brief Description of the Nature of the Project

Phase III development of Krishnapatnam Port is being planned to cater to about 154.0 MTPA of various types of cargo by the year 2021-22 plus 2.2 MTEUsPA of container cargo by the year 2025-26 comprising of 20 number of berths plus three numbers of SBMS along with marine and land based infrastructure to cater to loading / unloading, storage and multimodal transshipment of cargo.

2.3 Need For the Project and its Importance to the Country and Region

2.3.1 Preamble

Ports play a vital role in the overall economic development of the country. About 90% by volume and 70% by value of the country's international trade is carried out through maritime transport. As per the Planning Commission of India's Working Group Report on Ports prepared during Twelfth Five Year Plan (2012-2017), Indian ports which have a capacity to handle cargo traffic of about 1,240.4 MTPA by 2012 have to plan to augment a capacity level of 2,592.1 MTPA by the year 2016-17 and 3,130 MTPA by 2019-20.

This calls for commensurate development of the port infrastructure to cater to the estimated demand. The Maritime Agenda of MoS, GoI also lay emphasis on development of port capacity of the major ports under control of the GoI and non-major ports in maritime states being developed and managed through PPP as well. The estimated port capacity requirements as per the Maritime Agenda of MoS, GoI, 2020 in respect of major ports, non-major ports as well as non-major ports in Andhra Pradesh are presented in **Table 2-2** here after:

Table 2-2: Estimated Port Capacity Requirements (Source: Maritime Agenda MoS, GoI)

Year	Capacity Requirement in MTPA			
	All the Indian Ports	Major Ports	Non-major Ports	Non-major Ports in AP
2011-12 (Handled)	1240.04	741.36	498.68	75.70
2016-17 (Projection)	2592.12	1328.26	1263.86	174.20
2019-20 (Projection)	3130.04	1459.53	1670.51	207.20

The container traffic capacity estimates as per the Maritime Agenda, 2020 of the MoS, GoI for all the Indian ports including the non-major ports in Andhra Pradesh during the above period are presented in **Table 2-3** here under**:**

Table 2-3: Container Traffic Projection at Indian Ports (Source: Maritime Agenda MoS, GoI)

Year	Container Traffic Capacity			
	All the Ports of India		Non-Major Ports in Andhra Pradesh	
	MTPA	MTEUPA	MTPA	MTEUPA
2011-12	147.56 (Handled)	11.81	0.15 (Handled)	0.01
2016-17	384.45 (Projected)	30.75	41.5 (Projected)	3.32
2019-20	486.39 (Projected)	38.91	61.7 (Projected)	4.94

Accordingly, Krishnapatnam Port, a non-major port in the state of Andhra Pradesh is also called upon to augment its cargo handling capacity commensurately. In view of the developments taking place in the hinterland as well as in the maritime transport, and the longer lead times required to develop cost intensive port infrastructure, the port has undertaken a review of the traffic forecasts by engaging reputed consultants.

The market survey and in-house survey of KPCL have indicated that the projected traffic demand of Krishnapatnam Port by 2025-26 is 226.0 MTPA of various types of cargo plus 5.5 MTEUsPA of container cargo as against the approved port capacity being developed in the Phases I & II of 72.3 MTPA of various types of cargo plus 3.3 MTEUsPA of container cargo. Accordingly necessary port infrastructure to cater to handling of 154 MTPA of various types of cargo plus 2.2 MTEUsPA of container cargo comprising 15 number of berths plus 2 numbers of SBMs along with marine and land based infrastructure to cater to loading/unloading, storage and multimodal transshipment of cargo is required to be developed under the proposed Phase III development of the port.

This has further necessitated a review of the layout and allocation of land and marine infrastructure, cargo handling at various terminals and land use keeping in view the port road and rail connectivity, compatibility of handling the various types of cargo and environmental considerations. It is accordingly considered necessary to re-allocate the berthing front suitably including the development of an integrated container terminal amongst others.

2.4 Traffic Forecast

Based on the traffic forecast studies, the major commodities of cargo and volumes identified to be attracted to Krishnapatnam Port by the year 2025-26 are presented in **Table 2-4** below.

Table 2-4: Traffic Forecast

Sl.No	Cargo Type	Traffic Projected by 2021-22
1	**Coal**	**133.00**
2	**Iron Ore**	**18.00**
3	**General Cargo**	**23.00**
4	**Liquid Cargo** a) LNG 5.0 b) POL, PC, LPG and Edible Oil 15.0 c) Crude Oil & Products 27.0	**52.00**
5	**Containers**	**5.50 MTEUsPA**
	Total	**226.0 MTPA of various types of cargo + 5.5 MTEUsPA of container cargo**

2.4.1 Coal

Coal has been the primary source of commercial energy in the past and has been continuing its legacy. In India, coal is primarily used for power generation, iron and steel products, cement and ceramic material products, paper products, coke manufacturing and chemical manufacture for heating and steam generation.

Large scale import of thermal coal is required for the port based power plants being set up around Krishnapatnam such as APGENCO power plant (2400 MW), Thermal Power Tech (2640 MW), NCC Power Plant (2640MW) and UMPP (Reliance Power – 4000 MW) at the north side of port and four power plants viz Krishnapatnam Power Corporation ltd, Kineta Power Private Limited, Simhapuri Energy Private Limited and Meenakshi Energy Private Ltd at the south side of the port. In addition, a large number of non-captive users also import coal through Krishnapatnam Port. The anticipated coal requirement for all the captive power plants and non-captive users combined is expected to be of the order of **133.00 MTPA** by the year 2021-22 as indicated in **Table 2-5** here under:-

Table 2-5: Coal Traffic

Port Users	Traffic in MTPA		
	Forecast by 2021-22	**Approved Phase I + Phase II**	**Phase III Traffic Projection**
Port Based			
North Side Power Plants	46.00	10.0	36.00
South Side Power Plants	37.00	15.0	22.00
Others			
Hinterland	50.00	20.0	30.00
Total	**133.00**	**45.0**	**88.00**

2.4.2 Iron Ore

Iron ore export capacity of 18.0 MTPA exists at the Krishnapatnam Port. These exports have declined at present in view of the ban imposed by the central government of India. Keeping in view the infrastructure already developed and

nearness to the mining areas, Krishnapatnam Port is likely to attract iron ore exports once the existing ban on iron ore export is lifted by the government.

2.4.3 General Cargo

The general cargo comprises of import/export of fertilizer and fertilizer raw material, edible oil, lube oil, project cargo, granite, sugar, cement & cement clinker, barytes, feldspar, food grains, structural steel, pipes, wood and agri-products etc. The details of major commodities likely to be handled at Krishnapatnam port are as under:-

Fertilizer

India is a developing nation and agriculture is one of the primary contributors to the economy. The fertilizer demand during the terminal year of the 11th Five Year Plan has been estimated as 55 million tonnes. As per the planning commission's report on fertilizers, the demand supply gap estimated is 11.5 MT by the terminal year of the eleventh plan, which has to be met by imports. Krishnapatnam Port occupies a strategic position in the fertilizer imports in view of its location and large warehousing developed in the port. The port is already handling more than 2.0 MTPA of fertilizer imports which is likely to increase further up to 4.0 MTPA.

Granite

Granite exports through Krishnapatnam Port are on the increase in view of its location i.e., nearness to the hinterland. This position will continue during the years to come too and is expected to reach 3.0 MTPA.

Edible Oil

Already 7 numbers of edible oil refineries are operating near the port. Several more are also expected to come up in the near future. Edible oil imports through Krishnapatnam Port are also increasing. It is also likely to continue and further increase in the coming year's upto 3.0 MTPA.

Lubricating oil handling is also expected to materialize in the near future through the Krishnapatnam Port in view of the proposed plant of M/s SHELL of 0.3 MTPA capacity in the proximity of the port.

Other General Cargo

Increased exports of barytes, gypsum, raw sugar, agri and food products, limestone, clinkers, project cargoes etc., are likely to be attracted to Krishnapatnam Port.

Cement

During 2007-08, the export of cement from India touched the 2.16 million tonnes mark. However during 2008-09, the cement export experienced a fall, the export segment of the industry is expected to grow again on account of various infrastructure projects that are being taken up all over the world. Andhra Pradesh is the leading cement producer in India with 23 cement plants and about 25 MTPA installed capacity. Krishnapatnam Port has the advantage to emerge as the port of preference for cement exports and the likely volume of cement / clinker etc., is forecast to be about 9.0 MTPA.

Steel Products

India is the 7th largest producer of crude steel in the world. Currently India exports about 10% of its finished steel production. Additionally, it exports semi-finished steel. Krishnapatnam Port is the nearest port to the steel plants set up in Karnataka and those coming up in the Andhra Pradesh. Therefore, Krishnapatnam Port will be called upon to handle increased exports of iron and steel.

The estimate of total general cargo traffic volume is about **23 MTPA** by the year 2025-26as per details furnished in **Table 2-6** here under:-

Table 2-6: General Cargo

Name of Cargo	Traffic Forecast (MT)	Capacity of Phase I & Ongoing Phase II (MT)	Phase III Requirement (MT)
Fertilizer	4.00	2.65	1.35
Granites	3.00	1.62	1.38
Edible Oil& Lube Oil	3.00	1.71	1.29
Others	13.00	3.00	10.00
Total	**23.0**	**9.00**	**14.00**

2.4.4 Liquid Cargo

India's consumption of petroleum products is only about 1/5th of world's average per capita consumption. As per the planning commission's report, the growth in consumption is expected to be around 2.6 percent per annum.

India's demand for LNG/LPG consumption is increasing. The Gas Authority of India Limited has already taken up the task of developing a supply cum distribution pipeline all across the country. This will eventually call for developing facilities for import of LNG/LPG at the ports. As the consumption centers will be spread throughout the country, more or less all the ports will be required to cater to import i.e., unloading and storage of this commodity in the near future. Krishnapatnam Port is already gearing up to handle LNG traffic.

A MoU has been signed with LNG Bharat Private Ltd Hyderabad to handle **5.0 MTPA** of liquid natural gas at a dedicated berth. Another proposal for setting up of a LNG Re Gasification Terminal with associated facilities of 5.0 MTPA capacity has been finalised with M/s LEPL & Isomeric holdings Sdn. Bhd. (IHSB)

BPCL, IoT Infrastructure & Energy Ltd and Vopak India Ltd have shown a keen interest to handle POL, petro-chemicals, chemicals and edible oils up to **15.0 MTPA** from the port and need dedicated berths.

Yet another entrepreneur from Kuwait M/s. Al-Kharafi group has shown an interest to develop a crude oil refinery near the port and is negotiating with GoAP for the necessary sanctions. They expect to handle 9 MTPA of crude import plus 4.5 MTPA of POL products export initially which is likely to go up to 18 MTPA and 9.0 MTPA respectively calling for three SBMs in the open sea. SBMs for crude are likely to materialize once the plan for setting up of the refinery in the proximity takes shape along with the commensurate POL export facilities.

Liquid cargo berths for handling of POL, LNG, LPG, petrochemicals, chemicals, edible oil and SBMs for crude products are expected to generate a traffic of the order of **15.0 MTPA** of POL and Petro chemicals and **10.0 MTPA** of LNG at the liquid cargo berths and at the same time the refinery is expected to generate about **27 MTPA** of crude and products handling at the SBMs by the year 2025-26.

2.4.5 Container Cargo

With the advent of containerisation, most of the general cargo is being containerized. The container ports on the eastern coast are located at the extreme ends. Due to the absence of a container port near the central part of east coast, Central India and Madhya Pradesh depend on JNPT for their container transports. Even the container traffic pertaining to states of Karnataka, Andhra Pradesh and Tamilnadu also depend on JNPT to some extent. The expected shift of container traffic to Krishnapatnam is assessed as 5.5 MTEUsPA by the year 2025-26 as per Traffic survey of 2013, a more recent traffic survey estimates realization of this traffic volume by 2025-26.

Container traffic also calls for faster intermodal transport movements. Accordingly, an integrated container terminal with exclusive container handling berths is proposed to be developed in the Phase III development with due regard to the port road and rail connectivity and environmental aspects.

2.4.6 Port Craft Berthing and Repair Needs

With the increasing number of dredgers and harbour craft like tugs, barges, launches etc., commensurate lay-by and repair facilities by way of berths, wet basins, repair shops and workshops would be needed. It is therefore considered necessary that the port infrastructure shall cater to the repair needs by way of lay-by, repair jetties, dry dock, outfitting jetty and shore facilities like workshops and storage areas.

2.4.7 Coast Guard Jetty

Berthing facility for Coast Guard vessels is also proposed to be developed as required by them.

2.5 Importance to the Country and the Region

Development or expansion of a port will significantly contribute to the development of region and the country by way of improved imports and exports through the port generating revenues to the exchequer, employment generation and improved social infrastructure.

It is considered worthwhile to mention that with the handling of about 21 MTPA, 25.2 MTPA and 40.7 MTPA of cargo through Krishnapatnam Port during the years 2012-13, 2013-14 and 2014-15, the annual revenue accruals to various departments of the exchequer is about Rs. 1950 Crores, Rs. 2340 Crores and Rs. 3952 Crores as per details presented in **Table 2-7** here under:

Table 2-7: Revenue Accruals on Account of Krishnapatnam Port

Sl No	Government Department	Amount in Rs. Crores		
		2012-13	2013-14	2014-15
1	Customs & Excise Department	640.96	969.65	1,601.76
2	Railways	1056.92	1133.92	2,059.09
3	Central Taxes	227.19	194.11	241.95
	Total Annual Revenue accrual to Central Government	1925.07	2297.68	3902.80
4	GoAP by way of lease rent on land and concession fee	22.63	41.36	49.50
	Gross Annual Revenue accrual to Exchequer	**1947.70**	**2339.04**	**3952.30**

The revenue accrual to various departments of the Central and state Government attributable to cargo handling through Krishnapatnam Port is expected to grow with the increase in the volume of traffic handling. Thus, Krishnapatnam Port will undoubtedly emerge as a source for earning considerable revenue to the exchequer i.e., various departments of the Central and State Governments. These revenues get invested by the government in the needy sectors which in-turn generates developments in all related sectors.

Further, Krishnapatnam Port development has also been contributing to the accelerated growth of the region as well as the hinterland. The region is already witnessing industrial development by way of setting up of a large number of edible oil refineries, power plants and other industries in the proximity of the port. The development of Krishnapatnam Port is further contributing to the regional infrastructure development in all associated sectors viz., industrialization and SEZ's. Many more developments in the region are on the anvil.

These developments attributable to development to Krishnapatnam Port are contributing to direct and indirect employment generation, an improvement in the overall standard of living, development of social infrastructure like housing, education, health, etc. These positive impacts will continue to take place. Krishnapatnam Port is also undertaking schemes under its corporate social responsibility for improvement of the overall living standards in the neighbourhood villages.

The direct and indirect employment generated due to the port as on date is of the order of 7,000 numbers and 20,000 numbers, respectively.

2.6 Demand Supply Gap

In respect of the port, demand supply gap shall mean the gap between the port capacity requirements versus the port capacity availability. By undertaking substantial reviews of the traffic forecasts carried out through reputed experts and market surveys, more realistic estimates of traffic demand by the terminal year 2025-26 have been arrived at as 226.0 MTPA of various types of cargo plus 5.5 MTEUsPA of container cargo and the demand-supply gap assessed is presented in **Table 2-8** here under.

Table 2-8: Demand Supply Gap in Port Capacity for the Terminal Year 2021-22

S.No	Cargo	Units in MTPA/MTEUsPA		
		Traffic Projection by (2021-22)	**Approved Port capacity of Phases I & II**	**Gap in Capacity**
1	Coal	133	45.0	88
2	Iron Ore (Cum-Multipurpose)	18	18	-
3	General Cargo	23	9	14
4	Liquid Cargo	52	0.3	51.7
5	Containers	5.50 MTEUsPA	3.30 MTEUsPA	2.2 MTEUsPA
	Total	**226 MTPA Cargo + 5.5 MTEUsPA of Container Cargo**	**72.3 MTPA Cargo + 3.3 MTEUsPA of Container Cargo**	153.7 or say **154 MTPA Cargo+2.2 MTEUsPA of Container cargo**

To bridge the demand-supply gap of 154.0 MTPA plus 2.2 MTEUsPA of the port capacity by 2025-26, Phase III expansion of Krishnapatnam Port is envisaged.

2.7 Import Vs Indigenous Production

In as much as a port is not an industry but a facilitator, expansion of the port as already mentioned catalyzes the regional development through a rapid industrialization and growth of related infrastructure. Some of the imports serve as raw materials for various production purposes and increase domestic revenue accruals of the product thus generated on account of the value addition and also earn customs duty.

For example: To meet India's thermal coal and coking coal requirements for the steel plants and power plants, imports are taking place through various ports in India including Krishnapatnam Port from countries like Australia, Indonesia and South Africa. The imports via Krishnapatnam Port augment the production of more quantities of steel and more MW of power needed for the essential sectors which in turn contribute to increased indigenous production in relevant sectors. Similarly, the imports of fertilizers will contribute to increased agricultural yields and production of essential food grains etc.

The planned Phase III expansion of the Krishnapatnam Port involves procurement of certain construction equipment and higher capacity cargo handling equipment from overseas. Other items and technologies required will be mostly indigenous.

2.8 Export Possibility

As mentioned in the foregoing, expansion of Krishnapatnam Port Phase III will enable increased exports of domestic products like granite, ores, food grains and agri products, textile, tobacco, machineries etc., as bulk cargo/ general cargo/ container cargo as the case may be.

Port development also catalyzes establishment of SEZs which in turn result in considerable exports of end products.

The cargo exports through the ports result in considerable amount of Foreign Exchange earnings to the country.

2.9 Domestic / Export Markets

The Krishnapatnam Port, like all other ports of India facilitates development of both domestic and export markets for the products to be imported or exported by various port users.

Imports are: Dry Bulk Cargo like Coal, General Cargoes like Fertilizers, Chemicals, Edible Oil, Lube Oil, Timber, Machineries and Liquid Bulk like LPG, LNG, POL Products, and Chemicals, etc.

Exports are: Bulk Cargo like Ores, Minerals, General Cargoes like Granite, Textiles, Agro-Products, Lubricants, Steel, Machineries and Liquid Bulk like POL Products, Chemicals etc.

2.10 Employment Generation Due to the Project

Port expansion results in direct and indirect employment during the construction and operation. Owing to the nature of port acting as catalyst in triggering faster development of the region and hinterland, large scale indirect employment is likely to be generated in the port based industries and SEZs to be set up in the proximity of the port and various associated service sectors. The direct and indirect employment on account of proposed Phase III development of port and associated developments in the industries shall be of the order of 13500 workers of both skilled and unskilled categories.

3. PROJECT DESCRIPTION

3.1 General

Considering the liberalized Indian economy which is poised for a rapid growth, GoAP having recognized that ports would play a pivotal role in the emerging buoyancy in international trade of the Andhra Pradesh coast and in order to facilitate developments in power sector, industry, agriculture, mineral exploitation etc., decided to develop the existing Krishnapatnam minor port into a multipurpose all-weather, deep water port to handle the EXIM cargo while supporting the socio-economic growth in the region. Accordingly, the development of Krishnapatnam Port through PPP mode on BOST basis is being undertaken by M/s. Krishnapatnam Port Company Ltd in terms of the Concession Agreement entered into during the year 2004 with the GoAP. Krishnapatnam Port will continue to play a catalytic role in bringing about an industrial revolution in Andhra Pradesh, eastern Karnataka & northern Tamil Nadu by way of increased exports and imports to / from the hinterland leading to development of cement and steel industries, thermal power plants and many allied industries SEZs (special economic zones), logistic parks etc.

The Phase I & II developments of the Krishnapatnam Port cater to authorized port handling capacity of 72.3 MTPA of various types of cargo plus 3.3 MTEUsPA of container cargo. The approved facilities developed in 1240 ha (3064 acres) of land comprise of 17 nos of berths (3 in Phase I and 14 in Phase II - including one berth for liquid cargo) with necessary harbour protection works i.e., breakwaters, dredging and reclamation, navigational water ways viz: approach channel, turning circle, dock basins, navigational aids, harbor crafts etc., shore based infrastructure like cargo storage areas, roads, railways, bridges, water supply, drainage, operational, functional, administrative, disaster management-cum-control, welfare and amenity buildings, cargo handling equipment, conveyors, pipe lines, water supply, electrical power, area illumination, environmental works like greenbelts, STP, dust suppression measures etc.

