No.

Namibian Ports Authority
Republic of Namibia

Preparatory Survey on the Walvis Bay Port Container Terminal Development Project in the Republic of Namibia

Final Report
Executive Summary

March 2010

JAPAN INTERNATIONAL COOPERATION AGENCY

PADECO Co., Ltd.
Oriental Consultants Co., Ltd.

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Executive Summary

1 Introduction

After its harbour was deepened in 2000, the Port of Walvis Bay began attracting more container cargo. It is expected that throughput will reach 260,000 TEU per year in 2009. Although the container stacking yard is being expanded, the throughput may reach the limit of the handling capacity of the exiting port facilities in 2012 if this trend continues. To ensure that the Port of Walvis Bay will play a role as a container transhipment hub on the southwest coast of Africa as well as a gateway to land-locked countries, the Namibian Ports Authority (Namport) has launched a new container terminal project laid offshore at the south end of the port premises in 2007. In 2008, Namport conducted the pre-feasibility study of the project, which proposed to divide the project into three phases. Following to the results of the pre-feasibility study, this study has been conducted in order to conclude the feasibility of the Phase 1 Project.

This “Final Report” details all the aspects of the development of the new container terminal ranging from the demand forecast of container throughput to the determination of the physical dimensions of the container terminal, from the site investigations of subsoil, waves and currents to the basic design of the port facilities and cost estimate of both the initial investment and terminal operation, and from the economic and financial analyses of the project to the recommendations for project implementation. The report also studies contingent alternatives, which will be useful in case the new container terminal has to be located at a different site to avoid excessive environment impacts to the lagoon protected by the Ramsar Convention.

2 Current Transport Network with Respect to Walvis Bay

(1) Current Maritime Transport Network

Directly or by use of their websites, the JICA Study Team collected shipping routes and schedules of all the shipping lines who have scheduled calls as of August 2009 on the west, south and east coasts of Africa. As a result, a map has been created covering all of the current shipping routes in southern Africa as shown in Figure 1.

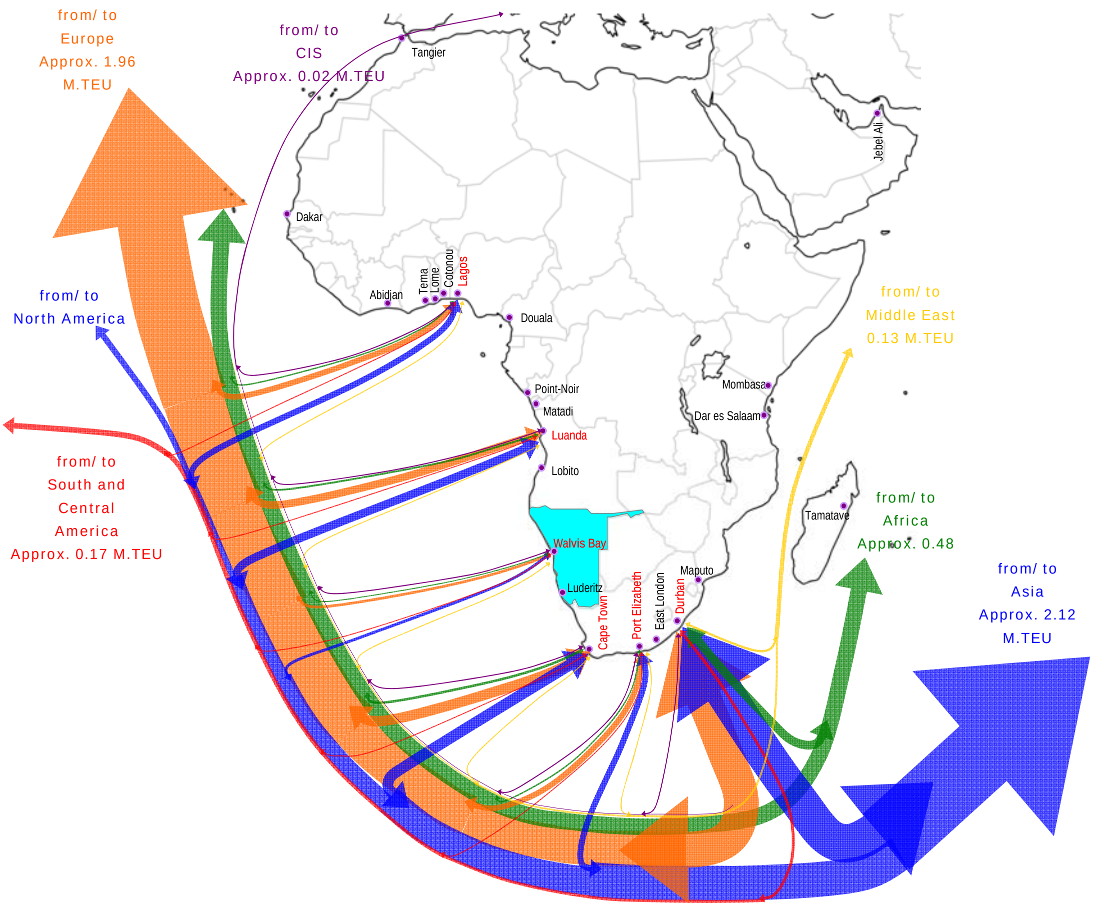
There are four main maritime routes namely, Europe–Africa, South America–Africa, Asia–Africa and Middle East/South Asia–Africa.