The CFO accorded by the APPCB vide order dt 8.6.2009 is being renewed periodically. Facilities created so far in Phases I & II development of Krishnapatnam Port are 10 berths and allied marine and shore based infrastructure. Development of the remaining berths along with associated infrastructure is now under progress.

The 12th Plan Working Group Report on ports of the Planning Commission and the Maritime Agenda 2020 of the Ministry of Shipping, GoI emphasized the need to increase the capacity of ports in India including the non-major ports in maritime states. Accordingly, duly reviewing the traffic forecasts for various types of cargo likely to be routed through Krishnapatnam Port, it is assessed that by the year 2025-26, there is a need to increase the capacity of the Krishnapatnam Port to handle 154 MTPA of various types of cargo plus 2.2 MTEUsPA of container cargo. This is in addition to the approved cargo handling capacity being created at Krishnapatnam Port in Phase I & Phase II.

3.2 Type of Project Including Interlinked and Interdependent Projects

The present project 'Phase III development of Krishnapatnam Port' is a port project catering to development of an additional 154 MTPA capacity to handle various types of cargo comprising of dry bulk cargo like Coal / Iron ore / limestone / Mines & Minerals & Other dry bulk cargo, Multipurpose & General break bulk cargo like Fertilizers and raw materials for manufacture of fertilizer / food grains / sugar / clinker / cement / Project cargo / timber & wood / machines/ Iron & steel products / Break Bulk etc., besides Edible oil, lube oil, liquid & Gas bulk cargo like Crude oil / Naphtha / POL / LPG / LNG / Ammonia / Chemicals / Phosphoric Acid / motor spirit / Kerosene / Aviation fuel / High speed diesel / Lubricating oil / Butane / Propane / CNG / Furnace Oil / Low sulphure heavy stock / Petro-chemicals, chemicals, crude etc., plus 2.2 MTEUsPA of container cargo by 2025-26.

The project proposals comprise of the development of 20 nos of berths (including three nos for Liquid cargo), 3 nos of SBMs along with marine and shore-based multimodal cargo transshipment infrastructure facilities comprising of road / rail network, bridges, storage areas, water supply, power supply, surface drainage, mechanical cargo handling equipment, belt conveyors, pipelines, environmental protection works, operational, functional, administrative, disaster management-cum-control and amenities building, Shore Protection & Reclamation works besides development of operation & maintenance infrastructures including 2 nos Dry Dock / Ship Repair Facilities (one for ports own craft, vessels of Indian Coast Guard and the other to cater to Naval & commercial vessels) with jetties / quay for berthing to facilitate repair and outfitting of vessels, port's maintenance dredgers, tugs, pilot launches, mooring boats etc., (Fitting Out Wharf's). The development of about 1000 RM of berthing facilities for the various Port Crafts and the Coast Guard vessels operating from Krishnapatnam Port base as requested by them is also catered to. This proposal also includes development of an integrated container terminal by relocating some of the container berths contemplated under the Phase II development (from along the southern arm to the western dock) keeping in view the port's road and rail connectivity, compatibility of cargo handling and environmental considerations.

Phase III development of Krishnapatnam Port is an independent project. There are no interlinked or interdependent projects to be processed simultaneously.

3.3 Location

Krishnapatnam port is located at 14^0 15' 10" N Latitude and 80^0 08' 05" E Longitude in the Sri Potti Sriramulu Nellore district of Andhra Pradesh and is situated at about 180 km north of Chennai Port on the east coast of India.

3.4 Details of Alternate Site

The GoAP embarked on the development of Krishnapatnam Minor Port (operating since 1825) into deep water, all weather, multi-commodity Port on PPP mode through BOST basis and awarded the Concession during 2004 to M/s. Krishnapatnam Port Company Limited. The GoAP have subsequently sanctioned land to an extent of Ac. 6800 for the development of Krishnapatnam Port vides its lr. dt. 15-10-2007. 70% of planned infrastructure of Phase-II development of the Krishnapatnam Port is completed on date and balance infrastructure in progress is expected to be completed soon. The proposed Phase-III expansion is located within the limits of the Ac. 6800 of land sanctioned by the GoAP for the Krishnapatnam Port. Examining alternative sites for the development of Krishnapatnam Port was considered by GoAP prior to embarking on the development of the minor port into an all-weather, deep water, multi-commodity port. As the Krishnapatnam Port has already been established & operational and the present project being an Expansion of the existing port and will be developed within the notified port limits, study of site alternatives is not relevant for the proposed Phase III expansion of the port. However alternative layouts within port have been examined separately in **Chapter -5**.

3.5 Size or Magnitude of Operation

The envisaged expansion plan for the Phase III development of Krishnapatnam Port caters to creation of an additional port capacity to handle 154 MTPA of various types of cargo plus 2.2 MTEUsPA of container cargo expected to be routed through the port by the year 2025-26. This is in addition to the cargo handling capacity of 72.3 MTPA of various types of cargo plus 3.3 MTEUsPA of container cargo authorized during Phase I & II developments of the port. With the expansion of Phase III which is now envisaged, the total port capacity would cater to handling of 226.00 MTPA of various types of cargo plus 5.5 MTEUsPA of container cargo.

Based on the vessel sizes expected to call at the port for various types of cargo, the required marine infrastructure to enable safe navigation and maneuvering of the vessels and shore based infrastructure including the cargo handling equipment are contemplated under the Phase III development of the port in a land area of Ha.1512 (Ac.3736).

3.6 Project Description With Process Details

The Phase III development of Krishnapatnam Port is proposed contiguous to the developments of Phases I & II and to optimally utilize the land earmarked by the GoAP for the Master Plan development of the port.

The proposed Phase III development of Krishnapatnam Port accordingly comprise of the following main components:

i. Construction of 20 berths (including 3 nos for handling liquid cargo) plus 3 nos SBMS to handle the additional cargo forecast.

ii. Procurement, installation and commissioning of cargo handling i.e., loading / un-loading equipment, cargo transfer systems (i.e., receiving / dispatch) like conveyors, RO – RO system, yard equipment, pipe lines etc.

iii. Site grading and leveling work.

iv. Development of cargo storage yards, warehouses, Tank Farms and areas for Free Trade Zones, Port based Industries and Container Freight Station.

v. Construction of a suitably designed rubble mound Shore Protection of about 1300 m long - south of the south breakwater spanning the mid length kink to the shore. The enclosed area of about Ac.41 is proposed to be utilized for pipeline corridors for the LNG, LPG, POL & crude oil and to accommodate related essential control / safety installations and allied infrastructure including South Breakwater maintenance facility by suitably reclaiming the same with dredge sand.

vi. Construction of a suitably designed rubble mound “Shore Protection” of about 1050 m long north of the North breakwater spanning between the Round-Head and the shore. The enclosed area of about Ac.40 is proposed to be utilized for pipeline corridors for the POL and to accommodate related essential control / safety installations and allied infrastructure including North Breakwater maintenance facility by suitably reclaiming the same with dredge sand.

vii. Development of the mangroves in suitable areas as a replacement of the mangroves falling with in the proposed project area for Phase III development. The said work will be undertaken duly availing expert advice with a request to the MoEF to place the onus of development and maintenance of mangroves on the Project Authority (GoAP) with the entire funding coming from the Concessionaire.

viii. Training of the Khandaleru creek at a location South-West of the Turning Circle No.2 by forming a straight cut across existing sand bar and thereafter reclamation of the meandering north and south arms to develop back space required for the West Dock berths.

ix. Dredging of 63 million cum for development of waterways and widening / deepening of existing port waterways including a second lane of the approach channel and undertaking maintenance dredging of 1.02 million cum per annum thereafter.

x. Reclamation of the low lying areas to make up the elevation of the existing land to the proposed working level with 29.0 million cum of dredged material and disposal of balance 34.0 million cum of dredged material at the approved disposal ground in the sea, beyond (-)20 m contour.

xi. Augmenting the necessary navigational aids and harbour craft.

xii. Augmenting the In-Plant services like roads and drains, railway lines, flyovers / grade separators on important road and rail crossings, bridges, water supply lines and electrical power supply including power lines, Pipe line corridor for Oil, LNG, LPG & POL, Conveyor's, erection and commissioning of additional transformers, electrical switchgear instrumentation and area illumination.

xiii. Augmenting the utilities like operational and disaster management cum control buildings, administrative and functional buildings, electrical substations, workshops and repair shops, Training & Skill Development Centers, truck parking areas.

xiv. Development of two nos Dry Docks with Fitting out Wharf / berthing and repair facilities for the port's dredgers and harbour craft etc., as well as Naval, Coast Guard and commercial vessels to ensure uninterrupted and safe port operation viz., lay-by and repair quay, work shop etc..

xv. Development of jetties about 1000 m long for berthing Ports Crafts and Coast Guard vessels with suitable back up yard for related facilities on a requested by them.

xvi. Augmenting the environmental protection works like dust suppression systems, truck wash areas, STP and greenbelt and Rain Harvest Systems.

xvii. Augmenting the welfare and amenity facilities like rest places, dispensaries, canteens, safety appliances etc.

xviii. Augmenting of on-line continuous AAQ monitoring equipment and

xix. Development of green belt along the beaches for aesthetic up gradation

3.7 Raw Material Required Along With Estimated Quantity

As the port is not a processing industry, requirement of raw material is not pertinent. Only construction materials like borrow earth (in addition to use of dredged material for reclamation) for making up the land to required elevation, stone aggregates for concrete works, road works and railway works; sand, bricks, stones of various sizes for breakwater construction etc. would be needed in addition to cement and steel. Details of the approximate quantity of construction material are given below:

- Soil / Gravel – 17.5 million tons
- Sand – 4.0 million tons
- Stone aggregates – 11.0 million tons
- Dredge material – 29.0 million cum

3.8 Resource Optimization / Recycling and Reuse Envisaged in the Project

The low lying areas would be reclaimed to the required elevation by re-cycling suitable dredged material in order to save the scarce natural resources (borrow earth). It is estimated that about 29.0 million cum of dredged material would be utilized for this purpose. Treated effluent from the Sewage Treatment Plants (STP) will be recycled for dust suppression and greenbelt. Similarly resource optimization by way of resorting to alternative materials for construction like fly ash gypsum bricks, aluminum and alloy steel door and window frames etc. would also be considered.

Rainwater harvesting ponds will be augmented for recharge of the aquifer and to conserve ground water.

Garland drains, collection pits and guard ponds will be developed for the coal yards and the run off would be recycled for dust suppression as is being done at present.

3.9 Availability of Water, Its Source, Energy / Power Requirement

3.9.1 Water Requirement

Water supply planned for Phases I & II will be extended to cater to Phase III development requirement comprising of:

- Potable water for consumption of operating personnel
- Potable water for ships calling at the port
- Water for dust suppression system
- Water for greenery
- Miscellaneous (Fire Protection)

The water requirement for the port upon completion of the proposed Phase III development for the above purposes is assessed as 5.0 MLD including 2.5 MLD envisaged for Phase I & II developments.

In terms of the Concession Agreement, GoAP has made a provision of 1 MLD of water supply from Muthukuru Reservoir for use at Krishnapatnam Port. GoAP also permitted drawal of 4.0 MLD of water from the Nakkala Kalava irrigation drain. Water from Muthukuru Reservoir is intended to meet domestic requirements for consumption. Water from Nakkala Kalava irrigation drain would be used for dust suppression, green belt, fire-fighting and other allied needs. STP treated effluent would also be recycled for plantation and dust suppression needs.

3.9.2 Power Requirement

The power required for port activities has been estimated based on the needs of cargo handling equipment and other operational uses including general consumption and illumination.

The power requirement which is about 45 MW for the Phases I & II would increase to 130 MW with the proposed development of Phase III. To meet power requirements, a 132/33 KV substation was built by KPCL in the port limits and APTRANSCO has committed to power supply of 45 MW, from the grid to the existing substation in the port limits. Additional power supply for Phase III would also be obtained from the APTRANSCO's power grid. As the port is supporting a number of power plants no shortage in power is expected.

Standby diesel generators of adequate capacity will be ensured to cater to emergencies during power failure. Uninterrupted power supply will be ensured for the IT system.

3.9.3 Quantity of Wastes to be Generated

About 90% of the waste likely to be generated at the port is bio-degradable type like road sweepings, food waste etc., which is about 900 kg/day would be subjected to composting for use as manure for green belt within the port.

About 10% of the waste likely to be generated at the port is non-biodegradable like plastic, shall be collected and disposed through vendors approved by APPCB duly following the norms. The non-biodegradable waste is about 100 kg/day.

Reuse/disposal/management of waste shall be as under:-

- Construction wastes and road sweepings, dust, would be used for land fill
- Food waste would be recycled as compost
- Non-biodegradable (plastic waste, used oils) wastes shall be disposed to APPCB authorized vendors.
- Used batteries shall be disposed by insisting on buy back while procuring.
- Cargo spillages shall be collected and cargo shall be returned to storage yards.
- Treated water from STP will be recycled for plantation and dust suppression purposes and sludge generated from STP shall be used as manure.

3.10 Schematic Representation of the Feasibility Drawing

The layout of the port infrastructure planned under Phase III development of Krishnapatnam Port along with existing port facilities is shown in **Drawing No. KP / PH-III / PFR / 03.**

4. SITE ANALYSIS

4.1 Connectivity

Krishnapatnam Port is located in the state of Andhra Pradesh on the east coast of India. It is about 180 km north of Chennai. Nellore town, the district headquarters of Sri Potti Sriramulu Nellore district lies at a distance of 25 km north-west and is the nearest town to the port. Krishnapatnam is connected by a 27 km long district road to Nellore. Another district road to Venkatachalam connects the national highway NH16 (Old NH 5 from Chennai to Calcutta) at Venkatachalam.

A 23 km long 4 lane dedicated port road connectivity from Krishnapatnam Port to the National Highway NH 16 (old NH 5) with feasibility to widen to 6 lanes has been formed by the GoAP in terms of the Concession Agreement.

The main BG trunk railway line connecting Chennai with the east and north passing through Nellore runs parallel to the coastline about 25 km away from the Krishnapatnam Port site. The nearest railway station is Venkatachalam.

A 19.4 km long electrified port rail connectivity from Krishnapatnam Port to Venkatachalam connecting the National Rail Grid is formed by the RVNL as a JV with GoAP, KPCL and other agencies to cater to traffic to / from the Port. Doubling work of the Port Rail Connectivity is nearing completion.

The nearest domestic airport is Tirupati at a distance of 120 km from the Krishnapatnam Port and international airport is at Chennai about 180 km from the port.

The existing port road and rail connectivity to the national transport network is shown on **Drawing No.KP/PH-III/PFR/04 (TOPOGRAPHIC DETAILS)**.

4.2 Land form, Land Use and Land Ownership

Krishnapatnam is a port town in Muthukuru Mandal of Nellore District. The port site is located at the confluence of Khandaleru. The neighbourhood villages to the port are Krishnapatnam, Gopalapuram on the north, Chalivendra and Narkellapalli, Pantapalem on the west and Gummala Dibba and Tammenapatnam on the south.

GoAP is the owner of the entire land and land for development of Krishnapatnam Port is being transferred on lease basis by the GoAP to KPCL in terms of the Concession Agreement. Land to an extent of Ha.2,752 (Ac.6800) including has been sanctioned for the development of Krishnapatnam Port by the GoAP during 2007.

The Phase I & II developments of the port have been approved in an area of Ha.1240 (Ac.3064) as per the CRZ and Environmental Clearances accorded by the MoEF within the limits of the land sanctioned by GoAP for the overall development of the port. Development of Phase III is now proposed in the balance extent of the land measuring Ha.1512 ha (Ac.3736).

The area earmarked for Phase III development of the port comprises of lands in possession of GoAP, forest lands and salt pans. In respect of land measuring Ha.418 (Ac.1033) belonging to Forest Department and Ha.314 (Ac.775.50) belonging to Salt Department, requisitions have been placed by the GoAP on the concerned authorities for transfer of these lands. Action is also being taken by the GoAP to expedite the process of handing over of these lands on lease basis to KPCL.

Existing mangroves in and around the port including an extent of Ac.9 as stipulated in the EC Conditions by MoEF for Phase I development are being protected even though said area (lying in the salt lands) is yet to be transferred by GoAP to KPCL. Mangroves to an extent of about Ha.50 (Ac.124) are being developed by KPCL in terms of the stipulation by MoEF while according EC for Phase II development of the port. In addition to the above, Mangroves spread over an area of Ha.111.87 present within the port boundary will also be protected.

4.3 Topography (along with Map)

Nellore district is generally flat and low elevation. Most of the area falls in the category of slopes less than 2%. It can be broadly divided into two divisions. The eastern half of the district is fairly flat and comprises of sandy coastal belt extending all along the district up to 7 km from sea coast. Krishnapatnam Port site which falls in the eastern half of the district comprise coastal plains, a few ephemeral creeks and the defunct Buckingham Canal. The port site is located at the confluence of the Khandaleru creek (Upputeru) with the Bay of Bengal. The port area consists of coastal plains. The terrain is generally flat. The topography details are shown in **Drawing No.KP/PH-III/PFR/04.**

4.4 Existing Land use Pattern

Land use of the project area around the Krishnapatnam Port site is predominantly rural. The immediate vicinity of Krishnapatnam Port, north and south of Khandaleru creek, is predominantly barren. Details of land use pattern are as under:-

Within Port Boundary

- Along the western side of Buckingham Canal, between Upputeru Creek and the Muthukuru road, the peripheral areas on the north and west have already been developed for port use during the Phase II. The remaining area is open scrub with abandoned salt pans and a few degraded mangrove patches. In this area it is proposed to develop port facilities such as coal stock yards, warehouses, rail, road, belt conveyor and pipeline facilities without disturbing the mangroves in an area of about Ac. 9.0 which is required to be protected as per Condition of Environmental Clearance for Phase I.
- The area between Muthukuru Road and Krishnapatnam Village along western side of Buckingham Canal is open scrub with abandoned salt pans and a few sparse patches of mangroves. A few road and railway lines have been developed along the Buckingham Canal as a part of the development of the Phase II and the balance area is now proposed for development of general cargo storage facilities, warehouses, truck parking, road & railway lines without disturbing the mangroves.
- On the eastern side of Buckingham Canal, a water body of about Ac.330.67 along with mangrove patches exists and these are being protected and will not be disturbed while further developed.
- Between the water body detailed above and the open coast, the area is barren vacant land with grass and other vegetation. This area is proposed to be used as coal storage area supported by roads and conveyor system running parallel to the coast in continuation of the existing Phase-II port facilities down South abutting Khandaleru Creek.
- About Ac. 1033 of Ipuru Reserve Forest land is located within the limits of the land sanctioned by GoAP for the development of the Krishnapatnam Port.

These are open scrub lands and are designated for the proposed Phase III development as a container terminal.

- The upper stretch of Khandaleru Creek within port boundary bifurcates into two arms separated by a sand bar. It is proposed to develop this area for construction of berths taking advantage of the main course of the creek. Some mangrove patches exist and it is proposed to replace them into the adjacent areas between the Ipuru Reserve Forest islands.
- On the southern side of the Khandaleru Creek the land is a scrub area with some vegetation comprising of Casuarina and cashew plantation. The area abutting the creek has already been developed during the Phase-II and further areas along the western and southern boundary are proposed to be developed as storage of general cargo, container freight stations, warehouses, Port based Industries, Free Trade Zones, coal storage, petro chemical storage, LNG storage & internal roads, railway lines, belt conveyors and pipelines.

The developments of Phase I & II were planned in an area of Ha.1240 (Ac.3064) of the designated land. The envisaged land use of this area of Phase I & Phase II developments is for various port's operational and other purposes such as development of berthing front, cargo storage areas, roads, railway lines, drains, bridges, circulation spaces, greenbelts, services, utilities, amenities, buildings etc.

Outside Port Boundary

- There are no national parks, marine parks, sanctuaries, wild life habitats including biosphere reserves, structures of archaeological importance and heritage sites within 15 km of the proposed project boundary.
- Tammenapatnam Reserve Forest (RF) is located south-west of the project site and beyond the Khandaleru Creek; Ipuru Reserve Forest is located to the north-west of the project site. These are mainly open scrublands interspersed with Casuarina plantations. Further south, Mommidi Reserve Forest (4.5 km), Kottapatnam Reserve Forest (3.5 km), open scrub with mixed vegetation, predominantly Casuarina and some cashew plantation are observed. Social forest comprising Casuarina plantations are also observed.

4.4.1 Straightening of Creek

Khandaleru Creek emanating from the upstream area to Krishnapatnam Port joins the Bay of Bengal near Krishnapatnam Port. Krishnapatnam Port development is taking place in phases, in and around the existing waterway and the lagoon area without hindering the flow through the Khandaleru Creek. In the western part of the lagoon on account of a shoal, the Khandaleru Creek flow is split in two streams with one meandering waterway towards the south and another meandering waterway towards the north, circumscribing the sand bar. For development of the port facilities contemplated under Phase III, it is necessary to form a harbour basin by forming a straight cut through the island and then reclaiming the meandering north and south arms to form the back space of berths. The proposal is shown in **Drg. No. KP/PH-III/PFR/05**. The existing width and cross section of the water way of Khandaleru Creek, upstream of the existing proposed straight cut, will be left undisturbed and by forming the straight cut, the flow will improve facilitating effective regulation of the creek. Further, as the straight cut is proposed to be utilised as a dock basin with a dredged level of (-) 17.30 m with berthing front on either side, deeper water would ensure unhindered discharge of upstream flood water and tidal exchange all through. The proposal detailed as above is also in corroboration of the recommendations of the Department of Irrigation, GoAP, who have recently conducted a survey of all such water bodies / creeks / rivers in the vicinity of the Krishnapatnam Port.

4.4.2 Development of Mangroves

The proposed Phase III development of the Krishnapatnam Port involves replacement of some mangroves existing on the upper stretches of Khandaleru creek between the Ipuru Reserve Forest islands in the project area. The exact extent will be known upon completion of the HTL, LTL and CRZ Demarcation Survey undertaken through an agency approved by the MoEF. The CRZ Survey map to be prepared by such agency will be submitted with the EIA Report. For development of mangroves in replacement of these mangroves, suitable area would be identified in the proximity of Krishnapatnam Port, in consultation with experts in this field.

Action for replacing of the mangrove existing in the areas designated for the Phase III development of the port to suitable areas outside the project area will be undertaken under close liaison with the experts. Suitable funds are earmarked in the project estimate towards the same. The area of mangrove requiring replacement and the area outside the project area identified for shifting are shown in **Drawing No./KP/PH-III/PFR/06.**

4.4.3 Shore Protection- South of South Breakwater

It is proposed to construct a rubble mound shore protection south of the south breakwater over a length of about 1300 m and reclaim an area of about Ha. 41. It is proposed to utilize the same for developing pipeline corridors for the LNG, LPG, POL & crude oil and to accommodate related essential control / safety installations and allied infrastructure including breakwater maintenance facility. The proposed shore protection & area for reclamation is shown in **Drg. No. KP/PH-III/PFR/07**.

4.4.4 Shore Protection North of North Breakwater

It is proposed to construct a rubble mound shore protection north of the North breakwater over a length of about 1050 m and reclaim an area of about Ha. 40. It is proposed to utilize the same for developing pipeline corridors for the LNG, LPG, POL & crude oil and to accommodate related essential control / safety installations and allied infrastructure including breakwater maintenance facility. The proposed shore protection and area for reclamation is shown in **Drawing No. KP/PH-III/PFR/08**.

4.4.5 Maintaining Existing Drainage

Four ephemeral drains exist in the development area; one of them serving as an agricultural drain and the rest as drainage path for the defunct salt pans. The agricultural drain would be diverted and maintained with the proposed culvert CED1. A culvert “CED 2” is proposed for one drain in the south which is crossing the port boundary and meeting the Buckingham Canal. The other two local drains would be reclaimed along with salt pans and the fish ponds except the part of one drain being maintained with suitable placed pipe lines for tidal exchange to the 9 acres of mangrove being protected.

The low lying land in the development area would be reclaimed for the port use. Separate drainage system suitable for the proposed land use would be planned and developed. The drains proposed to be altered and areas to be reclaimed are shown in **Drawing No. KP/PH-III/PFR/14.**

4.5 Existing Infrastructure

4.5.1 General

The layout drawing of Phase I & II developments as per CRZ and Environmental Clearances accorded is presented in **Drawing No. KP/PH-III/PFR/01**.

4.5.2 Berthing Front

The Phase I & II developments of the port are with 17 berths and other required marine and shore based infrastructure to cater to 72.3 MTPA of various types of cargo plus 3.3 MTEUsPA of container cargo. So far 10 berths with corresponding marine and on shore based infrastructure have been developed and have been put to effective use. Development of the balance berths and corresponding marine and onshore infrastructure is in progress.

4.5.3 Marine Infrastructure

Two rubble mound breakwaters, one on the north (1318m) and one on the south (1624 m) of the approach channel are built to afford protection to the harbor. These breakwaters are formed using natural stones of various grades as core and protected with suitably designed concrete armour 'KOLOS' blocks.

The dimensions and water depths of the approach channel, turning circle and other navigable water ways cater to the design vessels during the Phase I & Phase II developments are shown in **Table 4-3** here under:

Table 4-3 Design Dredged Depths for Phase I & II Developments

Location	Depth below CD (m)
Approach Channel (250m wide)	(-)21.6
Turning Circle (600 m diameter)	(-)20.7
Berth Area for 1,80,000 DWT Coal vessels	(-)18.0
Berth Area for Panamax (80,000 DWT) Coal vessels	(-)15.0
Berth area for General Cargo Vessels	(-)15.0
Berth area for Container Vessels	(-)15.0

4.5.4 Navigational Aids

The navigational aids installed during the Phase I & II developments of Krishnapatnam Port are 25 no's of channel marker buoy, 4 no's of beacon lights and 2 no's of transit lights.

4.5.5 Storage Yards

Cargo storage areas for dry bulk cargo like coal, iron ore and general cargo like fertilizer, granite, barytes etc are developed as per project contemplations. A container park area has been partly developed as contemplated. The balance Container Park areas are proposed to be located during Phase III development in the area proposed for the development of integrated container terminal in the west port area. Warehouses for fertilizer, agri-products and cement have also been developed and further augmentation is proposed in the Phase III development.

Pipelines for edible oil have been laid from the berth to the premises of the users as required. Mechanizations contemplated are being implemented hand in hand with availability of land on lease from GoAP. Dust suppression measures are in place to cater to bulk cargo handling. Balance works are in progress.

The breakup of cargo areas being developed during Phase I & II developments is presented in **Table 4-4** here under:

Table 4-4: Cargo Storage areas being developed under Phase – I & II

Type Of Cargo	**Area**
Storage area for Coal	140 ha (345 acres)
Storage area for Iron Ore	21 ha (52 acres)
Storage area for General cargo & Ware Houses	72 ha (178 acres)
Container Park area	210 ha (520 acres)
Total storage Area	**443 ha (1095 acres)**

4.5.6 Road / Rail / Pipe line Network

External port road and rail connectivity have been adequately formed by the GoAP and by the SPV "KRCL" respectively. With this connectivity in place, unhindered movement of goods to and from the port is taking place without impacting the existing public infrastructure in the region. Adequate internal roads, railway lines, pipe lines and conveyors are being developed.

Internal road and rail network with bridges commensurate with the project contemplations developed in the Phase I & II developments of the Krishnapatnam Port are as under:

- 4 Lane Roads: 41 km
- 2 Lane Roads: 15 km
- Single Lane Road: 2.5 km
- Railway line: 47 km with 15 sidings
- Railway Locos (Diesel): 4 No
- Road & Rail Bridges : 14 No's

4.5.7 Drainage

To cater to runoff, drainage is being developed along the roads and cargo storage areas. The runoff from cargo storage areas is routed through collection pits and guard ponds.

Details are as under:

- Alongside surface drains : 38 km
- Collection pits : 10 no's
- Guard ponds : 5 no's

Domestic sewage from the amenities building is treated at the 300 KLD STP. The treated effluent is recycled for dust suppression and plantation.

4.5.8 Water Supply

GoAP has sanctioned drawal of 1 MLD of water from Muthukuru reservoir and pipe line work is on hand. In the meantime i.e., till the pipeline work from Muthukuru Reservoir is completed by GoAP, domestic water requirement is being procured from authorized agencies. Storage water tanks have been already built in the port area. Internal distribution through trucks / pipelines to various consumption locations is in place. Irrigation authorities of GoAP have also permitted drawal of 4 MLD of water from the Nakkala Kalava irrigation drain. About 1 MLD of water from this source is presently being utilized to meet dust suppression and firefighting needs.

4.5.9 Other Infrastructure

The following infrastructure as required has been developed to cater to Phase I & Phase II developments:

- Administrative office buildings
- Substation and electrical rooms
- Disaster management cum control house,
- Work shop & loco parking Bay
- Operational building like yard master buildings, traffic and trade center etc
- Pump houses
- Field offices
- Gate complex
- Container freight station
- Bunkering
- Firefighting facilities
- Warehouses
- Custom inspection zone
- Documentation center
- Amenities blocks

4.6 Shore Line and Littoral Drift

The effects on the littoral drift and shore line changes, on account of construction of breakwaters and dredging of approach channel of Krishnapatnam Port, have been studied through numerical model studies by M/S HR Wallingford, UK during 2004 and 2007 for the Phase I & II development of the port. It was reported that “it is considered that the site may be characterized by erosion on one side of the port during part of the year, followed by recovery in the second part of the year. Hence rather than large scale erosion on one side of the port and accretion on the other side, as would occur at a site with high net transport to either north or south, the potential erosion of the coast and near shore may recover each year without intervention”.

After commissioning of the port, the shore line changes have been further monitored with the help of satellite images through INCOIS (Indian National Center for Ocean Information Services, Hyderabad) during 2008 to 2010 which confirmed that the shore line at Krishnapatnam port is fairly stable even after the construction of breakwaters. Continuous shore line data being collected by Krishnapatnam Port

on a monthly basis also indicate that the shore line is accreting except for seasonal variations. Thus the shore line is largely unaffected by the port development.

The proposed shore protection on the windward of the south & north breakwaters in shallow depths in the littoral zone is not going to influence the shore line stability as the full length of breakwaters is catered to in the numerical model study carried out to ascertain the sediment transport during the earlier phases of the port development. Further, coast would continue to be an accreting coast as the littoral drift intercepted by the breakwaters / shore protection works and dredging of entrance channel would continue to be deposited there.

Hence the Phase III development of the port comprising of development of berths in the lagoon area, dredging of navigational water ways and shore protection works adjoining the North and South breakwaters do not have any impact on the shore line.

4.7 Soil

An extensive programme of land and marine boreholes and soil analysis was undertaken in the 1998 & 2010 in the vicinity of Krishnapatnam port at the area proposed for development of north & south side berths, conveyor alignment, iron ore and coal stack yards and offshore location viz., the breakwaters, approach channel etc.

The area proposed for Phase III development is contiguous to the Phase I & II areas. It is therefore considered that the soil profile is likely to be similar at the berthing front proposed for the development of west and northwest docks. At the area proposed for north and south berths, the borehole shows a 10 to 12 m thick layer of fine silty clay, sand and sand overlying thick stiff clay having thickness of 10 to 20m. Below the stiff clay, dense silty sand having thickness varying from 10 to 22m is present. At some locations bottom silty sand layer is sandwiched with stiff clay layers. Bores are terminated at a depth of about 55m below G.L / bed level or where hard strata i.e., cemented sand is observed whichever is earlier.

All dredging is only in soft materials. As approved in EC the dredged non-cohesive material is being utilized for reclamation and the balance material is being disposed of at the approved disposal area in the sea, beyond (-) 20 m contour.

4.8 Climatic Data from Secondary Sources

4.8.1 Climate

The region is characterized by hot sub–tropical climate with harsh summers and annual recurring seasonal monsoon, which divide the year into four seasons as follows

- December to February : Northeast monsoon (wind blows predominantly from NE direction)
- March to May: Pre-Monsoon/Summer season (cyclones occur in May)
- June- September : Southwest monsoon (wind blows predominantly from SW direction)
- October & November : Post monsoon(cyclones are most frequent)

4.8.2 Temperature

In May, the mean daily maximum and minimum temperatures are 40.1ºC and 27.2ºC respectively. During December, the mean daily maximum and minimum temperatures are 28.7ºC and 20.2ºC respectively. The highest maximum and lowest minimum temperatures recorded at Krishnapatnam are 47ºC and 14.4ºC respectively.

4.8.3 Humidity

The climate at Krishnapatnam Port is tropical with average relative humidity of 76% over the whole year. The air is more humid throughout the year in coastal part than in the interior parts. The driest part of the year is May to August when the humidity is on an average varying between 45 and 55%. During September to April, humidity is around 80% in the morning and 70% in the afternoon.

4.8.4 Visibility

Visibility is good throughout the year at Krishnapatnam Port area. On an average, visibility is well above 4 km for 320 days in a year.

4.8.5 Rainfall

The region experiences two monsoon viz., south-west monsoon and north-east monsoon. The rainfall during south-west monsoon amounts to 31% of the annual rainfall, while about 50% of the rainfall occurs during the north-east monsoon period. The southern half of the district, particularly the coastal part under which the project site falls, receives rainfall during the early north-east monsoon period also. October and November are the months with highest rainfall. The average rainy days range between 40 and 44 days in a year. The average annual rainfall in the district varies from 1000-1200mm. The maximum annual rainfall of 1100 mm and above is recorded all along the coastal part of the district.

4.8.6 Currents

The tidal influx and efflux up and down the river cause horizontal movement of water at the location of Krishnapatnam Port. The maximum current velocity is 0.65 m/sec during the ebb tides and 0.61 m/sec during the flood tide. The structures are designed for a current velocity of 0.65 m/sec.

4.8.7 Tidal Data

The tides at Krishnapatnam are of diurnal in nature. The mean tidal variation is of the order of 0.7 m at spring tides and around 0.3 m at neap tides. Principal water levels with reference to chart datum as defined on Indian Naval Hydrographic Chart No.3034 are given below in **Table 4-5**.

Table 4-5: Tidal Data

Mean High Water Spring (MHWS)	:	(+) 1.2 m
Mean High Water Neap (MHWN)	:	(+)1.0 m
Mean Sea Level MSL	:	(+)0.8m
Mean Low Water Neaps (MLWN)	:	(+) 0.7m
Mean Low Water Springs (MLWS)	:	(+) 0.5m
Mean Lowest low water (MLLW)	:	(+) 0.3m

4.8.8 Wind

During the south-west monsoon period winds are predominantly from the south-western direction. During the post monsoon seasons winds are mainly north-western to north in the mornings and north-eastern to east in the afternoons. During the rest of the periods winds are mainly from directions between east and south. During summer and monsoon season wind speed is about 9 km/hr while it about 5 km/hr during the rest of the period. During north-east monsoon, wind velocity may go up to 50 km/hr and during cyclonic periods the wind speeds may go up to 105 km/hr.

4.8.9 Wave data

As part of numerical model studies carried out for the Phase I & II development of Krishnapatnam Port, M/s HR Wallingford, UK obtained offshore wave climate from the UK Meteorology Office for a location north east of Krishnapatnam. The data shows that the prevailing wave direction is from 135º N – 165 º N sector although larger waves come from east-north-east. Sea conditions at Krishnapatnam are usually calm with only slight swell. The offshore wave height of 8.9 m may be expected to have a return period of 100 years. Such waves will be depth limited in the inshore area and wave heights in the Krishnapatnam Port area are unlikely to exceed 5m depending on the local depth. Wave transformation studies were carried by M/s HRW to arrive at the near shore wave climate for design of the breakwaters (H_s of 6.0m is adopted for the design of breakwaters) and carrying out harbor tranquility studies. The offshore wave conditions, as reported by HRW in their report, where the 50:1 and 1:1 year conditions are derived from the U.K Meteorology Office model climate and the 1:50 and 1:100 year conditions due to cyclonic conditions are presented in **Table 4-6**.

Table 4-6: Wave Data (source:UK Met Office)

Return Period (Years)	Wave Direction(°N)	Hs (m)	Tz (Sec)	Tp (Sec)
50:1	60	1.2	4.6	5.9
50:1	90	1.2	4.6	5.9
50:1	135	1.4	4.9	6.3
1:1	60	2.4	6.5	8.3
1:1	90	2.4	6.0	7.7
1:1	135	1.85	5.9	7.6
1:5	60	2.85	6.5	8.3
1:5	90	3.41	7.4	9.5
1:5	135	2.16	6.2	8.0
1:10	60	3.06	7.5	9.6
1:10	90	3.89	7.6	9.7
1:10	135	2.4	6.3	8.1
1:50 Cyclone	Any	14.2	12.4	15.1 - 16.6
1:50 Cyclone	Any	16.2	12.7	15.8 - 16.7

4.8.10 Harbour Tranquility

To establish tranquility in the harbor and alongside berths, the numerical model analysis, navigation simulation studies and study of ship motions at berth were carried out by M/s HRW. The alignment of entrance channel including its width and turning circle have been reviewed and finalized considering wave transmission to facilitate smooth navigation of ships. The breakwater alignment and its design have been reviewed keeping in view the tranquility conditions required for berthing and maneuvering of ships and subsequent cargo handling operations. The model results have been analysed and the maximum value of the significant wave height along each of the berths/quays corresponds to locations as reported by M/s HRW.

3D Physical Model Studies of wave tranquility of the proposed port were also conducted at the laboratories of Lanka Hydraulic Institute Ltd, Sri Lanka during 2008, for evolving the layout of the port in order to ensure tranquility at the location of proposed berths in the harbour.

The proposed Phase III development area is covered within the area of numerical model studies undertaken at the stage of Phase II development. The model results are presented in **Table 4-7.**

It is noted that these wave heights are within the permissible limits for the types of cargoes intended to be handled alongside the berths. With the proposed straightening of the south breakwater, contribution of waves overtopping the south breakwater would be reduced and this will result in improved tranquility at the proposed liquid cargo berths proposed on the lee side of the south breakwater. Therefore, undertaking tranquility studies for the proposed Phase III development is not envisaged.