For the Europe–Africa Route, the maritime routes servicing the ports of the West Africa like Tema, Cotonou, and Lomé, are completely separated from those servicing Walvis Bay or the ports of South Africa. Currently, there is no maritime route from Europe directly servicing the West Coast of Africa, like Angola. Walvis Bay is considered to be the best gateway for cargo from Europe to the land locked countries of Southern Africa.

From the South America–Africa Route, only the Port of Walvis Bay and a few ports of South Africa are currently receiving maritime services. The Port of Walvis Bay is a transhipment port for the container cargos from South America to the ports of the west coast of Africa like Luanda in Angola. It has promising potential as a transhipment port to the ports of the west coast of Africa.

There are five maritime sub-routes in connection with Asia–Africa Route. They are the routes of 1) Asia–South Africa, 2) Asia–East Coast of Africa, 3) Asia–West Africa Direct, 4) Asia–West Africa via South Africa or Namibia and 5) Asia–East Africa–South Africa–West Africa. It is notable that all the shipping lines provide services to the ports of Southern Africa before going to call at the ports of West Africa, which are very congested and have ships wait for the berthing for many days. Among the sub-routes of the Asia – Africa Route, the above 1) and 2) are not relevant to Walvis Bay. On the sub-route 4) panamax container vessels are currently calling at Walvis Bay on the way to West Africa. In connection with the sub-routes 3) and 5), and when the new container terminal is built, Walvis Bay is a potential container transhipment port to the west coast of Africa as well as the gateway port to the land-locked countries of Southern Africa in transporting cargo from Asia.

As it is located at the opposite side of the continent, there will be no big role that the Port of Walvis Bay can play in connection with the Middle East/South Asia – Africa Route.



Source: JICA Study Team collecting routes and schedules from shipping lines.

Figure 1 Shipping Routes To and From Africa

(2) Current Land Transport Network

Figure 2 shows the Development Corridors of the Southern Africa. The roles of the four corridors, the so-called "Walvis Bay Corridors", as a whole will be more important for inland transport of container cargoes to and from the Port of Walvis Bay in the future. The four Walvis Bay Corridors are: (i) the Trans-Kalahari Corridor connecting Walvis Bay with Botswana and Gauteng of South Africa, (ii) the Trans-Caprivi Corridor going to Zambia and Zimbabwe, (iii) the Trans-Cunene Corridor to Angola and (iv) the Trans-Orenje Corridor down to South Africa. Among these four corridors, the busiest is the Trans-Cunene Corridor as a logistic trunk road of commodities from Asia to the southern part of Angola. In the future, the Trans-Caprivi Corridor will be strategically important for Walvis Bay to consolidate its status as the gateway port to the landlocked countries of the southern Africa.

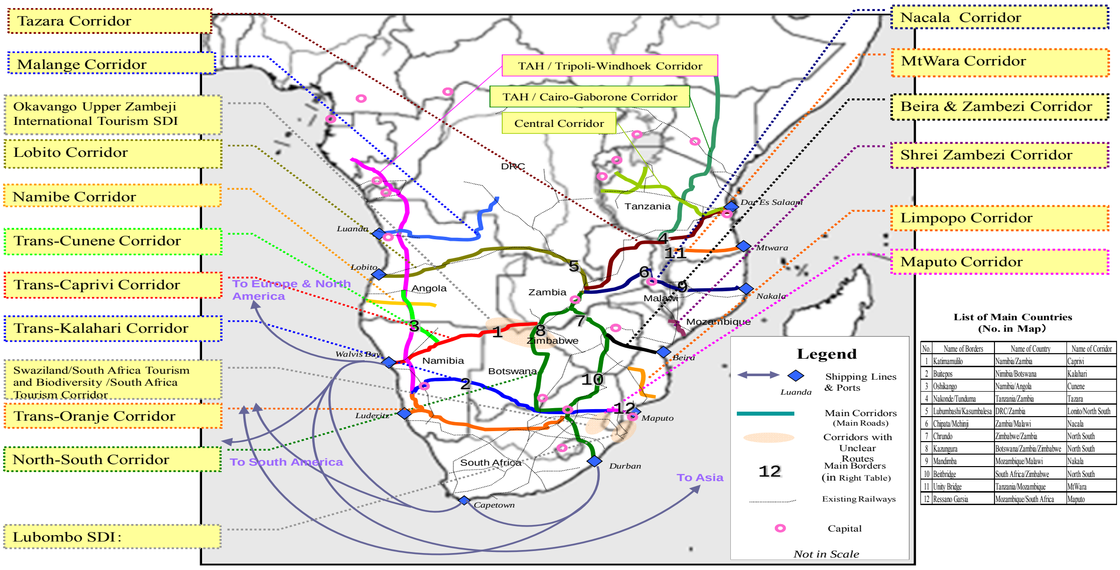


Figure 2 Development Corridors of Southern Africa

3 Demand Forecast of Container Throughput

Demand forecast of the total container throughput consists of two separate forecasts. One is the growth of the container throughput due to the socio-economic growth of the groups of countries contributing to the import, export, transhipment and transit at the Port of Walvis Bay. This estimate takes into account the container growth from 1996 to 2008, a trend of growth. The other estimate is the container throughput the new container terminal can capture from other ports on the south and west coasts of Africa. These two estimates are summed up as the total demand forecast of the new container terminal in 2015. The resulting container throughput is estimated as in the table below:

Table 1 Summary of Container Cargo Demand Forecast (With-the-Project)

(Unit : TEU)

Year	Imports	Exports	Tranship - ment	Transit			Total
				Inbound	Outbound	Subtotal	
2015	36,964	63,571	461,656	48,668	14,284	62,952	625,144
2016	38,620	66,478	462,381	54,056	17,884	71,941	639,420
2017	40,349	69,519	463,107	59,820	22,392	82,212	655,187
2018	42,156	72,698	463,835	65,914	28,036	93,950	672,638
2019	44,044	76,022	464,563	72,262	35,102	107,364	691,993
2020	46,017	79,499	465,293	78,744	43,949	122,693	713,501
2021	47,652	82,489	466,229	84,978	47,643	132,621	728,990
2022	49,345	85,591	467,167	91,704	51,647	143,351	745,454
2023	51,098	88,810	468,107	98,963	55,988	154,950	762,966
2024	52,913	92,151	469,049	106,795	60,693	167,488	781,601
2025	54,793	95,616	469,993	115,246	65,794	181,040	801,442

Source:JICA Study Team

4 Physical Principles

Several ports in neighbouring countries are extraordinarily congested because of rapid economic growth in recent years and poor port facilities. However, some ports are planning to deepen their navigational channels and increase the number of container terminals. Under this situation, to be a competitive regional hub port capturing enough demand from the ports of neighbouring countries, the new container terminal at Walvis Bay needs to develop physically. It is necessary to deepen the port for larger ships in order to attract Panamax container vessels for Phase 1, which is the most popular type of container mother ships on the southern African Coast. In the later future, it is very probable that an 8000 TEU post-Panamax container vessel will call at the Port of Walvis Bay. Also, the new container terminal will need a longer berth which can simultaneously accommodate one mother and one feeder container vessels. The resulting principal dimensions of the major port facilities recommended are shown in the table below:

Table 2 Design vs. Project Dimensions

Facilities		Phase 1	Phase 2
Approach Channel	Width	134 m	191 m
	Design Vessel	Panamax	8,000 TEU
	Depth	CD −14.1 ~ −14.5 m	CD −16.35 m
	Design Vessel	Panamax	8,000 TEU
Turning Basin	Diameter	450 m	525 m
	Design Vessel	Panamax	8,000 TEU
	Depth	CD −13.5 m	CD −15.5 m
	Design Vessel	Panamax	8,000 TEU
Quay	Length	550 m	1,100 m
	Design Vessel	Panamax + Feeder	Panamax + Feeder
	Depth	CD −15.5 m	CD −15.5 m
	Design Vessel	8,000 TEU	8,000 TEU
QGC Crane	Containers	17 rows	17 rows
	Design Vessel	8,000 TEU	8,000 TEU

Source: EIA Consultant and JICA Study Team

5 Layout of Port Facilities

(1) Approach Channel

The alignment of the existing approach channel should be maintained, as use of the existing channel is economical and no issues with ship manoeuvring at the Port of Walvis Bay have been reported. The ship manoeuvring simulation conducted by EIA Consultants has reportedly concluded the approach channel should be slightly deepened toward the channel entrance to CD – 14.5 m. As the width of the existing channel is 134 m and is sufficient for Panamax vessels, no widening of the approach channel is required for Phase 1.