Table 4-7: Wave Conditions from the ARTEMIS Numerical Model of Phase II at Output Location (Shown in DrgNo.KP/PH-III/PFR/8) at the Berths and Quays

Locations	Hso = 1.2	Hso = 1.2	Hso = 1.4	Hso = 2.4	Hso = 2.4	Hso = 1.85	Hso = 16.2	Hso = 16.2	Hso = 16.2
As in Drg No. 7	50:1 60º Tm=5.6 (s)	50:1 90º Tm=5.6 (s)	50:1 135º Tm=7.2 (s)	1:1 60º Tm=7.9 (s)	1:1 90º Tm=7.3 (s)	1:1 135º Tm=7.2 (s)	1:100 60º Tm=15.5 (s)	1:100 90 º Tm=15.5 (s)	1:100 135º Tm=15.5 (s)
1	0.5	0.4	0.3	0.4	0.4	0.3	0.5	0.5	0.5
2	0.4	0.4	0.4	0.4	0.3	0.4	0.4	0.5	0.5
3	0.6	0.6	0.3	0.3	0.4	0.3	0.8	0.8	0.8
4	0.7	0.8	1.1	0.8	1.1	1.4	1.3	1.3	1.2
5	0.5	0.7	0.3	0.5	0.4	0.3	0.9	0.9	0.9
6	0.3	0.4	0.2	0.2	0.2	0.2	0.5	0.5	0.5
7	0.5	0.6	0.3	0.4	0.5	0.3	0.8	0.8	0.7
8	0.2	0.3	0.2	0.2	0.2	0.3	0.6	0.5	0.5
9	0.4	0.4	0.2	0.4	0.4	0.2	1.0	1.0	0.9
10	0.4	0.3	0.2	0.3	0.4	0.3	0.9	0.8	0.8
11	0.6	0.6	0.4	0.6	0.5	0.5	0.6	0.6	0.5
12	0.4	0.4	0.2	0.3	0.2	0.2	0.6	0.5	0.5
13	0.5	0.5	0.3	0.4	0.5	0.5	0.5	0.5	0.5
14	0.4	0.5	0.3	0.3	0.4	0.4	0.6	0.6	0.6
15	0.4	0.4	0.3	0.3	0.2	0.4	0.9	0.9	0.7
16	0.4	0.5	0.2	0.2	0.3	0.3	0.4	0.5	0.4
17	0.4	0.5	0.2	0.2	0.3	0.3	0.4	0.5	0.4
18	0.4	0.5	0.2	0.2	0.3	0.3	0.2	0.5	0.4
19	0.4	0.5	0.1	0.3	0.2	0.2	0.4	0.5	0.4
20	0.5	0.5	0.3	0.3	0.5	0.4	0.7	0.7	0.4

4.8.11 Cyclones

In the post monsoon period, storms and depressions originating in the Bay of Bengal pass through the district and neighbourhood causing wide spread heavy rains with gusty winds. Thunder storms occur during the period from March to November, being more frequent during the late half of the south-west monsoon and in the early part of retreating monsoon season. Based on the available records the number of cyclones crossed the east coast between Chennai and Machilipatnam region encompassing Krishnapatnam, over the period from 1931 to 1970 total to 41. Thirteen of these cyclones were of a severe nature with wind speeds exceeding 87 Kmph**.**

Ever since taking up development of Krishnapatnam Port, the following cyclone storms have been experienced. The details of cyclones are presented in **Table 4-8** here under.

Table 4-8: Details of Recent Cyclones

S.No	Name of Cyclone	Dates of Cyclone Impact	Maximum wave height experienced in meters	Max Wind Speed in Kmph
1	Khaimuk	14.11.2008 to 15.11.2008	4 to 5	27
2	Laila	17.05.2010 to 21.05.2010	4 to 5	40
3	Jal	04.11.2010 to 09.11.2010	2 to 3	35
4	Thane	26.12.2011 to 30.12.2011	4 to 5	38
5	Nilam	28.10.2012 to 01:11.2012	4 to 5	55

4.9 Social Infrastructure Available

As per 2011 census, the population of Sri Potti Sriramulu Nellore district was 29, 63,557 with a density of 227 person/sq.km. The population as per 2001 census for Nellore district was about 26, 59,661 with a density of 203 persons/ sq.km.

In the previous census of India 2001, Nellore District recorded increase of 11.16 percent to its population compared to 1991 and the corresponding increase during 2001-2011 was 11.55%. Average literacy rate of Nellore in 2011 was 69.15% compared to 65.08% in the 2001 census. As per the 2011 census, 70.93 % population of Nellore districts lives in rural areas of villages.

The major occupation of the households in the district are (i) agricultural labour (47.67%) followed by (ii) cultivators (21.27%), (iii) service in private and government departments (9.32%), (iv)Trade and commerce (6.78%), (v) Industrial workers including salt pan workers (4.07%), (vi)Household industries (2.97%), (vii) Livestock and fisheries (2.88%), (viii) Transport, storage and communication (2.73%), (ix) Construction workers (1.91%) and (x) mining and quarrying (0.40%)

Nellore District has 38 large and medium industries in sectors such as sugarcane crushing, prawn processing, shrimp feed, drugs, pharmaceuticals, dry batteries, carbon electrodes, beverages, textiles, dairy units, aluminum cans, rubber, mould caps, iron castings etc. Consequent upon commissioning of the port, edible oil refineries, thermal power plants, steel plants and other industries are coming up in addition to manufacturing units and a number of SEZs in the area near the port. Nellore town is known for its vast spread of educational institutions and professional colleges. There are a number of hospitals including super-specialty corporate hospitals. The existing road and drainage system is under improvement. There are also increased investments in the housing, educational facilities and other social infrastructure by various individuals and institutions. The overall living standard in the neighbourhood villages has improved as a result of direct and indirect employment generation on account of the port and other port based industries and institutions coming up in the region.

5 PLANING BRIEF

5.1 Planning Concept

Marine infrastructure viz., approach channels, turning circle and dock basins, quay walls, dredging & reclamation, Subsea Power and Optic Fiber cables & Offshore Subsea Oil and Natural Gas Pipelines to and fro SBMs etc., shore based infrastructure like cargo transit and storage areas, cargo handling equipment, warehouses and terminal buildings, road, rail, conveyor and pipeline networks, bridges, utilities and services such as power and water supply, drainage, sewerage, fire-fighting, administrative, operational, welfare & amenity buildings, Marine Control Tower Building, repair shops, dry docks for repairs of floating crafts and vessels, Shore protection works workshops, environmental protection works etc., are planned for development to cater to the cargo traffic forecast.

5.1.1 Design Vessel Size

Selection of design vessel size is important for planning the port, as various port infrastructure facilities required are dependent upon the design ship sizes. To assess the most appropriate vessel size, a review of world-wide ships operating & on order as well as vessels visiting Indian ports including Krishnapatnam Port was carried out.

Design Vessel Size

Based on above analysis, design vessel sizes considered for various types of cargo are given in table below:-

Table 5-1: Proposed Design Vessel Size at Krishnapatnam Port

S. No.	Type of Cargo/Vessel Type	Ultimate Phase			
		Vessel Size (DWT)	Length (m)	Beam (m)	Draft (m)
1.	**Bulk Cargo (Coal, Iron ore)**				
a.	Coal at specified mechanized terminals.	300,000	327.0	55.0	21.4
	.(future for Valemax)	380,000	365.00	65.0	24.0
b.	Coal at other mechanized terminals	180,000	290.0	44.0	18.0
c.	Coal at semi-mechanized terminals	105,000	260.0	42	14.0
d.	Iron Ore	200,000 (future)	300.0	50.0	18.0

S. No.	Type of Cargo/Vessel Type	Ultimate Phase			
		Vessel Size (DWT)	Length (m)	Beam (m)	Draft (m)
		150,000	283.0	47.0	16.0
2.	**Liquid Bulk**				
a.	POL, Chemical at jetty	150,000 (future)	274.2	48	17.0
		115,000	250.0	44	15.0
b.	Crude and products at SBMs	300,000	330.0	58	22.5
c.	LNG at jetty	155,000	345.0	55	13.0
3.	**Containers**				
a.	Main Line Vessels	18,400 TEU	400.0	59.0	18.0
		14,000 TEU	366.0	52.0	16.0
b.	Feeders	5,000 TEU	294.0	32.2	13.5
4.	General Cargo (Fertilizer, granite, food and agri products, steel and iron products, timber, sugar, cement, cement clinker, feldspar, barites, other ores, edible oil, lube oil etc.)	105,000	260.0	42	14.0

5.1.2 Navigational and Operational Requirements

The basic navigational and operational requirements to service the vessels calling at port are

- Sufficient depth and width in approach channel
- Adequate stopping distance
- Favorable weather and tranquil sea conditions in the harbour area
- Sufficient depth in harbour area and at the berths
- Adequate berthing infrastructure including berth fixtures like fenders
- Mooring system
- Navigational aids.

Dimensions of navigable water ways generally comply with guidelines provided in the BIS Code of Practice IS: 4651– 1980 “Code of Practice for Planning and Design of Ports and Harbours - Part V - Layout and Functional Requirements”.

5.1.2.1 Navigable Channel

The dimensions of navigation channel and the parameters like stopping distance, width at entrance have been arrived at considering an 18,340 TEU capacity container vessel having the maximum LOA i.e., 400 m LOA. Width and depth of first lane of the approach channel and diameter of the first turning circle & its depth are arrived at considering a 380,000 DWT design coal vessel having a maximum beam and draft of 65 m and 24.0 m respectively. Width and depth of second lane of the approach channel and diameter of the second turning circle & its depth are arrived at considering 18,340 TEU & 14,000 TEU design container vessel having a maximum beam and draft of 59 m and 16 m respectively.

a. Alignment

The approach channel of Krishnapatnam Port is aligned in the E-W direction with a bearing of 84.5^0-264.5^0 up to the turning circle. This is based on navigation simulation studies carried out in the earlier phases of the port development. The same alignment of the approach channel would be followed for the Phase III development too.

b. Channel Depth

Generally, the depth in the channel is determined by:

- Vessel's loaded draft
- Ship's motion due to waves, such as pitch, roll and heave
- Character of the sea bottom, soft or hard
- Wind influence on water level and tidal variations.

As per IS 4651 (Part V), under keel clearance to be provided in the protected channel is 10% of the draft of the design vessel, 15% in turning circle and 20% in unsheltered areas. However, considering operational aspects, a 15% under keel clearance is planned in the inner channel also i.e. from breakwater up to the first turning circle.

To optimize the dredging quantity, of the two lane approach channel, one lane of 260 m wide is proposed to be dredged eventually to cater to deep draft vessels (upto 380,000 DWT) and in the remaining 230 m width of the second lane is proposed to be dredged to cater to vessels with draft up to 18 m (18400 TEU container vessel).

Further, to optimize the dredging requirement, sailing of the deep draft loaded coal vessels of 380,000 DWT is proposed to be undertaken in the approach channel, inner channel and the turning circle during rising high tide; accordingly, a tidal advantage of (+) 0.9 m CD is considered while assessing the dredged depth requirement for these vessels. The dredged depth requirement for other categories of design vessels is arrived at for unrestricted operations considering the LLW which is (+) 0.3 m CD to ensure safety during all stages of tide.

From the above considerations, the depths required in the navigation channel are worked out and presented below:

Table 5-2: Channel Depth

Description	Vessel			Channel Depth (in 'm' w.r.t CD)	
	Size (DWT)	LoA (m)	Draft (m)	Outer Channel	Inner Channel
Deep draft lane (Coal Carrier)	300,000 plus (future)	upto 365	24	(-)27.9*	(-) 26.7*
	180,000	290	18	(-)21.3	(-)20.4
Shallow draft lane (Container Vessel)	14,000 TEU	366	16	(-)18.9	(-)17.3

* 0.9 m rising tide advantage will be taken

c. Channel Width

The number of ships of various average parcel sizes expected to call at the port annually for the traffic envisaged on completion of Phase III development as per details presented in **Table 5-8** which is equal to 16.2 sailings per day on an average considering 330 days of working days per year. It is not considered feasible to undertake these ship movements through the existing single lane channel.

Therefore it is proposed to widen the approach channel into a two lane channel. It is proposed to establish feasibility to develop two lane approach channel and include dredging of the second lane to cater to container vessels in the scope of present Phase III. It is however, proposed to undertake necessary dredging to deepen the

channel to cater to 380,000 DWT coal vessels as and when the demand for the same arises.

As per IS: 4651 (Part V) – 1980, the width of the channel shall be between 3B to 5B for a one way channel and 6B to 8B for a two way channel. The opening between the breakwaters is about 515 m. Considering the dredged depth required for the design vessel contemplated in the Phase III and allowing for adequate berms at the toe of the breakwaters as well as dredging slopes, it is feasible to accommodate a 260 m wide dredged channel at the breakwater opening which is equal to 4.00 B of maximum design coal vessel of 380,000 DWT and 3.90B for the design container vessel of 18,400 TEU capacity.

For Phase III of Krishnapatnam Port, a channel width of 300 m is considered for the one-way approach channel and 490 m for the two-way channel (4.60B of design coal vessel + 3.90 B of design container vessel).

To optimize the dredging quantity of two way channel, separate lanes are proposed - one for deep draft vessels and the other for shallow draft vessels. The design vessels considered for deep and shallow draft channels are 300,000 DWT coal vessels and 18,340 TEU container vessels respectively. In as much as the ships arrive from the south side with reference to international shipping routes, it is considered advantageous to form the second lane of the approach channel on the south side of the existing approach channel.

Details of the one way and two way channels are given in **Table 5-3** below.

Table 5-3: Channel Width

	One lane channel	**Two lane channel**
Channel Width (m)	300 (4.6x65*)	490(4.6x65*+3.2x59**)

* The beam of the 380,000 DWT coal carriers is 65 m.

** The beam of the 18,340 TEU container carriers is 59 m.

The existing channel width of 250 m is adequate till vessels likely to call at the port exceed 180,000 DWT. Further widening and deepening would be undertaken as and when coal vessels bigger than 180,000 DWT are likely to call at the port.

d. Width of Entrance

The width of entrance between pier heads shall be a minimum of 0.7 to 1.0 times length of largest design vessel as per IS: 4651 (Part V) – 1980. Accordingly, the minimum entrance width needed between the breakwaters for navigation of the 380,000 DWT coal vessel of 365 m LoA would be 255 m and that for the 18,340 TEU capacity container vessels with LoA of 400 m would be 280 m. The entrance width of 250 m proposed between the breakwaters dredged to (-)26.7 m CD to cater to loaded 380,000 DWT design coal vessel envisaged during Phase-III development corresponds to 349 m (which is more than 280 m) at (-)17.1 m CD for 18,340 TEU container vessel. Therefore, the requirement of entrance width is satisfactorily met with for the design vessels.

5.1.2.2 Stopping Distance

The protected length of the approach channel from the nose of breakwaters up to the center of turning circle, called stopping distance shall cater to various categories of vessels contemplated.

As per IS: 4651 (Part V) – 1980, it should be between 3 to 8 times the length of the largest vessel visiting the port depending upon its condition of loading (i.e., whether fully laden or ballasted). The stopping distance within the breakwaters available is 1830m. It corresponds to 4.575 times the length of the largest design container vessel and 5.60 times of largest design coal vessel. This is considered adequate in as much as adequate tug power would be available during vessel maneuvers in these areas. Extension of the existing breakwaters is not necessary.

5.1.2.3 Turning Circle Dimensions and Depth at Berths

a. Turning Circle

The turning circle, required to swing and berth the vessels, is very important and must have proper configuration, dimensions and access.

As per IS: 4651 (Part V) – 1980, the minimum diameter of the turning circle should be 1.7 to 2.0 times (1.7 for protected locations and 2.0 for exposed locations) the length of the largest vessel to be turned, where vessels turn by free interplay of the propeller and rudder assisted by tugs. As the turning circle is located in the area protected by breakwaters, a turning circle with 1.7L (where L is the length of design vessel) as diameter is considered adequate for safe maneuvering of vessels.

Keeping these requirements in view, the dimensions of the turning circles would be as hereunder:

Table 5-4: Dimensions of Turning Circle

Location	Cargo	Vessel Size	LoA (m)	Draft (m)	Diameter (m) 1.7 x LoA	Dredged Depth (m wrt CD)
Turning Circle I*	Coal	Upto 380,000 DWT (future)	365	23.0	620.0	(-)26.7
		180,000 DWT	290	18.0	493.0	(-)20.4
Turning Circle II**	Container	18,400 TEU	400	14.5	680.0	(-)16.4
		14,000 TEU	366	16	622.2	(-)18.1
	Iron ore (future)	200,000 DWT	300	18	510.0	(-)20.4

* The existing 600 m diameter turning circle is planned in Phase II with (-) 20.4 m dredged depth. This when deepened to (-) 26.7 m to cater to 380,000 DWT (future) coal vessels would form a turning circle of 620 m diameter. Duly considering dredged slopes, this works out to 1.72 times the LoA of 380,000 DWT vessel (365 m) and is adequate as per planning norms

** The 18,400 TEU container vessel of 400 m LoA governs the second turning circle diameter of 680 m.

b. Depth at Berths

As per IS 4651 (Part V) the under keel clearance of 0.6 to 0.75 m is to be provided at the berths. However, keeping the safety parameters in view, an under keel clearance of 1 m with reference LLW (+0.30 m CD) is considered at berths. The depth at the berths for various sizes of the ships is assessed on the above consideration. In Phase II, the entire harbour area except inner channel, turning circle and coal / iron berths is dredged to (-) 15.0 m CD. Hence, in Phase III, also the minimum depth at the berths is proposed as (-) 15.0 m CD and dredged depth proposed alongside berths is given below as **Table 5-5**.

Table 5-5: Dredged Depths Proposed at Berths for Various Sizes of Ships

S. No.	Cargo	Vessel Size	Draft (m)	Depth at Berth (m) w.r.t CD
1.	Coal	380,000 DWT (future)	24.0	(-)24.70
		180,000 DWT	18	(-)18.7
		105,000 DWT	14	(-)15.0
2.	Iron Ore	200,000 DWT (future)	18	(-)18.7
		150,000 DWT	16	(-)16.7
3.	Container	18340 TEU / 14000 TEU	16*	(-)16.7
		5000 TEU	13.5	(-)15.0
4.	POL	150,000 DWT	17	(-)17.7
		115,000 DWT	15	(-)15.7
5.	LNG	155,000 DWT	13	(-)15.0
6.	General cargo	105,000 DWT	14	(-)15.0
7.	Crude & Products at SBMs	300,000 DWT	22.5	(-)26.7**

* *Deeper draft of 16 m corresponding to 14,000 TEU container vessels is considered. For flexibility, all berths are designed to cater to 200,000 DWT vessels except the berths designated for 380,000 DWT coal carriers*

** *Considering 20% under keel clearance as the SBMs are in open sea*

5.1.3 Berthing Requirements

5.1.3.1 Parcel Size and Cargo Handling Rates

Though the dimensions of design vessel is the guiding parameter in arriving at the dimensions of the navigable water ways, for ascertaining the requirement of number of berths for each commodity of cargo considered, it is prudent to consider average ship size and average parcel size. Suitable cargo handling rates appropriate to the parcel sizes are considered and turnaround time has been accordingly assessed duly taking into account time required for berthing, de-berthing, survey etc. The average parcel size, cargo handling equipment and rated capacities considered for various types of cargo are presented in the table5-6 below:

Table 5-6: Cargo Handling Rates Envisaged On Completion of Phase III

S.No	Cargo	Design Ship Size (DWT)	Average Ship Size (T)	Proposed Cargo Handling Equipment per berth and Rated Capacities	Average hourly handling (T/TEU)
1	**Coal**				
1.1	Coal Mechanized	380,000	270,000	3 Nos of 2000 TPH Grab unloaders	3x2000x0.5* = 3000
1.2	Coal Mechanized	180,000	140,000	2 Nos of 2000 TPH Grab unloaders	2x2000x0.5* = 2000
1.3	Coal Semi-mechanized	105,000	75,000	2 Nos of 2000 TPH Grab unloaders	2x2000x0.5* = 2000
2	**Iron Ore**				
2.1	Semi Mechanized	60,000	50000	2 Nos of 1200 TPH unloaders or MHCs	2x1000x0.7* = 1400
2.1	Mechanized	200,000	160000	1 No of 5000 TPH Ship Loader	1x5000* = 5000
3	**General Cargo**				
3.1	Fertiliser Mechanized	105,000	75,000	2 Nos of 1000 TPH unloaders or MHCs	2x1000x0.5* = 1000
3.2	General Cargo	40,000	30,000	Ships gear and/or MHCs with 500 TPH	2x500x0.7* = 700
4	**Containers**				
4.1	Main Line Vessel Berths	18,400 TEU	6,000 TEU	5 Nos of Quay Cranes with 25 moves per hour	5x25x1.3** = 162

S.No	Cargo	Design Ship Size (DWT)	Average Ship Size (T)	Proposed Cargo Handling Equipment per berth and Rated Capacities	Average hourly handling (T/TEU)
4.2	Feeder Vessel Berths	5,000 TEU	3,000 TEU	4 Nos of Quay Cranes with 20 moves per hour	4x20x1.3** = 104
5	**Liquid Cargo**				
5.1	Crude Oil at SBMs	300,000	220,000	Ships pumps @ 5000 TPH	5000 TPH
5.2	POL at Jetty	150,000 / 115,000	85,000	Ships pumps @ 2000 TPH	2000 TPH
5.3	LNG	267,000 Cum	240,000 Cum		

* Effective capacity of equipment
** Box ratio considering 20 feet to 40 feet containers

5.1.3.2 Effective Working Days and Working Hours per Day

While Krishnapatnam Port remains open 365 days in a year and 24 hours a day for operations, the effective working days for calculating the requirement of number of berths is taken as 330 days duly considering the downtime on account cyclonic weather, maintenance etc. and the effective berth availability as 22 hours a day and 60% rated output of the cargo handling equipment.