(2) Turning Basin

A new turning basin should be provided in front of the new container terminal. A calling container vessel will be turned at the turning basin and berthed portside to the new container terminal. The water area between the new container terminal and the existing berths has to be wide enough in the long-term to turn an 8,000 TEU container vessel. As recommended by the EIA Consultants, the diameter and depth of the turning basin for Phase 1 are determined to be 450 m and CD −13.5 m, respectively. The turning basin for 8,000 TEU container vessels will be located according to future development by enlarging the turning basis in Phase 1 to 525 m in diameter and CD −15.5 m in depth.

(3) Alignment of Berths

The berth of the container terminals including that for future development should be aligned straight in order to maximize the usage of the quay so that more vessels can simultaneously unload/load their cargo and consequently reduce the waiting time for berthing. Determination of the orientation of the berth alignment needs to consider the future expansion of the port as well as the volume balance between dredging and reclamation. The current alignment Namport has envisaged is technically reasonable in consideration of the prevailing wind direction, which is mainly southern.

(4) Causeway to Container Terminal

The causeway is located at the south of Berth No. 8. This is the only location that minimizes interference with the existing port facilities and tourist jetties. In addition, as the causeway is near to the mouth of the lagoon, the environmental concerns here are raised but proved inconsequential. To smoothly align the existing road and railway to the new container terminal, its width will have to be 65.0 m to accommodate right-of-way including 2 lane carriage ways, railway tracks, a green belt and a reserve strip included for future use.

6 Layout of Container Terminal

(1) Cargo Handling Method

A cargo handling system using rubber-tired-gantry (RTG) cranes is preferable to other cargo handling systems like a straddle carrier system and a chassis system. An RTG system can utilize the area effectively and, as a result, is the most popular system in the world. If desired, the system can be automated.

(2) Required Capacity

The total throughput of container cargo at Walvis Bay is estimated to increase from 625,000 TEUs in 2015 to 801,000 TEUs in 2025. Among the throughput, the existing Berths 1 through 3 are supposedly able to handle 250,000 TEUs. Thus, the new container terminal has to handle the remaining 375,000 TEUs in 2015 and 560,000 TEUs in 2025. In this case, the capacity of the terminal is limited by the yard capacity up to 583,000 TEU. The demand is considered to reach to the yard capacity in 2026. To meet this demand, the terminal should be complete CD -13.5 m deep and 550 m long by the end of 2015 at latest. Equipment and buildings to be constructed at the initial stage are indicated in the table below:

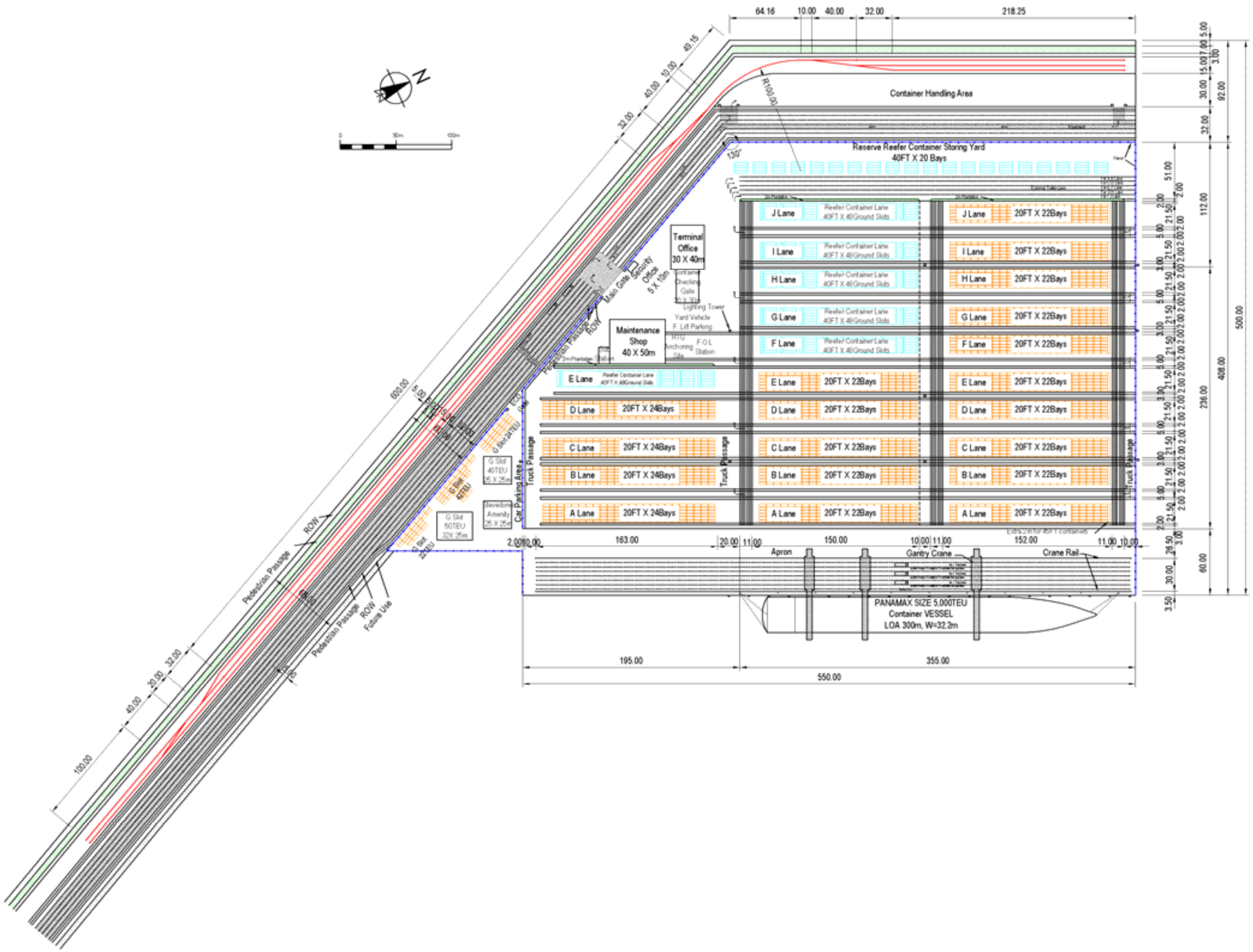
Table 3 Required Equipments/Facilities

Equipment/Facilities	Remarks	Quantity
STS Cranes	For 17 rows (8000 TEU vessel)	3
RTG's	1 over 4 tiers	8
Tractor Heads		17
Chassis		20
Terminal Office	5 story bldg, 5,100 m^2 floor area	
Maintenance Shop	2 story bldg, 2,500 m^2 floor area	
Checking Gate	1 story bldg, 580 m^2 floor area	
Security Office	1 story bldg, 15 m^2 floor area	
Amenity Building	2 story bldg 1,250 m^2 floor area	

Source: JICA Study Team

(3) Layout of Container Terminal

The proposed layout of the new container terminal is shown in Figure 3. The total ground slots accommodate 3,132 TEU, among which 576 TEU slots will be used for reefer containers. The rail gauge of STS cranes is 30 m and the distance between the centres of the wheels of the RTG is 23.45 m spanning 6 bays and one truck lane.



Source: JICA Study Team

Figure 3 Layout of New Container Terminal

7 Layout of Railway Terminal

(1) Operation Scheme

In the near future, a considerable increase of railway transport is expected for the Trans-Cunene Corridor since the railway is being extended to cross the border with Angola at Oshikango. Railway projects along the Trans-Caprivi Corridor and the Trans-Kalahari Corridor are also planned. For the Caprivi Corridor, however, transport modal shift from railway to truck and vice versa is feasible at Tsumeb or Grootfontein located on the railway to Oshikango. The solution to this issue is of great concern since the railway transport scheduled operation must be a dedicated train of 35 wagons bound for Oshikango.[1] Once scheduled operation of a 35 wagon train with capacity of 70 TEUs in each direction starts, the demand of railway transport will increase rapidly following the high growth rate of shipped/landed container cargos to/from the Port of Walvis Bay. Based on the result of demand forecast of railway in 2025, the railway container terminal should have an annual capacity to handle 168,000 TEUs for 300 days with total handling time of 4 hours per train to operate 4 trains per day. The estimated average frequency of the freight train per day by corridor is as follows:

Table 4 Average Frequency of the Freight Train per Day by Corridor

(unit: # of trains)

	2015	2020	2025
Trans-Cunene Corridor	0.7	1.6	2.3
Trans-Caprivi Corridor	0.2	0.3	0.4
Trans-Kalahari Corridor	0.2	0.3	0.4
Total	1.1	2.2	3.1

Source: JICA Study Team

(2) Layout of Railway Container Terminal

As the length of the terminal is not sufficient to operate a 35 wagon train at the phase 1 stage, three rail tracks will be provided: two tracks for loading/unloading and one for locomotive passing. A shunting yard with three rail tracks will be provided along the causeway.

A railway terminal of interlocking concrete pavement 350 m long and 30 m wide is provided for the reach-stacker operation and the temporary stacking of containers.

8 Natural Conditions at the Project Site

(1) Meteorological and Oceanographic Conditions

The winds are characterised by high velocity, high frequency south to south-westerly winds in the summer and high velocity, low frequency east to north-westerly winds in the winter. The weather of Walvis Bay is very dry. It is reported that its long-term mean annual rainfall is less than 20 mm, although totals range from 0 to over 100 mm per year. Prevailing offshore waves are south and south-westerly and their occurrence is about 98% of the total. Protected from the south and south-westerly waves by a sand peninsula, the water area where the new container terminal is planned is very calm. Occasionally in winter, however, east to north-westerly winds blow and waves of a low frequency intrude through the opening of the bay. All slope protection,

[1] On October 16, 2009, TransNamib Holding Ltd, the state enterprise operating railway in Namibia, announced the call for expression of interest for "Consultancy Services for the Rehabilitation of the Walvis Bay – Tsumeb Railway Line." The de-facto proposals are scheduled to be submitted on or before October 30, 2009. The announcement says that the consultancy services are to advise TransNamib about rehabilitation, procuring of financing through PPP, designing and implementation of the rehabilitation project.

therefore, has to be designed against these intruding waves. By and large, however, under these meteorological and oceanographic conditions, there should be no considerable idling time during construction of the new terminal.

(2) Bathymetry and Subsoil Formation at Phase 1 Area

The seabed elevation at the Phase 1 area surveyed by use of a 200 kHz echo-sounder is CD - 3 m to -5 m and becomes deeper further offshore with about a 1 (V) to 200 (H) slope. Because the echo-sounder picks up fluid diatoms accumulated on the seabed surface, the soil surface is considered a bit lower than reported in the survey results.

Regarding the subsoil revealed by borehole exploration, an unexpectedly thick layer of diatom-origin silt exists deeper than 24 m below the seabed at the Phase 1 area. Three boreholes drilled 50 m below the seabed could not confirm the thickness of this diatom-origin silt layer. At a shallower depth, a relatively thin diatom-origin silt layer of 1 to 2 m thickness was found at several boreholes. The diatomaceous layer at the seabed surface is not as thick as previously discussed but only about 0.6 m to 0.9 m thick.

The borehole exploration reveals the fact that there are five soil formations below the seabed. The first is a diatomaceous layer as mentioned, which is geo-technically classified as very soft sandy/clayey silt. The second is a very loose to very dense sandy layer whose thickness is between 2m to 16m and thickens as the borehole goes further offshore. The third layer is firm to very stiff sandy/clayey silt of diatomaceous origin. Because of its origin, this silt is lightweight and not cohesive at all. The thickness of this diatomaceous silt layer varies much from 0 m to 7.5 m. The fourth is a sandy layer of 3 m to 6 m thickness sandwiched by the diatomaceous silt layers above and below. The last layer confirmed by the borehole exploration is a stiff to hard diatomaceous silt layer encountered at about 24m below the seabed. Diatomaceous silt ranging mostly from 1.06 to 1.20 g/cc in wet unit weight is considered too light to support a heavy gravity structure. It is also compressive so that reclamation needs extra elevation for the settlement.

9 Major Civil Works

(1) Dredging and Reclamation

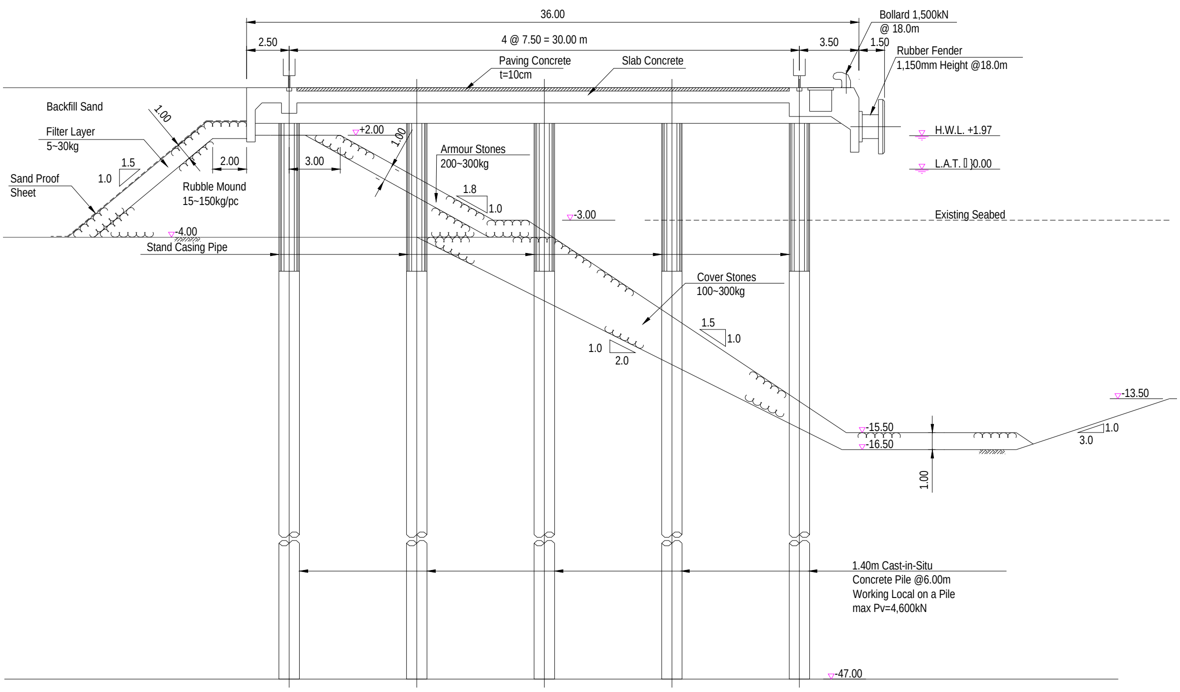
According to the borehole exploration conducted at the turning basin area, materials to be dredged up to CD – 13.5 m for Phase 1 consist of the second to fourth formation of the subsoil, among which a very dense sandy layer exists. A cutter suction dredger (CSD) equipped with a heavy ladder and a high-torque cutter is most appropriate here. According to previous dredging records, the soils to be dredged along the approach channel are sandy materials covered with diatomaceous sediments. Offshore disposal of the diatomaceous sediments is technically impossible meanwhile sandy materials are economically used as reclamation materials. Thus, the deepening and widening of the existing channel will be carried out by a trailing hopper suction dredger (THSD) equipped with a discharging pump and pipeline outlet. When dredged by a THSD, all the diatomaceous sediments will overflow from THSD to the sea and sandy materials will remain in the hopper. These sandy materials will be discharged into the reclamation area using the pump and pipeline. A combined deployment of CSD and THSD is the optimal solution for the dredging and reclamation.