In respect of fertilizer as the cargo is hygroscopic in nature it needs to be handled during non-monsoon season only. Therefore, the effective working season would be about 180 days a year and during remaining period of the year, the berth/s is assumed to be available for handling other general cargoes.

5.1.3.3Time for berthing / De-berthing and Peripheral Activities

Apart from the actual time for loading / unloading cargo, additional time is required for other activities such as berthing and de-berthing of ships, obtaining customs clearance, surveys, positioning and hook-up of equipment, post operation survey (where necessary), waiting for pilots and clearance for navigation. About 6 hours is the anticipated time for the following activities presented in Table 5-7.

Table 5-7: Time for berthing/ De-berthing Activities

Operation	Time (In Hours)	
	For all vessels except containers	Container Vessels
Piloting, arrival time	0.75	0.5
Swinging, berthing time	0.75	0.5
Connection / documentation time	1.5	1.0
Disconnection / documentation time	1.5	1.0
De-berthing time	0.75	0.5
Departure time	0.75	0.5
Total arrival / departure time	**6.0**	**4.0**

5.1.3.4 Berth Occupancy

In order to arrive at the number of berths required for handling projected cargo, the concept of 'Berth Occupancy' is used. Berth Occupancy is expressed as a percentage of the number of days a berth is occupied by a vessel to the total number of berth-days available.

It is well recognized that ships arrive at a port in a random fashion. In view of this, sometimes, more than one ship will wait to occupy a berth and hence, a queue will be formed. This problem has been statistically analyzed for a totally random system and the average waiting time will be minimized when the berth occupancy does not exceed 60% for single berth operation, 65% for a two berth operation and up to 70% for more berths in respect of general cargo ships which suffer a relatively higher degree of randomness compared to other ships and in respect of other ships the berth occupancy adopted is slightly higher as may be seen hereunder.

Table: 5-8: Berth Occupancy Recommended

No of Berths	Recommended berth Occupancy	
	General Cargo Terminals	Other Berths
1	60	65
2	65	75
3	70	80

The requirement of berths for handling various types of cargo envisaged (refer Table 2) is worked out taking into consideration the throughput, parcel size, cargo handling rates, etc. and presented in **Table 5-9**.The berth occupancy is also worked out and shown in the same table reasonably confirm to the above limiting percentages.

Table 5-9: Overall Requirement of Berths upon Completion of Phase III

S. No.	Description	Unit	Coal (133MPTA)			Iron Ore (18MPTA)		General Cargo (23 MPTA)		Liquid Cargo (52 MPTA)			Container 5.5MTEU's	
			300,000 plusDWT	180,000 DWT	Panamax	*60000 (Initial)*	200000 (Final)	Fertiliser	Others	LNG / LPG	POL	SBMs	Main	Feeder
1	Cargo volume	MTPA / MTEU's	30	83	20	*6*	18	4	19	10	15	27	3.0	2.5
2	Average parcel size	'000T / TEU's	220	140	75	*50*	160	75	30	105	85	220	6	3
3	Number of vessels	no.	137	593	267	*120*	113	54	633	95	177	123	500	834
4	Effective working hours	Hrs /day	22	22	22	*22*	22	22	22	22	22	22	22	22
5	Average cargo handling rate (Table 5-14)	T/hr	3000	2000	2000	*1400*	5000	1000	700	2000	2000	5000		
		TEUs / hr											162	104
6	Service time per ship	Hrs	74	70	38	*35*	32	75	43	53	43	44	37	29
7	Additional time for peripheral activities	Hrs	6	6	6	*6*	6	6	6	6	6	3	4	4
8	Total time per ship	Hrs	80	76	44	*41*	38	81	49	59	49	47.00	41	33
		Days	3.63	3.46	2	*1.86*	1.73	3.69	2.23	2.69	2.23	2.14	1.87	1.5
9	Total berth-days required	Days	498	2052	534	*163*	196	200	1419	256	395	263	935	12514
			3084					1619		651			2186	
10	**Number of berths**	**no.**	**2**	**9**	**2**	***1***	**1**	**1**	**8**	**2**	**2**	**3**	**5**	**5**
11	Total berth-days available	Days	4290			*330*	330	2970		1200		540	1650	1650
12	Berth occupancy	%	**72**			*50*	**60**	**55**		**55**		**49**	**67**	

The berth occupancy is thus within acceptable limits.

Total number of vessels per annum (excluding vessels at SBMs) = 3410.

5.1.3.5 Requirement of Berths and Quay Length

a. Requirement of berths

Considering the total number of berths arrived in **Table 5-9** above and accounting those being developed under Phase I & II developments, Phase III berth requirement to handle the envisaged traffic is presented hereunder in **Table 5-10**:

Table 5-10: Berths Required for Phase III

Type of Cargo	Total Berths Required	Number of Berths Sanctioned		Number of Berths to be Developed in Phase III
		Phase I	Phase II	
Coal	13	1	5	7
Iron Ore	1*	1*	-	-
General cargo	9*	1*	2	6
Container cargo	10 ***	-	6***	4***
Liquid alongside berths (LNG/LPG/POL/Chemicals)	4	-	1	3
Total Berths Excluding SBMs	**37**	**3***	**14 ****	**20**
Liquid at SBMs	**3**	**-**	**-**	**3**

* During Phase I the berthing front approved to cater to Iron Ore, Coal and General cargo is three berths numbered as **N3, N4** and **N5**.

** During Phase II development 14 berths for various types of cargo are approved and being developed. These berths are numbered as **N1, N2, N6, N7, N8, N9, NW1, S1, S2, S3, S4, S5, S6** and **L1**.

*** Keeping in view the advancement in container handling, world over, vis-à-vis provisions made in the Phase II, requirement of equipment has been reviewed and catered to in the Phase –III development.

With the 20 berths and 3 SBMs now envisaged in the Phase III, the total berths available in the port would be 37 (3+14+20) and 3 SBMs proposed in deep waters outside the breakwaters within the port limits.

b. Berth Dimensions

The size of the berth will depend upon the dimensions of the largest ship and the number of ships which will use the terminal. As per the BIS code IS:4651 (Part V)–1980 the length of wharf or quay for a single vessel should be 50 to 60 m more than the overall length of design ship and where more than one vessel is to be accommodated it shall be a minimum of length of design vessel plus 10 percent. The width of the quay shall be based on the gauge of crane track to be provided on the berths. Quay requirements for cargo vessels are to be ascertained, keeping in view the number of berths and design ship dimensions. The details of berth dimensions are accordingly assessed and given in **Table 5-11** below.

Table 5-11: Berth Dimensions

Cargo Type	No. of Berths	Length of Largest Vessel (m)	Length of Berth (m)	Width of Berth (m)
Coal 300,000 DWT / Valemax	4	327 / 365	375 / 415	30
Coal 180,000 DWT	1	290	320	25
Coal Panamax	2	260	300	25
Container Main liners	2	400	440	35
Container Feeders	2	294	320	35
Fertiliser / General Cargo	6	260	300	25
Liquid cargo	3	345	400 (hook to hook)	Dolphins
Liquid Cargo SBMs	2	330		SBM
Total	**20 Berths + 3 SBMs**			

5.1.4 Berthing and Repair Facility including dry dock for Port Crafts, Naval & Commercial Vessels

The port has to also cater to berthing of port craft like tugs, pilot launches, mooring launches and dredgers.

At present the Krishnapatnam Port has 6 no of dredgers, 5 no of tugs, 2 no of barges, 1 no of pilot launches, 1 no of survey launch, 2 no of mooring launches, 2 no of work boats etc., The number of port craft is also expected to correspondingly increase with the Phase III Development. Therefore for berthing and undertaking periodic repairs of such marine craft, out fitting and repair facilities are required to be developed.

The Indian Coast Guard (ICG) at present is generally utilizing the logistics and communication facilities of the Navy and to some extent the maintenance facilities of the Navy. Of late, the CG has started setting up its own logistics, Communication and maintenance facilities especially where naval facilities do not exist. Krishnapatnam Port is one such location where ICG have requested for setting up of dedicated provision for the above facilities.

5.1.4.1 Port Craft Jetty

It is considered essential to provide berthing facility adequate for at least two dredgers, six tugs (double banking) and six launches (double banking) in addition to watering and bunkering barges, one each. This berth length would enable both berthing and outfitting needs like bunkering, water supply, periodic overhaul etc. Berths length 800 m are allocated for this purpose as detailed hereunder.

Table 5-12: Requirement of Quay Length for Cargo Vessels

Vessel Type	No. of Berths	Unit Berth Length (m)	Berth Length Required (m)
Dredger	2	150	300
Tugs	3	70	210
Water & Bunkering Barges	2	100	200
Launches	3	30	90
Total			**800**

5.1.4.2 Coast Guard Jetty

The Indian Coast Guard operating from Krishnapatnam Port have expressed their need for a land base with a helicopter landing facility besides berthing & Dry Docking facilities for their crafts. Accordingly land and jetty are earmarked for use by the Coast Guard. A 200 m long jetty to cater to Coast Guard vessels is proposed with a provision to increase the length of the berthing further as may be needed

5.1.4.3 Dry Docking, Berthing and Repair Facility

The repair facility is required to be adequate to undertake hull repairs and periodical painting of the hull for the longest port craft viz., Trail hopper Suction dredger (LoA:114.5 m, Beam:20.6 m and Draft :8.5 m). A repair Dry Dock of 150 m length, 50 m width and 12.0 m depth (with -9.5 m CD sill level at entrance) is proposed for this purpose. A repair quay length of 200 m is considered necessary to attend to engine repairs and fitting out purposes.

The vessels of the ICG range from 20 m LOA patrol boats to about 100 m long pollution control vessels. The dry dock of 150 m long and 50 m wide with a 100 m long Fitting Out Wharf proposed on the South Port to the west of Berth S1 is considered adequate at present to cater to the maintenance & repair needs of the ICG vessels as well as ports dredgers and floating craft. This location would be very close to the proposed location for the Coast Guard facilities and close to the Port Craft Jetty.

5.1.5 Dry Dock Facility

Ship repair is a location-dependent business. Ships tend to repair close to their operating routes to avoid expensive deviations, and location in relation to the available market is of paramount importance. According to industry sources, vessels from the east coast mostly visit shipyards in Singapore for dry docking, while dredgers, tugs and cruise boats go to Colombo for repairs due to non-availability of dry docks in the Indian coast and quick turnaround time. The waiting period for some of the vessels in Indian docks are said to be over 12 months. Some vessels are reportedly sailing to China docks due to cheaper tariff.

There is limited effective capacity for ship repair on the east coast of India. The opportunity for Krishnapatnam Port lies in the general international commercial sector & the niche international market for the shipyard is the mid-size sector of Handy to Panamax size plus a local market share of small ships size of up to 150m length. The proposal is to have a facility of about 325 M long will have marine facilities, water depths, facilities for vessel launching and docking, dry dock,

wet berth requirements, maintenance shop and warehousing facility at the beginning of the East Quay of the Northern dock and easily accessible from the turning circle.

5.1.6 Cargo Storage Area Requirements

The storage yard acts as a buffer between the ship unloading system and cargo evacuation system. Storage area must be planned so that a maximum amount of cargo can be stored in a minimum area. The cargo storages are dependent upon types of cargo and their dwell time in the port. The receipt and dispatch systems for various types of cargo should ensure least dwell time of cargo in the port.

5.1.6.1Storage for Coal

Out of the total 133 MTPA of coal traffic forecast by the end of 2025-26, the approved capacity for Phases I & II is 45 MTPA and the forecast for Phase III is 88 MTPA. The coal storage capacity required to handle the traffic is assessed as under:

Out of the total demand for coal imports through Krishnapatnam Port, 83 MTPA is the assessed demand of the 8 port based users. While it is a normal practice to provide one month capacity as storage at port, it is proposed to provide storage to cater to 15 days in the port for these users.

The balance 50 MTPA is the import demand of other users. In this category, 30MTPA is assessed to be handled through mechanized stream while 20 MTPA is likely to be serviced through semi-mechanized stream.

While normal dwell time of 30 days in the port is adequate in respect of the users serviced through a mechanized stream, a dwell time of 45 days is considered minimum for the users to be serviced through semi-mechanized stream.

It is also recalled that during Phases I & II development of the port catering to 45 MTPA of coal imports, storage of 2.9 MT is planned in addition to a 0.25 MT of temporary storage.

Considering the coal storage developed in Phases I & II, the storage requirement to be developed in Phase III is arrived at and presented hereunder:

Table 5-13: Coal Storage Requirement- Phase III

S.No.	Category	Annual Throughput	Dwell Time / Other Basis	Storage required (in MMT)
1.	**Port based Users / North**			
a.	APGENCO	8	15 days	0.33
b.	UMPP	16	15 days	0.67
c.	TPCL	11	15 days	0.45
d.	NCC Power	11	15 days	0.45
2.	**Port based Users / South**			
a.	Simhapuri Energy Pvt Ltd	8	15 days	0.33
b.	Meenakshi Energy Pvt Ltd	10	15 days	0.41
c.	Krishnapatnam Power Pvt Ltd	8	15 days	0.33
d.	Kineta Power Ltd	11	15 days	0.45
3.	**Other Users**			
a.	Mechanised stream	30	30 days	2.50
b.	Semi-mechanised stream	20	45 days	2.50
Emergency Storage (same as in Phase –II)				0.25
			Total	**8.67**
Less storage created in Phases I & II including temporary storage				3.15
			Net Storage Required in Phase III	**5.52**

The height of stacking of coal in the storage yards is considered as 12 m during operations and 14m for emergency i.e., same as in the Phase-II.

5.1.6.2 Container Storage Area

In Phase II, an area of about Ha.210 (Ac.520) is allotted for container storage and other support facilities.

In view of developments taking place in the region and the formation of hub ports, the share of container movement by feeder vessels and empty containers is expected to increase initially resulting in increased number of ground slots. Hence, it is considered necessary to review the area required for container storage.

Of the 5.5 million TEUs of annual traffic it is assessed that about 3.0 million TEUs are likely to be handled by main liners, 1.5 million TEUs by feeder vessels, and about 1.0 million TEUs shall be empty containers.

Duly reckoning the above, the average dwell time of containers is assessed as 8 days and the required storage capacity of the container yard works out to 120,000 TEUs, excluding a reserve.

The containers will be stacked 3-4 high. The area requirement per TEU is 10 m^2 as per UNCTAD norms with 3 high stacking. The empties would be handled in a separate zone within the container yard by reach stackers and the area requirement per TEU is about 20 m^2 as per UNCTAD norms. The weighted average area requirement per TEU works out to about 15 m^2.

Considering the ratio of average to maximum stacking height as 0.60 and 30% reserve, the container park area for 120,000 TEUs works out to be Ha.385 (Ac.945).

As per norms, an area of Ha.24 (Ac.60) is also provided for the purpose of container handling related activities.

Provision of about Ha.60 (Ac.150) is made for container freight stations assuming that 30% of container traffic would use the CFS facility at the port.

Thus the total area assessed for container handling related activities is Ha.469 (Ac.1160). Duly reckoning the Ha.210 (Ac.520) considered during Phase I, the land requirement of Ha.259 (Ac.640) for Phase-III development is catered to in the land allocation for container handling and above mentioned related purposes.

5.1.6.3 General Cargo

Fertiliser being hygroscopic in nature will be stored in warehouses.

Other general cargo comprises of barytes, clinker, gypsum, rock phosphate, project cargo, agriculture products, limestone, cement, steel products, edible oil and lube oil.

Barytes, clinker, gypsum, rock phosphate, project cargo, lime stone and steel products will be stored in open areas. Agricultural produce and cement will be stored in warehouses.

Fertiliser and agricultural products are seasonal cargo and are handled for 6 months in a year. The stacking height and dwell time considered for assessing the storage area for fertiliser and agricultural products are 3.5 m and 60 days, respectively.

The stacking height and dwell time considered for assessing the storage area for other general cargo are 1 m and 30 days, respectively.

Edible oil and lube oil are directly pumped to users through pipelines and do not require major storage in the port.

Based on requests being received for development of cement clinker units and bitumen blending and storage etc., a land area of Ha.12 (Ac.30) is allotted.

5.1.6.4 Liquid Cargo

Liquid cargoes to be handled at Krishnapatnam Port are LNG, POL products and crude oil. Crude Oil will be directly pumped from SBMs to the refineries through pipelines. LNG / POL will be pumped through pipelines from jetty to the storage area. While pipelines being laid from the liquid berth during Phase-II are proposed to be routed on trestles from jetty up to the south breakwater and on pipe supports to be built on rock fill towards lee side of the south breakwater. It is proposed to beneficially utilize the accretion noticed on the sea side of breakwaters near the coast by providing suitably designed protection works capable of withstanding the incident waves. In respect of liquid berths proposed during this Phase-III development, the pipelines are proposed to be laid on trestles from berths up to the respective breakwaters and thereafter on land proposed to be reclaimed between the existing breakwater and proposed shore protection. It is also proposed to accommodate related essential control / safety installations and allied infrastructure including breakwater maintenance facility on this reclaimed land which is beyond the safety zone for the liquid cargo berths.

Storage will provided for LNG and POL products in suitable tanks. Considering safety clearances, a total area of Ha.186 is provided for liquid cargo storage to cater to the anticipated liquid cargo handling of 52 MTPA.

Two island type platforms connected with approach trestles are proposed to be developed as tank farms for LNG, based on trade demand.

5.1.6.5 Total Cargo Storage Area Requirement

By following the acceptable planning norms the requirement of storage for various cargoes for the Phase III cargo is worked out as Ha.900 (Ac.2225). Details are as under:

Table 5-14: Cargo Storage Area Requirements for Phase III

Parameter	Storage Area (ha)				
	Coal	General cargo		Liquid Cargo	Container
		Fertiliser & Agri Products	Other General Cargo		
Annual throughput in MTPA / MTEUsPA	88	3	9.50 *	51.7	5.5***
Average Dwell Time in *days (As mentioned in Section 5.1.6.1)*		60	30	30	8
Turnaround of cargo in nos per year	12 & 9	3**	12	12	45
Storage requirement Million Tons	5.52	1.0	0.80	4.31	0.12 MTEUs
Height of stock pile in m/ Nos	12	3.5	1	Varies	3 to 5
Angle of repose in degrees	35	N A	Varies	-	NA
Bulk density in t/cum	0.85	0.8	0.8	Varies	NA
Required storage area in Hectares	**204**	**57**	**193**	**206**	**469** (385 ha container parking +24 ha for container handling + 60 ha for CFS)
Less Storage area of Phase II proposed to be utilized for Phase III		**-**		**20**	**210*** **
Net Required storage area in Hectares	**204**	**57**	**193**	**186**	**259**

* Excluding edible oil, lube oil etc. which are directly pumped to user premises through pipeline

** Fertiliser cargo being handled in crop season only i.e. for 6 months

*** Storage area is assessed for the overall container handling envisaged in as much as it is proposed to develop integrated Container terminal in the west port area. The storage area catered to in the Phase-II for container handling i.e., Ha.210 is deducted therefrom to arrive at the net container handling area for Phase-III.