Also, the existing approach channel is to be deepened to a depth of CD −14.1 m from CD −13.1 m on average, with a length of about 7km and a width of 134m. In consideration of the sandy soils to be dredged, the 13 km distance to the designated disposal area, and the navigation of vessels calling at the port, the approach channel dredging has to be carried out by a THSD.

The reclamation volume is approximately 3.53 million m^3, of which about 2.081 million m^3 will be the sands to be dredged by CSD within 1.5 km from the reclamation. The sands to be dredged by THSD from the approach channel are estimated about 1.983 million m^3, of which about 1.218 million m^3 will be used for reclamation. As a result, the sands to be disposed of offshore are estimated about 72,000 m^3. All the excavated materials from the quay wall approximately 231,000 m^3 will be used for reclamation.

(2) Quay Wall

The depth of the quay wall is designed at CD -15.5 m for an 8,000 TEU container vessel. In Phase 1, a 550 m length of the quay wall should be completed by 2015 to meet the demand of Panamax vessels. Remaining at the same depth, eventually its length will be 1,100 m after completion of Phase 2 to be fully adapted to post-Panamax 8,000 TEU container vessels. From the soil formation along the quay alignment, an open concrete deck supported with cast-in-situ concrete piles of 1.4 m diameter is considered the most feasible. A typical cross section of the quay wall is shown below:



Source: JICA Study Team

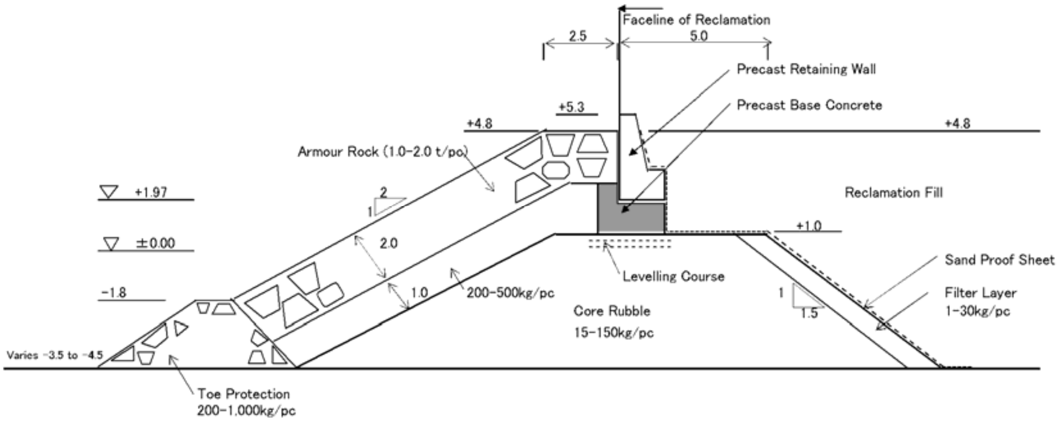
Figure 4 Typical Cross-Section of Quay Wall

(3) Slope Protection

The Northwest and Northeast Revetment (Seawall) is installed upon the seabed at an elevation of around CD −3.5 to −4.5 m. The revetment is designed in the form of sloped protection from the wave action and covered by armour stones. A rubble mound of 15 kg to 150 kg per piece is placed in a seaside slope in 1 (V) to 2 (H). On the rubble mound vertical precast concrete gravity walls are installed. The seaside front surface is protected by two layers of armour stones of 200 to 500 kg/pc and 1.0 to 2.0 ton/pc. The toe is protected by a rock mound of 200 to 1,000 kg/pc stones. The thickness of the primary armour layer is 2.0 m. As the newly reclaimed strata are vulnerable to erosion by waves, an armour stone layer has to be placed to protect the entire slope.