5.1.7 Cargo Handling Equipment

The cargo handling equipment at berth and storage areas for various types of cargo is presented in the table hereunder:

Table 5-15: Cargo Handling Equipment Envisaged for Phase III

S. No.	Cargo	Equipment Type	Rated Capacity	No. of Berths	Quantity
1.	Coal	**Berth Equipment**			
		Grab Unloader	2000 TPH	7	16 nos (5x2+2x3)
		Dock conveyor	4000 TPH / 6000 TPH		2.8km
		Stockyard Equipment			
		Belt conveyor	4000 TPH / 6000 TPH		33.0 km
		Stack tubes			2 pairs
		Stacker-reclaimers	4000 TPH / 2000 TPH		12 nos
		Stacker			2 nos
		Transfer silo for users			1 nos
		Pay loaders			60 nos
		Bulldozers			60 nos
		Trucks	40 T		60 nos
		In-motion weigh bridges			4 nos
		Wagon loading station			2 nos
2.	General Cargo, & Fertilisers	**Berth Equipment**			
		Mobile harbour cranes (Fertiliser)	1000 TPH	2	4 nos
		Dock conveyor	2000 TPH		1.20 km
		Mobile harbour cranes (other general cargo)	500 TPH	5	10 nos
		Storage Yard Equipment			

S. No.	Cargo	Equipment Type	Rated Capacity	No. of Berths	Quantity
		Belt conveyor (Fertiliser berth to warehouses)	2000 TPH		8.5 km
		Bagging plants			10 nos
		Belt conveyor (Bagging plants to wagons)			3.1 km
		Belt conveyor (warehouses to cement berth / silo; dock conveyor and loading by user)	1000 TPH		4.1 km
		Edible oil pipeline	12" dia		10.5 km
		Lube oil pipeline	12" dia		17 km
		Fork lift truck	5 T		17 nos
		Fork lift truck	10 T		8 nos
		Pay loader			12 nos
		Cement silos			2 nos
3.	Containers	**Berth Equipment**	**Phase III require-ment**	**Additional requirement by rationalization of Phase II requirement (Table 5-16)**	**Total**
		Rail-mounted quay crane (5 per each main liner berth and 4 per each feeder berth)	25 moves per hour for main liners and 20 moves per hour for feeders	4 / 19 nos (3x5+1 X4)	22 nos* / 41nos
		Storage Yard Equipment			
		Rubber tyred gantry cranes		27nos (9)	72 nos* / 99 nos
		Rail mounted gantry crane		9 nos (1x9)	14 nos* / 23 nos
		Reach stackers		3** (27÷9)	- / -
		Truck & trailers		54 nos (6x9)	117 nos* / 171 nos

S. No.	Cargo	Equipment Type	Rated Capacity	No. of Berths	Quantity
4.	Liquid cargo	**A. Berths:** The operational equipment like unloading arms, pipelines, storage facility, fire-fighting arrangements and evacuation arrangements will be worked out by the user agency and specific approval for terminal operation would be obtained separately.			
		B. SBMS: The operational equipment, pipelines, storage facility, fire-fighting arrangements and evacuation arrangements will be worked out by the user agency and specific approval for terminal operation would be obtained separately.			
5.	Others	Railway Locomotives			2 nos

* The container yard equipment rationalized considering the equipment provided in Phase II is shown in **Table 5-16**.

** The Phase III requirement of 3 reach stackers will be met from the surplus available in Phase II as shown in **Table (5-16)**.

The provision of container handling equipment made in Phase II has been reviewed. Keeping in line developments taking place the container handling equipment required to handle the container traffic forecast has been reassessed. The requirement of equipment is arrived at duly taking into account the equipment planned in Phase II. Details of the same are presented in **Table 5-16** and catered to in the equipment requirement of Phase III.

Table 5-16: Container Handling Equipment Envisaged during Phase III for Rationalization of Phase II Provisions

S. No	Description	Rail-Mounted Quay Crane	Rubber Tyred Gantry Cranes	Rail Mounted Gantry Crane	Reach Stackers	Truck and Trailers
1.	Total container handling equipment required for 6 berths (Phase II)	27 (3x5+3x4)	81 (3x27)	27 (1x27)	9 (81÷9)	162 (6x27)
2.	Provision made for container handling equip-ment in Phase II	5	9	13	12	45
3.	**Net require-ment to be catered to in Phase III**	**22**	**72**	**14**	**(3 surplus)**	**117**

5.1.8 Shore Protection near South & North Breakwaters

From the liquid cargo berths (LNG & POL), the pipelines are proposed to be laid on trestles up to the breakwater and thereafter in a corridor of about 10 m wide each for pipelines from each jetty, towards seaward side of existing south breakwater, as laying of all the pipelines from the proposed three berths on the lee side of the existing breakwater is not feasible due to likely multiple pipeline crossings.

As area towards the seaward side of the existing south breakwater where pipelines are proposed to be located even though is getting accreted it would be subject to wave attack during monsoons and cyclonic weather. To conserve the said land it is proposed to undertake necessary protection works to withstand the incident waves and reclaim the said area to uniform level by utilizing dredged sand. Further, control houses and safety installations essential for handling liquid cargoes required are also proposed to be accommodated in the same area. The extent of reclaimed area between the proposed protection works from the kink of the south breakwater up to the shore is Ha.16.50 (Ac.41). The length of the Shore protection from the kink to the outfall point of the breakwater is about 1300 m. The reclaimed area lying beyond the safety zone for the liquid berths would also be used for accommodating other essential infrastructure control and safety installations & allied infrastructure including breakwater maintenance yard. A layout showing the proposed shore protection is enclosed as **Drawing No.KP/PH-III/PFR/07.**

Similarly it is proposed to conserve the accreting beach on the north of North breakwater by means of a suitable designed shore protection work from shore upto the kink of the North breakwater and reclaim the area of Ha.16 (Ac.40) between the existing breakwater and Shore Protection would be reclaimed to uniform level by utilizing dredged sand. The length of the Shore protection from the kink of North Breakwater to the outfall point of the breakwater is about 1050m. The reclaimed area lying beyond the safety zone for the POL berth would also be used for accommodating other essential infrastructure control and safety installations & allied infrastructure including breakwater maintenance yard. Layout of the proposed shore protection on North of North Breakwater is also shown in the enclosed as **Drawing No.KP/PH-III/PFR/08.**

The design and cross-sections of the existing breakwaters which were arrived at by undertaking 3D physical model studies during the Phase I & II developments of the port are proposed to be adopted for the proposed shore protection work also, as may be appropriate to the bed contours at the location. The proposed shore protection works in shallow depths in the littoral zone is not going to influence the shore line stability as the full length of breakwaters has been catered to in the numerical model study carried out to ascertain the sediment transport during the earlier phases of the port development. Further, the coastline on either side of the port is seen to accreting except some minor seasonal changes. The coast on either side of the harbor would continue to be an accreting as of now.

5.2 Population Projection

The population of Nellore District is 23.92 lakhs, 26.59 lakhs and 29.66 lakhs as per 1991, 2001, 2011 census respectively. The growth rates for decades 1991-2001 and 2001-2011 are 11.2% and 11.5%, respectively.

The urban population of Nellore district is 5.69 lakhs, 6.03 lakhs and 8.62 lakhs as per 1991, 2001, 2011 census respectively. The annual growth rates during the decades 1991-2001 and 2001-2011 are 0.5 % and 3.6%, respectively. The reason for such a high annual urban population growth rate during the decade 2001-2011 may be attributed to Krishnapatnam Port development and other developments in the region.

The proposed Phase III development of Krishnapatnam Port will encourage a revolutionary development of the region including setting up of port based industries. This would again result in a continued population influx to the urban areas and transformation of some of the rural areas into urban areas. It is assumed that the prevailing percentage growth rate of the decade 2001-2011 will continue in view of the proposed development and the cumulative urban population of Nellore District in 2023 may reach 12.31 lakhs i.e. an increase of urban population by 3.69 lakhs.

5.3 Development Strategy

The design vessel influencing the development of marine infrastructure in the harbour area is the 380,000 DWT coal vessels. The coal vessel size being handled alongside berths at most of the loading ports is from 170,000 DWT to 200,000 DWT. Hence, it is proposed that the approach channel and manoeuvring areas will initially cater to 180,000 DWT coal vessels and 18,400 TEU container vessels. However, the design and construction of civil works of corresponding coal berths will cater to 300,000 DWT as well as the Valemax vessels (360,000-380,000 DWT) ship size to enable deepening alongside such berths.

While feasibility for development of 2nd lane of the approach channel is included in the Phase III to cater to 18,340 TEU design container vessel, deepening of the water ways including the approach channel to cater to 300,000 DWT plus vessels will be undertaken depending upon readiness of the loading ports and chartering of such vessels to the port.

While only liquid handling berths are proposed under the present scope, leaving corresponding handling equipment, operating facilities and storage requirements to the actual user who is expected to obtain specific installation and operation environmental clearance (EC) separately. Similarly EC is requested only for construction the SBMs under the present scope while the EC for actual installations and operations would be obtained separately by the actual operator.

5.4 Study of Alternative Layouts

In as much as the Phase III is a part of progressive development of the green field port commissioned during 2009, within the Master Plan it is highly location specific and therefore no alternative locations are relevant at this stage. Instead, two of the feasible layout plans are examined. The first one is a modular extension without any change in the existing plan of cargo handling locations whereas the second one being a partially modified scheme of existing plan of cargo handling locations to ensure an environmentally harmonious merging of the proposed extension for a proper zoning of compatible cargoes.

The following aspects are common to these alternatives:

- The Phase II layout which was revised on account of non-availability of designated lands (due to delay in handing over of land by GoAP) and submitted for approval of MoEF, as shown in **Drawing No. KP/PH-III/PFR/01**, has been adhered to.

- In order to optimally utilize the land being leased by GoAP as per the Master Plan, road and rail connectivity is to be formed to these areas from the port entrance. Therefore, suitably designed road and rail bridges are considered essential and have been proposed across the Khandaleru Creek without impeding the creek hydraulics.

- To improve creek hydraulics, it is proposed to straighten / divert the Khandaleru Creek by forming a straight cut across the sand bar with cross section area not less than that of the existing water course of the main arm of the Khandaleru Creek. The existing meandering arms of the creek becoming redundant upon forming the proposed straight cut are proposed to be reclaimed with dredged material to utilize the same areas for the port use.

- On both the banks of the proposed straight cut / diversion of the main arm of Khandaleru Creek, it is intended to develop suitable berthing front for the port use.

- Out of the total 20 berths required in Phase III, it is proposed to accommodate 17 berths in the areas having immediate back up space, 2 nos liquid cargo berths for LNG / POL / Chemicals on the lee of south breakwater with pipe line connections to the respective storages areas away from berths and 1 no liquid cargo berth for POL etc., on the lee of North breakwater with pipe line connections to the respective end users away from berth.

- The three SBMs are proposed within the port limits near the (-) 30 m CD contour.

- As the three islands of the Ipuru RF area are being developed for port use as contemplated in the Master Plan and the dormant creeks adjacent to these islands are also proposed to be reclaimed for port use, mangrove development at suitable areas in replacement of the existing sparse mangrove patches along

periphery of the creeks adjacent to these islands would be undertaken duly following the advice of experts in this field.

- Four ephemeral drains exist in the development area; one of them serving as an agricultural drain and the rest as drainage path for the defunct salt pans. The agricultural drain would be diverted and maintained and a culvert is proposed for one drain in the south which is crossing the port boundary and meeting the Buckingham Canal. The other two local drains would be reclaimed along with salt pans and the fish ponds except the part of one drain being maintained for tidal exchange to the 9 acres of mangrove being protected.

5.4.1 Alternative Layout I

In this alternative, of the 17 berths requiring immediate backup area, it is proposed to provide 10 berths by extending the northern dock in the north port and three berths in the northwest dock. The western dock will be allocated for small craft and repair facility. The allocation of berths required in Phase III is made keeping the re-designation of berths mentioned above. The proposed layout of Alternative I is shown in **Drawing No. KP/PH-III/PFR/09**.

5.4.2 Alternative Layout II

In this alternative, it is proposed to develop the berths required in Phase III by creating docks in the north, west and northwest ports. In the west and northwest ports, docks are proposed on both banks. In the north port on the north side it is proposed to locate coal berths. The allocation of berths required in Phase III is made keeping the re-designation of berths mentioned above. The proposed layout of Alternative II is shown in **Drawing No. KP/PH-III/PFR/10**.

5.4.3 Evaluation of Alternative Layouts

Both alternatives are given appropriate weightages in **Table 5-17** to evaluate and arrive at the best option.

Table 5-17: Comparison and Ranking of Alternative Layouts

Sl. No.	Criteria	Layout-I (existing)		Layout-II (proposed)	
		Remarks	Ranking	Remarks	Ranking
1.	Siting of berths.	Berths planned in 2 arms on land (in the North) + 2 arms in creek (in West). a) More capital dredging and loss of valuable land b) Oblique creek diversion by dredging around the existing Islands. Puts extreme pressure on bank stability.	2	Berths planned in 1 arm on the land (in the North) + 3 arms in creek (in West). a) Less dredging due to shifting of second arm from land into the creek, b) Straight creek diversion by cutting at the center of the existing Island. Provides better streamlining of flow of water.	5
2.	Grouping of compatible cargo	The Coal, Container and General Cargo berths are discretely located with no possibility for a harmonious grouping resulting in: a) Impact of Coal handling on General and Container Cargoes. b) Cross movement of different cargoes.	2	Container and general cargo berths satisfy the requirement of harmonious grouping while keeping a distinct separation with coal handling berths to ensure a) Avoidance of cross movements. b) Isolation of dirty cargo from neat cargo.	5
3.	Development of land	Involves; a) Reclamation of water body b) Compensatory mangrove development	5	Involves; a) Reclamation of water body b) Compensatory mangrove development	4

Sl. No.	Criteria	Layout-I (existing)		Layout-II (proposed)	
		Remarks	Ranking	Remarks	Ranking
4.	Additional coal berths	Two more coal berths required for the southern side power plants are planned at FTP-I area resulting in: a) Three discrete locations for thirteen berths b) Longer and extra numbers of Belt Conveyors between berths and the Power Plants.	3	All the three berths required for the Southern Side Power Plants are at one place and similarly all the ten required for the Northern Side are at one place resulting in: a) Convenient location in two clusters as need based b) Optimum length and numbers of belt conveyor to the Power Plants.	5
5.	Planning of container berths	Container berths on the Southern Side are exposed to waves resulting in down time	3	Container berths are planned in a more sheltered area resulting in no down time.	5
6.	Container movements within the terminal	Area for container storage and handling for the Southern Side berths falls at a longer distance resulting in: a) Extra movements and longer haulage. b) Higher cost of handling.	2	Container handling area is just behind the berths resulting in: a) Avoidance of unnecessary internal movements and extra haulage. b) Lesser cost of handling	5
Total			**17**		**29**
Rank			**2**		**1**

From the above it may be seen that Alternative Layout II ranks 1st and permits complete isolation of container handling terminals away from coal handling terminals considering both up wind and downwind directions thereby is creating a very congenial environment and compatibility of cargo handling which also helps in attracting major international container terminal and shipping line operators.

5.5 Recommended Port Layout

From Table 5-17 above, it is found that Alternative II satisfies the requirement of compatibility of cargo handling, operational feasibility, environmental compatibility and optimization of dredging quantity, and is also the most suitable layout. The recommended port layout is shown in **Drawing No. KP/PH-III/PFR/03**.

To render development of an integrated container handling terminal in the west port area from considerations of road and rail connectivity and environmental compatibility in cargo handling, it is proposed to re-designate the berths being developed in Phase-I & II developments. The cargo handling contemplated at the berths envisaged in Phase-I & II development as per EC accorded and the proposed re-designation of these berths under the Phase-III development now envisaged is presented in Table-18 hereunder:

Table 5-18: Details of berth utilization and re-designation proposed:

Sl No	Cargo Type	No of Berths developed in Phase-I	No of Berths developed in Phase-II	Total Number of berths developed in Phase-I & Phase-II	Berth Numbers designated in Phase-I & Phase-II EC	No of berths Proposed in Phase-III	Total Number of berths in Phases I, Phase-II & Phase-III	Berth Numbers proposed for the cargo handling	Redesignation of Berths Proposed
	Coal	1	5	6	N-5, N-6, N-7, N-8, N-9, S-4	7	13	N-5, N-6, N-7, N-8, N-9, N-10, N-11, N-12, N-13, N-14, S-4, S-5, S-6	S-5 and S_6 from Container to coal
	Iron Ore	1	-	1	N-4	-	1	NW-2	
	General Cargo	1	2	3	N-2, N-3, NW-1	6	9	N-3, N-4, NW-1, NW-3, W-8, W-9, S-1, S-2, S-3	a. S-1, S-2, S-3 from container to GenCargo b. N-4 from Iron Ore to GenCargo
	Containers	-	6	6	S-1, S-2, S-3, S-5, S-6, N-1	4	10	N-1, N-2, W-1, W-2, W-3, W-4, W-5, W-6, W-7 W-10	N-2 from GenCargo to Container
	POL	-	1	1	L-1	3	4	L-2, L-3, L-4	
	Total	3	14	17		20	37		

The proposed utilization of berths upon completion of Phase III development duly considering the envisaged re-designation for various types of cargo is given hereunder along with the design dredged depths at the berths:

Table 5-18: Proposed Utilisation of Berths upon Completion of Phase III

Cargo	Phase I	Phase II	Phase III	Total No. of Berths	Berths designated cargo-wise	Design Vessel (DWT)	Design Dredge Depth (m) CD
Coal	1 (N5)	5 (N6, N7, N8, N9 S4)	7 (N10, N11, N12, N13, N14, S5, S6)	13	N5,N6,N7, N8,N9,N10, N11,N12, N13, S4, S5	180,000	(-)18.7
					N14, S6	380,000	(-)24.7 (to be deepened in future)
Iron Ore	1 (NW2)			1	NW2	150,000	(-)16.7
						200,000	(-)18.7 (to be deepened in future)
General Cargo	1 (N3)	2 (N4, NW1)	6 (NW3,W8, W9, S1, S2,S3)	9	N3,N4,NW1, NW3,W8,W9, S1, S2, S3	105,000	(-)15.0
Container	NIL	6 (N1, N2, W1,W2, W3,W4)	4 (W5, W6, W7,W10)	10	W10	14,000 TEU	(-)15.2
					N1, N2, W1, W2, W3, W4, W5, W6, W7,	18,400 TEU	(-)16.7
Liquid Cargo Berths		1 (L1)	3 (L2, L3, L4)	4	L1	150,000 (future)	(-)17.7
					L2, L3, L4	115,000	(-)15.7
SBMs			2 (SBM 1, SBM 2, SBM3)	3	SBM 1, SBM 2, SBM 3	300,000	(-)26.7
Total	**3**	**14**	**20 + 3 SBMs**	**37 + 3 SBMs**			

*** Irrespective of cargo, all berths shall be designed for 200,000 DWT vessels for flexibility except the four berths designated to handle 380,000 DWT plus coal carriers (S5, S6, N13 & N14)**

5.6 Land use Planning

Of the Ha.2753 (Ac.6800) of land sanctioned by GoAP for the development of Krishnapatnam Port, Ha.1240 (Ac.3064) of land has already been designated for Phase I & II developments. About Ha.133.6 (Ac.330) of the existing water body is retained intact. For Phase III development, cargo storage area, road, rail & parking areas, green belt, utilities & amenities, berths and transit areas are planned in the Ha.1512 (Ac. 3736) area. The land use pattern is proposed keeping in view the compatibility, environmental aspects and transport connectivity. The combined Land use Plan of existing Phase I & II along with proposed Phase III development is shown in **Drawing No. KP/PH-III/PFR/11**.

The break-up of the proposed land use during the Phase III development for various functions is presented below**.**

Table 5-19: Proposed Land use (Phase III)

Function	**Phase III Area Allotment**	
	Ha.	**Ac.**
Cargo Storage Area	640	1581
Container Related Activities and Container Freight Stations	259	640
Berths and Transit Areas	68	168
Road, Rail & Parking Areas	305	753
Green Belt	152	375
Utilities & Amenities	48	119
Port based industries	40	100
Total	**1512**	**3736**

5.7 Dredging

The capital dredging requirement of Phase III development to cater to the dredged depths mentioned above at various navigable areas and for forming

the second lane of the approach channel to cater to 18,400 TEU / 14,000 TEU container vessels, a total quantity of about 63 million cum of soft soil dredging is assessed.

The material to be dredged mainly comprises of sand and silty soil which can be used for reclamation of the low lying areas to be used for development of port infrastructure including back up areas for berths to the extent needed.

Out of the 63 million cum to be dredged, a quantity of about 28 million cum would be utilized for reclamation of low lying areas to be utilized as back up areas and the balance i.e., about 35 million cum would be disposed-off in the sea at the disposal areas already identified during Phase II in deeper areas i.e., beyond (-) 20 m contour. A total of 25 million cum of dredged material was disposed-off during Phase II at the disposal area as against 43 (52-9) million cum planned and no significant build up in the bed contours is noticed due to uniform spreading in a large area and effective dispersion.

As the quantity of dredged material proposed to be disposed-off at the identified disposal area of (35 sq. km) 7 km x 5 km in the sea is 35 million cum spread in about 4 years (time frame assessed for implementation of Phase III development), with an average of about 8.75 million cum per year, the bathymetry of the dredge dumping ground is not likely to cause any concern. All precautions now being followed for disposal of dredged material will be continued to be followed during the implementation of Phase III also and the dredge disposal area will be continued to be monitored as of now.

Further capital dredging for deepening of the navigable water ways to cater to 380,000 DWT coal vessels / 200,000 DWT iron ore vessels and dredging associated with SBMs will be undertaken depending upon the readiness of the loading / unloading ports and chartering of such vessels to the port.

The proposed dredging layout is shown in **Drawing No. KP/PH-III/PFR/12.** The location plan of the dredged material disposal areas is shown in **Drawing No. KP/PH-III/PFR/13.**

5.8 Maintenance Dredging

M/s HR Wallingford have carried out simulation of the spring and neap tidal conditions at Krishnapatnam Port using SANDFLOW 2D and TELEMAC 2D models and have calculated the tidally induced sedimentation, both sand and mud, in the approach channel and harbor areas. The annual maintenance dredging anticipated upon completion of envisaged Phase III development is about 1.02 million cum. The same is proposed to be disposed off at the identified disposal areas beyond (-) 20 m CD Contour.

5.9 Reclamation

The proposed finished ground level of the land developed in Phases I & II is (+) 3.9 m CD. An area of about Ha.1512 (Ac.3736) is proposed to be developed in Phase III also to the same level. This also include reclamation of areas in the water bodies lying in the west port area measuring about Ha.133.80 (Ac.330) adjacent to the Ipuru Forest area and Ha.32 (Ac. 80) in between the existing breakwaters and the proposed Shore protection at North & South sides. The areas proposed to be reclaimed are shown in **Drawing No. KP/PH-III/PFR/14.** The quantity of material required for reclamation of Phase III land is about 39 million cum. While considering that the top 0.50 m of the fill is gravel or hard-standing / pavement, about 29 million cum of the dredged material will be used for reclamation of the low lying areas. The existing ephemeral drains proposed to be integrated with the project area are also shown in this drawing.

5.10 Assessment of Infrastructure Demand

5.10.1 Road Connectivity

A 23 km long 4 lane wide dedicated port road connectivity has been formed connecting the National Highway (NH 16) by GoAP as an external infrastructure. It is feasible to widen the same to 6 lanes as and when needed to meet increasing traffic. Thus, the local roads will not experience any impact on account of the proposed Phase II development of Krishnapatnam Port.

To optimally utilize the land in the north, south and west ports connectivity to external road network is required. Accordingly, in continuation to the roads

planned in the south and west port required bridges are planned across the Khandaleru Creek, Buckingham Canal and the existing creek in the north port to facilitate continuity of road access.

The main internal roads catering to the container yard, bulk cargo yards, general cargo are planned for 4 lane development. The other internal roads shall be of 2 lane width, roads with nominal traffic and the peripheral road along the boundary shall be of single lane width. A total length of 97 km of 4 lane roads, 69 km of 2 lane roads, 7 Km of Single lane road and 5 nos of Road Flyovers on Railway lines would be formed in Phase III. Suitably designed storm water drains are also planned adjacent to the roads.

5.10.2 Railway Connectivity

A 19.4 km long dedicated double line electrified port rail connectivity has been formed by RVNL in JV with KPCL, GoAP and NMDC. Internal railway lines shall cater to all the cargo yards namely containers, bulk cargo, fertiliser, liquid cargoes and general cargoes.

To optimally utilize the land in the north, south and west ports connectivity to the external rail network is required. Accordingly, in continuation to the rail sidings and lines planned in the north, south and west ports, required number of rail bridges are planned across the Khandaleru Creek, Upputeru Creek and Buckingham Canal.

To improve the overall efficiency of the operations, a merry go round system is planned as being insisted by the trunk railways. Adequate loop lines, lines for engine escape, break vans; sick wagons and repair facilities are also catered to in the planning. In the Phase III, 168.0 TKM of broad gauge railway line with provision for electrification is provided. Krishnapatnam Port owns 4 (four) locomotives, it is proposed to increase the same to 6 nos to cater to the increasing demand of the Phase III development. Three yard master buildings, one each in the north, south and west ports are proposed to ensure proper signaling and railway operations. Three loco parking bays, one each in the north, west and south ports are proposed to for repair and maintenance of the

locomotives. The layout of railway yards including take off points for various yard etc., would be firmed up during further detailing

The internal road and rail network of Krishnapatnam Port is as shown in **Drawing No. KP/PH-III/PFR/15.**

5.10.3 Bridges

To connect the port's operational area lying towards south of Khandaleru Creek and east of the Buckingham Canal with road and railway network on the west (exit corridor) in the north and to facilitate faster deployment of heavy duty trucks and railways for transport of cargo to / from port and hinterland as well as reduce smoke emissions from cargo trucks, following bridges / culverts are required to be taken up during the proposed Phase III development in addition to those formed during the Phase I & II developments of the port:

- Development of Road Bridge RB22 & Rail Bridge RB-11
- Relocation of Road Bridge RB-7 & Railway Bridge RB10 is proposed on the Khandaleru Creek.
- Two road bridges (RB21 & RB 23) & one Road Bridge – cum - Flyover (RB12) are proposed on Buckingham Canal.
- Two Road Bridges (RB19 & RB20) on the diverted drain / creek.
- To provide railway and road connectivity between iron ore yard in the west port area and coal yards in the north port area for movement of empty iron ore rakes for effective utilization for coal loading etc., the existing road bridge "EX1" across Upputeru Creek is proposed to be modified as road-cum-rail Bridge.
- Strengthening of 3 existing bridges / culverts on Buckingham Canal (RB16, RB17, RB18) to integrate the Port's operational area separated by creek system and to facilitate faster deployment of heavy duty trucks and railways for transport of cargo to / from port and hinterland as well as reduce smoke emissions from cargo trucks are also proposed.

Flyovers:

Apart from the above, to ensure free movement of cargo five flyover bridges / grade separators on important road and rail crossings are proposed and are marked as F4-F8.

The bridges and flyovers proposed in Phase III are as shown in **Drawing No. KP/PH-III/PFR/03.**

5.10.4 Service Corridor

Adequate service corridors are proposed for accommodating belt conveyors, pipelines, electric lines, etc. The service corridors within Krishnapatnam Port are as shown in **Drawing No. KP/PH-III/PFR/15.**

5.10.5 Water Requirement

Water is required at the port for the following activities:

- Supply to ships
- Supply to port staff and port users
- Pollution control and firefighting purposes
- Environmental conservation and maintenance of greenery in the port
- Miscellaneous.

The requirement of water for the above-mentioned activities is estimated and presented below.

Table 5-20: Water Requirement

S. No.	Activity	Phase III Water Requirement (m^3/Day)
1	Domestic Supply	600
2	Dust Suppression	1150
3	Gardening	200
4	Miscellaneous (Fire protection)	550
	Total	**2500**

Water requirement during the construction is expected to be around 50 m^3/day.

The water requirement of Phase I & II put together is 2.5 MLD including 0.4 MLD for domestic use. Thus the total consumption for Phases I, II & III would be 5.0 MLD including 1.0 MLD for domestic use.

It is feasible to meet the water requirement from the available sources, as GoAP have agreed to supply a total of 5 MLD of water comprising of 1 MLD of water from Muthukuru Reservoir and 4 MLD of water from Nakkala Kalava Irrigation drain. The water from Muthukuru Reservoir would be utilized for domestic purposes while that from Nakkala Kalava drain is proposed to be used for dust suppression, firefighting, plantation and other miscellaneous purposes. STP treated water will continue to be recycled for dust suppression and plantation purposes. Necessary additional storage tanks pump houses and pipelines will be provided as required.

5.10.6 Power Requirement

The electric power is required for the following port operations:

- Quay cranes at the berths and shore supply to the ships
- Cargo transfer system from berth to stack yard
- stockyard equipment
- Lighting of the port
- Miscellaneous.

Quay-side cranes and some yard equipment will be power-driven. Ships at the berth need shore supply for their domestic use and refrigerated cargo. The requirement of electric power for the above-mentioned activities is estimated and is presented in **Table 5-21** below.

Table 5-21: Estimated Electrical Power Demand

Items	Phase III (MW)
Cargo Handling Equipment on berths & power supply to ships	35
Port Lighting – Yard and Miscellaneous	50
Total	**85**

The power requirement during the construction stage is expected to be around 1 MW. The power requirements would be sourced from the APTRANSCO.

5.10.7 Buildings

Various buildings envisaged in the port complex are as follows:

Table 5-22: Details of Buildings Envisaged:

S.No.	Building Type	No. of buildings	Area of Buildings SqM
1.	Administrative Building	3	10800
2.	Canteen	3	2160
3.	Transport building	3	25200
4.	Medical Centre	3	2160
5.	Central store	3	1080
6.	Transit complex	7	79365
7.	Yard master building	3	3240
8.	Security building	4	2160
9.	Workshop	3	1080
10.	Marine academy	1	1400
11.	Seaman's building	1	1400
12.	Bank bulding	1	720
13.	Services building	1	720
14.	Operational control building	10	4150
15.	DMP building	1	720
16.	Gate control building	3	600
17.	Fire station	2	600
18.	Loco parking Bay	2	410
19.	Electric sub-station	5	6000
20.	STP	5	615
21.	Container Terminal Building	2	1800
22.	Marine Control Tower	1	360
23.	Other Buildings (Miscel)	6	2490

Location plan of the above buildings is as shown in **Drawing No. KP/PH-III/PFR/16.**

5.11 Amenities / Facilities

5.11.1 Navigational Aids

The following navigational aids are proposed for Phase III of Krishnapatnam Port:

- Fairway buoys
- Channel marker buoys
- Front and rear leading light towers

5.11.2 Port Craft

The port should provide pilot assistance for safe maneuvering of ships and suitable capacity tugs to bring vessels safely along the berths. Two tugs of capacity 70 T bollard pull, two tugs of 50T bollard pull and a 25 knots speed pilot launch are required in addition to mooring launches. As in Phase II, the port crafts required in Phase III are proposed to be procured by outsourcing from suitable agencies.

5.11.3 General Lighting

General lighting of the port will be provided using light towers of suitable height and at appropriate spacing. The average lighting level will be 50 Lux. Additional lighting will be provided where required for special purposes.

5.11.4 Storm Water Drainage

A network of storm water drains will be provided. The entire storage area, quay aprons and traffic lanes will be provided with sloping surfaces towards drainage canals. Run off from the coal storage areas will be routed through collection pits and guard ponds with re-circulation facility.

In order to avoid contamination of the harbour basin, the following design features will be applied:

- Truck wash areas will be provided with suitable oil and grease separation facilities for recirculation and re-cycling of water.
- Dust suppression systems are proposed in the stockyard to reduce air pollution caused by handling coal. A network of surface drains is proposed to collect water flowing from the stockyards and lead into the guard ponds.

5.11.5 Bunkering

Provision for supply of fuel oil and fresh water bunkering will be made.

5.11.6 Environmental Aspects

At the bulk cargo storage and vehicular movement areas, dust suppression measures by mechanized spraying of water shall be resorted to. Further details as required would be incorporated during implementation stage to confirm to the EMP proposed in the EIA report.

In Phase III, green belt development is planned along the boundary (50 m wide) and along periphery of dust generating cargoes (20 m wide) to contain the dust / pollution. It is also proposed to develop 13 ha of green pastures on the southern beach. In addition, avenue plantation is proposed along the median and alongside the road. About 152 ha of greenbelt development is proposed during the Phase-III development of the port.

The berths and aprons will be provided with a slope towards drains and the wash / runoff waters from these areas will be routed to suitable solids collection pits.

Monitoring of the environmental parameters of ambient air quality, noise, marine and ground water quality will be carried out confirming to statutory standards. General environmental protection works also include:

a. Environmental studies during Phase III development
b. STPs for treatment of waste water
c. Alteration of drainage features within the port boundary
d. Dust suppression
e. Replacement of mangroves
f. Oil spill contingency measures
g. Road sweeping equipment
h. Augmentation of continuous AAQ monitoring equipment

The mechanical cargo handling system cost estimates provide for necessary dust suppression measures. For all other works mentioned above, provision is made in the cost estimate under the head ‘environmental protection works.

6 PROPOSED INFRASTRUCTURE

This chapter describes details of infrastructure proposed for Phase III development in the processing and non-processing areas with due attention to environmental aspects.

6.1 Port Area (Processing Area)

6.1.1 Infrastructure Proposed in Phase III

The infrastructures proposed in Phase III are as follows:

- 20 berths and 3 SBMs to handle the following cargo:
  - 7 berths to handle 88 MTPA of coal
  - 6 berths to handle 14 MTPA of general cargo like (Fertilizer, agri-products, granite, edible oil, lube oil, barytes and others)
  - 4 berths to handle 2.2 MTEUs of container cargo and commensurate equipment to rationalize the requirement planned in Phase II
  - 3 berths to handle 25 MTPA of liquid cargo (Crude oil, POL, LNG, LPG) and
  - 3 SBMs to handle 18 MTPA of crude oil and 9 MTPA of Products
- Cargo Storage area for the envisaged Phase-III Traffic demand is Ha. 973 (Ac.2402).
- Storage area for cargoes other than containers is Ha.900 (Ac.2220)
  - Coal - Ha.204 (Ac.504)
  - Fertiliser & Agri Products - Ha. 57 (Ac.140)
  - Other general cargo - Ha.193 (Ac.477)
  - Liquid cargo - Ha.186 (Ac.460)
- Area for Container storage and related activities is Ha.259 (Ac.640)
  - Container storage - Ha.239 (Ac.590)
  - Container related activities like refers etc,. - Ha. 9 (Ac. 23)
  - Container freight station - Ha. 20 (Ac. 50)
- Berths and transit areas - Ha. 40 (Ac.100)
- Road, rail & parking areas - Ha. 72 (Ac.178)
- Green belt - Ha.152 (Ac.375)
- Utilities & amenities - Ha. 49 (Ac.120)
- Port based industries - Ha. 40 (Ac.100)

Total area required for Phase III development - Ha.1512 (Ac.3736)

- Equipment

Cargo	Equipment Type	Rated Capacity	No. of Berths	Quantity
Coal	**Berth Equipment**			
	Grab Unloader	2000 TPH	7	16 nos (5x2+2x3)
	Dock conveyor	4000TPH/ 6000TPH		2.8km
	Stockyard Equipment			
	Belt conveyor	4000TPH/ 6000TPH		33.0 km
	Stack tubes			2 pairs
	Stacker-reclaimers	4000TPH/ 2000TPH		12 nos
	Stacker			2 nos
	Transfer silo for user			1 nos
	Pay loaders			60 nos
	Bulldozers			60 nos
	Trucks	40 T		60 nos
	In-motion weigh bridges			4 nos
	Wagon loading station			2 nos
General Cargo, & Fertilisers	**Berth Equipment**			
	Mobile harbour cranes (Fertiliser)	1000 TPH	2	2 nos
	Dock conveyor	2000 TPH		1.20 km

Cargo	Equipment Type	Rated Capacity	No. of Berths	Quantity
	Mobile harbour cranes (other general cargo)	500TPH	5	10 nos
	Storage Yard Equipment			
	Belt conveyor (Fertiliser berth to warehouses)	2000 TPH		8.5 km
	Bagging plants			10 nos
	Belt conveyor (Bagging plants to wagons)			3.1 km
	Belt conveyor (warehouses to cement berth / silo) (Dock conveyor and loader by user)	1000 TPH		4.1 km
	Edible oil pipeline	12” dia		10.5 km
	Lube oil pipeline	12” dia		17 km
	Fork lift truck	5 T		17 nos
	Fork lift truck	10 T		8 nos
	Pay loader			12 nos
	Cement silos			2 nos

Cargo	Equipment Type	Rated Capacity	No. of Berths	Quantity		
Containers	**Berth Equipment**			**Phase III requirement**	**Additional requirement by rationalization of Phase II requirement**	**Total**
	Rail-mounted quay crane (5 per each main liner berth and 4 per each feeder berth)	25 moves per hour	4	19 nos (4x5)	22 nos*	41 nos
	Storage Yard Equipment					
	Rubber tyred gantry cranes			27nos (3x9)	72 nos*	99 nos
	Rail mounted gantry crane			9 nos (1x9)	14 nos*	23 nos
	Reach stackers			3** (27÷9)	-	-
	Truck & trailers			54 nos (6x9)	117 nos*	171 nos
Liquid cargo	**A. Berths:** The operational equipment like unloading arms, pipelines, storage facility, fire-fighting arrangements and evacuation arrangements will be worked out by the user agency and specific approval for terminal operation would be obtained separately.					
	B. SBMS: The operational equipment, pipelines, storage facility, fire-fighting arrangements and evacuation arrangements will be worked out by the user agency and specific approval for terminal operation would be obtained separately.					
Others	Railway Locomotives			2 nos		

* Container Handling Equipment Envisaged during Phase III for Rationalization of Phase II Provisions is shown in **Table 5-16**.

** The Phase III requirement of 3 reach stackers will be met from the surplus provision available in Phase II as shown in **Table (5-16)**.

- Dredging and disposal of dredged spoil
  (including the 2nd lane of the approach channel)
  - Capital dredging - 63 million cum
  - Dredge material to be used for reclamation - 29 million cum
  - Disposal of dredged spoil at identified disposal areas beyond (-) 20 mCD - 34 million cum
  - Annual maintenance dredging and disposal of dredged spoil at identified disposal areas beyond (-) 20 mCD Contour - 1.02 million cum

- Rubble mound Shore Protection along the shoreward reclamation of the South & North breakwater about 1300 m and 1050m long respectively
- Reclamation of the enclosed area between the breakwaters and the rubble mound shore protection (about Ac. 41 on the southern side and Ac. 40 on the northern side) and to utilize the same for pipeline corridors for the LNG, LPG, POL & crude oil and to accommodate related essential control / safety installations and allied infrastructure including breakwater maintenance facility.
- Reclamation of 39 million cum comprising of 29 million cum of dredged material. The remaining 10 million cum would comprise of gravel / hard-standing / pavement.
- Straightening of Khandaleru Creek by forming straight cut across the existing sand bar and thereafter reclamation of meandering north and south arms (Ha. 133.80) to develop back space required for the berths
- Development of mangroves in replacement of those existing in the project area to suitable area in the proximity of the port
- Internal roads
  - 4 lane roads - 97 km
  - 2 lane roads - 69 km;
  - Single Lane - 7 km
- Adequate truck parking – Ha.60 (Ac.100)

- Internal railway lines and sidings 168 TKM with 3 numbers of loco Parking Bay for day to day repairs & maintenance of the locomotives
- Bridges
- Bridges on Khandaleru Creek
  - Two road bridges (RB7 & RB22)
  - Two railway bridge (RB10, RB11)
- Bridges on Buckingham Canal
  - Two road bridges (RB21 & RB 23)
  - One Road bridge-cum-flyover (RB12)
- Bridges on drain / creek
  - Two road bridges (RB19 & RB20)
- Modification / Relocation of existing road bridge (EX1) as road-cum-rail bridge on Upputeru Creek
- Strengthening of existing bridges / Culverts on Buckingham Canal
  - Three Road Bridges (RB16, RB17, RB18)
- Five flyovers (F4,F5,F6,F7 & F8)
- Gate complexes, weigh bridges, administrative, operational and functional, welfare and amenities buildings.
- 10 control buildings - Two near corners of North dock (CB-1 & CB-2), One along western end of the Northern Arm (CB-3), Two near corners of the North-West dock (CB-4 & CB-5), four on the corners of the Western Dock (CB-6,CB-7,CB-8 & CB-9) and one near western end of the Southern berthing front (CB-10).
- Port craft jetty - 800m long
- Coast Guard Jetty - 200m long
- Dry Dock & Repair facility
  - Repair dry dock No 1- 150 m length, 40 m width and 12.0 m depth (with -9.5 m sill level at entrance) with repair quay - 200 m long
  - Repair dry dock No 2- 335 m length, 65 m width and 15.0 m depth (with -12.5 m sill level at entrance) with a leading in jetty of 100 m long and repair quay/ Fit out wharf - 250 m long
- Utilities like Power, Water supply. Sewage treatment plant etc.
- Environmental works like STP, dust suppression measures, mangrove development and greenbelt development.
- Development of green pastures on southern beach for aesthetic upgradation.

6.1.2 Designation of Berths

It is proposed to relocate the container terminal from the south port to the west port area and suitably re-designate some of the berths of Phases I & II to handle other cargo from considerations of need for efficient road and rail connectivity to the container traffic with the national transportation grid, high ship handling productivity, compatibility of cargo handling at neighbouring berths and environmental aspects where feasible without disturbing the mechanization and conveyor systems already being developed in the Phases I & II.

Overall designation of berths for various cargoes is summarized hereunder:

Location	No of Berths for Various Cargoes				
	Coal	Iron Ore	General Cargo	Container	Liquid Cargo
Lee of South Breakwater	-	-	-	-	3
Lee of North Breakwater	-	-	-	-	1
North Quay	2	-	2	2	-
South Quay	3	-	3	-	-
North West Quay	-	1	2	2	-
North Dock	8	-	-	-	-
West Dock (Straight Cut)	-	-	2	6	-
SBMs in Port Limits (Open Sea)					3
Total	**13**	**1**	**9**	**10**	**4Berths + 3 SBMs**

6.1.3 Navigable Waterways

The dimensions and dredged depths proposed for various navigational waterways to be developed during the Phase III are as follows:

Description	Proposed Dimension	Proposed Dredge Depth in Phase III (in m CD)
2nd lane of outer Approach channel	230 m wide	(-)18.90
Deepening and widening of existing second turning circle near the west and northwest docks	680 m dia	(-)18.10
Liquid Cargo berths L2 . L3, L4	400 m 400 m each	(-) 17.70 (-) 15.70
North dock N10, N11 N12, N14	350 m each 450 m each	(-) 18.70 (-) 24.70
North West dock NW-2, NW3	300 m each	(-) 16.70 / (-) 15.00 as required
West dock W1 W2 – W9 . W10	300 m 400 m each 450 m	(-) 16.70 / (-) 15.00 as required
Other maneuvering areas		(-)17.30 / (-)19.50 / 26.70

6.1.4 Summary of Infrastructure Required in Phase III

The Phase III development activities are planned in an area of Ha.1512 (Ac.3736) and broadly comprise the following:

A. 20 Berths and 3 SBM's within Port Limits (to cater to 154 MTPA of various types of cargo and 2.2 MTEUsPA of Containers)

7 berths to handle 88 MTPA of coal, 6 berths to handle 14 MTPA of general cargo (Fertilizer, agri-products, granite, edible oil, lube oil, barytes and others), 4 berths to handle 2.2 MTEUsPA of container cargo, 3 berths to handle 24.70 MTPA of liquid cargo (POL, LNG, LPG & crude oil) and 3 SBMs to handle 18 MTPA of crude oil and 9 MTPA of products. These berths are proposed in the South & North docks, the north-west dock and the west dock along with required backup area, cargo storage areas, warehouses and other pertinent infrastructure. It is proposed to relocate the Phase II container terminal from the south port area to the west port area on account of environmental considerations, compatibility of cargo handling and efficient road and rail connectivity. Accordingly, cargo handling at the berths has been designated (**Table 5.18**).

B. Dredging

About 63 million cum of dredging in soft soils for achieving required depths in the navigable waterways and alongside Berths.

Out of the total dredging quantity, it is proposed to use about 29 million cum for reclamation of port lands and the balance 34 million cum of dredge material is proposed for disposal at the dumping ground identified in Phase II beyond (-) 20m contour.

C. Straightening of Khandaleru Creek

Straightening of Khandaleru Creek by forming a straight cut across the existing sand bar in Khandaleru Creek near the west port for development of west dock and thereafter reclaim the meandering north and south arms of the creek (Ha.133.80) to serve as back space required for the berths.

D. Shore Protection for reclamation area near South and North Breakwaters

It is proposed to construct suitably designed rubble mound structures of about 1300 m long on the southern side and 1000 m long on the northern side which would act as shore protection for the accretion observed near coast at the land fall points of the breakwaters and conserve the said area by reclaiming these areas to uniform level by utilizing dredged sand. The sheltered areas (Ac. 41 on the southern side & Ac. 40 on the northern side) between the existing breakwater the shore protection mound are proposed to be utilized for pipeline corridors for the LNG, LPG, POL & Crude oil and to accommodate related essential control / safety installations and allied infrastructure including breakwater maintenance facility by suitably reclaiming the same with dredge sand.

E. Replacement of the existing mangroves

Mangroves existing in the project area would be replaced at suitable areas within the proximity of the port.

F. Changes in Water Bodies

Four ephemeral drains exist in the development area; one of them serving as an agricultural drain and the rest as drainage path for the defunct salt pans. The agricultural drain would be diverted and maintained. A culvert is proposed for one drain in the south which is crossing the port boundary and meeting the Buckingham Canal. The other two local drains would be reclaimed along with salt pans and the fish ponds except the part of one drain being maintained for tidal exchange to the 9 acres of mangrove being protected.

G. Bridges

Development of two road (RB7 & RB22) and four railway bridges (RB10, RB10A, RB11& RB11A) on Khandaleru Creek, one railway bridge (RB14) and four road bridges (RB12, RB13, RB21 & RB 23) on Buckingham Canal, two road bridges (RB19 & RB20) on drain / creek, modification of the existing bridge (EX1) on Upputeru creek as Rail-Cum-Road Bridge and strengthening of 5 existing bridges / culverts on Buckingham Canal (RB15, RB16, RB17, RB18 & EX2) to integrate the Port's operational area separated by creek system and to facilitate faster deployment of heavy duty trucks and railways for transport of cargo to / from port and hinterland as well as reduce smoke emissions from cargo trucks..

H. Operational Control Buildings

Two near corners of North dock (CB-1 & CB-2), One along western end of the Northern Arm (CB-3), Two near corners of the North-West dock (CB-4 & CB-5), four on the corners of the Western Dock (CB-6,CB-7,CB-8 & CB-9) and one near western end of the Southern berthing front (CB-10).

I. Port Craft Jetty, Repair Dry Dock and Coast Guard Jetty

Development of two jetty's 800 m long for Port Crafts and 200 m long Coast Guard vessels, a Repair Dry Dock 150 m long, 40 m wide and 12.0 m depth with (-) 9.5 m sill level at entrance) with a 200 m long repair quay and another Repair dry dock 335 m in length, 65 m in width and 15.0 m in depth (with -12.5 m sill level at entrance) with repair quay of 200 m long

6.2 Non-Operational Area (Non Processing Area)

The non-operational area comprises of residential area, hospitals, training centers and commercial establishments like banks, etc. An area of 20 acres is allotted for institutional area like banks, etc and an area of 35 acres is provided for fuel storage and other services. About 10 acres is allotted for residential bachelor accommodation.

6.3 Green Belt

In Phase III, green belt development is required along the boundary of the western port and also around the storages to be developed in Phase III.

As the area south of the west port is reserve forest land and also as the cargo storage proposed in west port is for containers, the green belt width proposed along the west port boundary is 50 m. A 20 m wide Greenbelt is proposed around the dry bulk storages.

In addition, avenue plantation is proposed along the median and alongside the road. It is also proposed to develop 13 ha of green pastures on the southern beach for aesthetic up-gradation.

It is proposed to develop 152 ha of green belt in Phase III.

6.4 Social Infrastructure

The proposed Phase III expansion of Krishnapatnam Port is located within the limits of the area sanctioned for the development of the port by GoAP. The proposed Phase III development of the port does not involve any resettlement and rehabilitation activity. Phase I & II developments of Krishnapatnam Port involved resettlement and rehabilitation for which GoAP has already implemented appropriate resettlement and rehabilitation plans. KPCL also voluntarily supplemented to the R&R schemes under its CSR initiatives.

CSR activities implemented through CVR foundation in the neighbouring villages are aimed at improving overall living standards in the neighbouring villages, catering to the following aspects:

- Housing,
- Education,
- Health,
- Protected water supply
- Imparting vocational skills – driving, welding,
- Women empowerment – tailoring, embroidery, pickle making, etc.
- Community services like old age homes, places of worship, community halls and supply cooking gas

Under the CSR activities of the Krishnapatnam Port, CVR Foundation runs 27 schools in nearby villages and has established a hostel building in Nellore for the students pursuing higher education i.e. from Intermediate to Post Graduate level standard with free boarding & lodging facilities. It has also developed NAVANEETHA PUBLIC SCHOOL, a school of international standard for the benefit of the local population. It has Academic and a Hostel facility in an iconic building with a total built-up area is over 65,000 Sft, complete with modern infrastructure facilities.

Up to the year 2014-15, Krishnapatnam Port has undertaken CSR activities amounting to Rs. 75.3 Crores including supplementing the R & R measures. Funds are allocated for CSR activities annually. An amount of Rs 14.0 crores is budgeted for the year 2015-16 towards CSR activities.

6.5 Connectivity (Traffic &Transportation Road/Rail/Water ways etc.)

6.5.1 Rail

Double line electrified rail connectivity has been developed from Venkatachalam on the main line to Krishnapatnam Port connecting the port with the Chennai-Howrah trunk line.

6.5.2 Road

A four lane expressway was developed by R&B department from Venkatachalam on NH-16 (old NH-5) to Krishnapatnam Port. It is feasible to widen the same to 6 lanes. The developed connectivity with the port ensures quick movement of goods and personnel. In view of the exclusive connectivity to the NH-16 which forms a part of Golden quadrilateral the impact on the existing traffic in the region is minimal.

Further, NHAI proposes to develop NH-16 as six lane road (from Ichapuram to Tada) considering the future traffic.

6.5.3 Waterways

The waterway passing through Krishnapatnam Port is Buckingham Canal is under the control of Inland Waterways Authority of India, which was developed for inland navigation during the British regime. Presently it is defunct. The flow regime of Buckingham Canal is preserved.

6.6 Drinking Water Management (Source & Supply of Water)

In Phase III, about 600 KLD of water is estimated for domestic purposes and 1900 KLD for dust suppression, plantation and fire-fighting purposes etc., totaling to 2500 KLD. The planned water consumption for Phase II is 2.5 MLD with about 400 KLD of for domestic purposes. Thus, the total drinking / potable water demand would be about 1.0 MLD and the overall water requirement shall be 5.0 MLD.

GoAP has allocated 1 MLD of potable water from the nearby Muthukuru reservoir in terms of the Concession Agreement and laying of pipe lines from Muthukuru Reservoir to the port boundary is on hand. Irrigation department of GoAP has also permitted the drawal of 4 MLD of water from the nearby Nakkala Kalava irrigation drain.

The domestic water requirement of 1.0 MLD would be met from the Muthukuru Reservoir supplies and the requirement of 4.0 MLD towards dust suppression, plantation, firefighting etc., would be drawn from Nakkala Kalava irrigation drain. Necessary additional storage tanks, pump houses and pipelines will be provided as required.

Rainwater harvesting pits are provided to recharge ground water.

6.7 Sewerage System

One 300 KLD STP is under operation. Additional STPs, with a total of about 700 KLD are proposed be established in the port to cater to the sewage that would be generated from the Phase III domestic demand. The treated effluent shall be recycled for dust suppression and plantation purposes.

Isolated buildings will be provided with septic tanks and soak pits.

6.8 Industrial Waste Management

As a port is not an industry no industrial wastes are generated. Leachate and runoff from coal storage areas shall be routed through garland drains and collection pits into guard ponds and shall be recycled for dust suppression.

6.9 Solid Waste Management

The solid waste from the utilities like canteen are being segregated as biodegradable and non-biodegradable waste and collected separately by providing bins at respective places.

About 90% of the waste which is likely to be generated at the port amounting to about 900 kg/day is biodegradable and would be subjected to composting for use as manure for green belt within the port.

About 10% of the waste likely to be generated at the port is non-biodegradable like plastic, shall be collected and disposed through approved vendors of APPCB duly following the norms. The non-biodegradable waste is about 100kg/day.

The composting site shall be located at a suitable location.

6.10 Power Requirement & Supply / Source

The power requirement is about 45 MW for the Phases I & II and it would increase to 130 MW for the Phase III. GoAP has agreed to provide power supply as an external infrastructure, in terms of the Concession Agreement. To meet power requirements, a 132/33 kV substation was built by KPCL in the port limits and APTRANSCO has provided power supply of 45 MW, from the grid to meet the demand of Phases I & II. Additional power supply for Phase-III would be provided by the GoAP from the APTRANSCO's power grid. Five additional sub-stations are proposed within the port boundary to cater to the Phase III power requirement.

However DG sets are proposed as back-up for safety lighting and safety equipment during power failures

7 REHABILITATION AND RESETTLEMENT (R&R) PLAN

GoAP is the owner of the entire land earmarked for the development of Krishnapatnam Port and the same is being transferred on lease basis to KPCL in terms of the Concession Agreement.

The proposed Phase III development of the port does not involve any resettlement and rehabilitation activity.

The Phase I & II developments of the Krishnapatnam Port involved resettlement of four villages and local fishermen for which GoAP sanctioned R & R measures amounting to **Rs 58.06 Crores** for the project affected families (PAFs) in the villages. GoAP has rehabilitated them by building 500 houses. In addition to the GoAP's share, Krishnapatnam Port have voluntarily supplemented the R& R schemes by development of social infrastructure like improved housing, road, water supply, power supply, community facilities, along with green belt zones in the resettlement areas. Krishnapatnam Port is committed to balanced and sustainable development in harmony with the surrounding environment and has taken up several socio-economic growth initiatives besides other clean and green measures as part of CSR initiatives in line with applicable guidelines being implemented through CVR foundation.

The community infrastructure has improved also on account of CSR activities being undertaken by the port in the neighbouring villages.

Up to the year 2014-15, Krishnapatnam Port has undertaken CSR activities amounting to Rs. 139.70 Crores including supplementing the R & R measures. Funds are allocated for CSR activities annually. An amount of Rs 10.70 crores is budgeted for the year 2015-16 towards CSR activities.

8 PROJECT IMPLEMENTATION SCHEDULE AND COST ESTIMATES

8.1 General

The implementation schedule aims at completing the proposed development of Phase III facilities of Krishnapatnam Port within a fixed time frame and is prepared considering the various activities involved in the project and duration of each activity.

8.2 Proposed Development

The main components for the Phase III development of Krishnapatnam Port comprises of:

Pre-development Activities

- Field surveys and investigations
  - Topographic surveys
  - Geotechnical investigations (terrestrial)
  - Oceanographic surveys
  - HTL - LTL & CRZ demarcation
- Baseline environment survey (marine and terrestrial) & EIA Report
- Environment and CRZ clearance from MoEF
- Detailed Project Report
- Technical closure
- Financial closure

Development Activities

- Area development
- Capital dredging and reclamation
- Construction of berths
- Development of cargo storage areas and ware houses
- On-shore infrastructure including supply and installation of material handling equipment, conveyors, pipelines etc.
- Internal road and railway networks, water supply and drainage
- Power supply, switch gear and area illumination
- Services, utilities, environmental works
- Operational, functional, administrative, welfare and amenities buildings.

8.3 Time Schedule

Following pre-development activities are expected to take about 12 months time upon approval of the TOR by MoEF:

- Field surveys and investigations
- Environmental and CRZ Clearance by MoEF
- CFE by APPCB

Technical Closure and Financial Closure are to be achieved prior to the commencement of Phase III development of the port. These activities would require about 12 to 18 months for completion and shall be taken simultaneously with the pre-development activities.

Implementation of the envisaged Phase III Development i.e., port construction is expected to take about **60** months after grant of CRZ & EC Clearance by MoEF. The project implementation schedule for the development activities is depicted by a bar chart in **Drawing No. KP/PH-III/PFR/17**.

Details of the main development activities / items identified are given below.

8.3.1 Civil Works

8.3.1.1 Dredging and Reclamation

The estimated quantity of capital dredging is about **63 million cum.** About 29 million cum of the dredged material will be used for reclamation and 34 million cum is proposed to be disposed off at the approved disposal area beyond (-) 20 m CD. The time estimate for completing the dredging and reclamation is about 54 months.

8.3.1.2 Berth Construction

During Phase III, it is proposed to develop 20 berths within the protected water areas of the port comprising of 7 berths for dry bulk cargo, 6 berths for general cargo, 4 berths for container cargo and, 3 berths for liquid cargo in addition to the 3 SBMS for liquid cargo in deep waters within port limits. The quay wall for all dry bulk, general cargo and container cargo berths shall be relieving platform type construction comprising of a substructure of RCC diaphragm wall with combination of vertical and raker piles and an RCC deck super structure.

Liquid cargo berths shall be dolphin type structures formed with RCC pile substructure and RCC deck superstructure connected with walkways supported on RCC piles. These berths will be connected by means of piled approaches to the respective breakwaters on the Southern & Northern sides. Construction of all the berths will be completed in about 45 months.

The SBMs comprises of readily fabricated bought out steel buoy with standard anchorage & evacuation pipe system.

8.3.1.3 Shore Protection on the windward side of the Breakwaters

Development of rubble mound shore protection structures 1300 m & 1000 m long are proposed windward of the existing South & North breakwater respectively. The rubble mound breakwater shall be suitable designed and formed with rock under-layers protected by armour layer. The placement of rock / quarry run will be progressed by end on dumping method. A 0.5 m thick quarry run i.e., filter layer will be placed over the bed before the placement of core material. It is envisaged the construction of rubble mound breakwater can be completed in 36 months.

8.3.2 Mechanical and Electrical Works

Mechanical and electrical works relate to cargo handling equipment, electrical system, control system, communication system etc. The estimated time for completion of these works is about 54 months.

8.3.3 Onshore Development

8.3.3.1 Buildings

A suitable number of buildings as per their functional requirements shall be provided at the port like administrative building, warehouses, port operation building, canteen, gate house, fire station building, sub-station with control room etc. The total construction of these buildings will take 45 months.

8.3.3.2 Stockyards

Stockyards are proposed for stacking of coal with suitable ground improvement and drainage facilities. The estimated time for completion of these works is about 46 months.

8.3.3.3 Road and Rail

During Phase III, it is proposed to develop 97 km long of 4 lane road, 69 km of 2 lane of road, 7 KM of single lane road and 168 TKM of rail within the port area. The time required for the completion of rail and road is 52 months.

8.3.3.4 Utilities and Environmental Aspects

Utilities and environmental aspects comprise water supply, drainage, sewage system, security system, firefighting facilities, green belt, replacing the mangroves, pollution control, dust suppression, waste reception facilities. The estimated time for completing these facilities will be scheduled to synchronize with overall project completion.

8.4 Capital Cost Estimates for Phase III Development

The approximate capital cost estimates for the Phase III development of the project works out to **Rs. 12256 Crores** and an abstract of the same is furnished below in **Table 8-1**.

Table 8-1: Abstract of Cost Estimates

S. No	Item	Cost (Rs. In Crores)
1.	Project Preliminaries and Site Development	450.00
2.	Dredging and Reclamation	1153.00
3.	Berths	2025.00
4.	Buildings	697.00
5.	Stockyards	574.00
6.	Road and Railway Works	1018.00
7.	Cargo Handling Equipment	6131.00
8.	Utilities and Others	39.00
9.	Environmental Protection Works	90.00
10.	Port Crafts and Aids to Navigation	6.00
11.	Shore Protection Works	73.00
	Total	**12256.00**

DRAWINGS