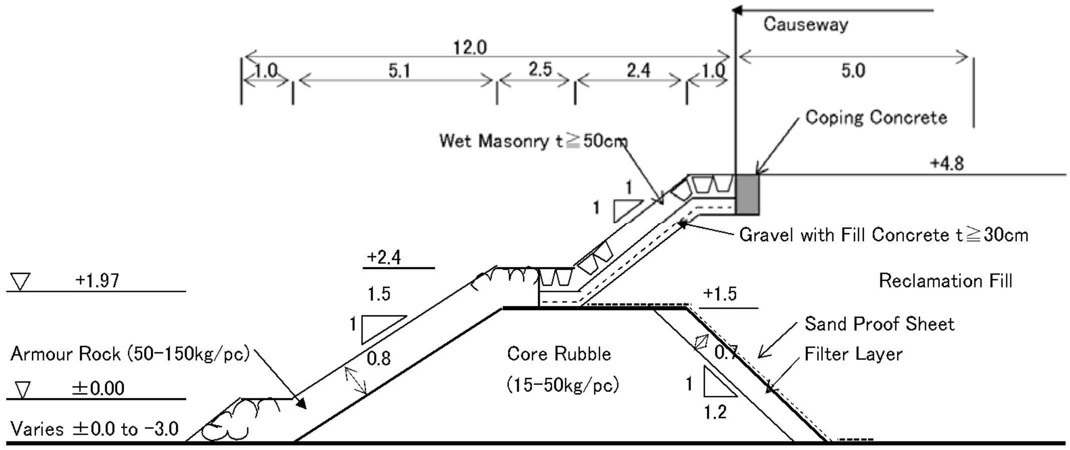
Revetment along the Causeway is formed by a rubble mound base whose top elevation is CD+1.5 m on which a slope facing wet masonry revetment in a slope of 1 (V) to 1 (H) is provided to the top level of the causeway at CD +4.8m.

The cross sections are shown below.



Source: JICA Study Team

Figure 5 Northwest/Northeast Revetment (Seawall)



Source: JICA Study Team

Figure 6 Causeway Revetment

(4) Road

The access road to the container terminal on the causeway has two lanes. On the port side of the causeway, one lane is reserved as a sideway for the working boat jetties. The road behind the container terminal has 3 lanes, wide enough for vehicles to queue for entrance to the terminal gate. The asphalt surfacing pavement is applied on the same base, sub-base, and sub-grade as for the interlocking concrete block (ICB) pavement currently used by Namport.

(5) Yard Pavement and Lighting

The yard pavement will be built from ICB, chosen for easy maintenance. No concrete sleepers will be provided to support the corner blocks of container boxes. Pre-stressed concrete tracks will be provided for RTG travelling. For yard lighting, 9 electric lighting poles are installed.

(6) Railway

As Namport is not changing rails, the standard layout and dimensions of railway track for 48 kg/m rail will be used.

(7) Others

Other civil works included in the package of Phase 1 are: (i) buildings (terminal office, workshop gate and fence); (ii) water supply; (iii) power supply; (iv) fire fighting / sewerage; (v) electrical works; and (vi) landscaping.

10 Construction and Equipment Cost

(1) Basic Presumptions for Cost Estimate

In the following section, the Construction Cost is estimated for the Phase-1 Project and the terminal yard expansion project. The Equipment Cost is estimated for procurement and maintenance for 30 years. The basis of the cost estimate is described as follows:

- The cost estimate is based on the information collected at Walvis Bay in June and July 2009. Quotations submitted by contractors to Namport are also used.
- The unit costs are in general based on locally available materials, labour and construction equipment.
- The unit costs are essentially based on data and information from Namport for projects similar in nature, such as cost of ICB, road construction and railway construction.
- The unit costs for container handling equipment are based on quotations obtained from the supplier. 4% of equipment cost is estimated for the maintenance cost of each piece of equipment, including procurement of spare parts.
- The unit costs per m^2 for each building facility are based on the size, structure, number of floors and function as indicated on the container terminal layout plan.
- The costs for the electrical power supply system including the substation, distribution system and associated works are based on quotations Namport has obtained.
- Unit costs of the quay wall work are established based on the quotations obtained from several contractors.
- The unit costs of dredging and reclamation are based on data and information from Namport and a quotation from a European dredging contractor.
- All costs are estimated in Namibian Dollars (N$) and divided into foreign and local currency portions based on the experience in projects of similar nature.

(2) Construction and Equipment Cost

Based on the basic presumptions above, the construction cost was estimated as shown in Tables 5 and 6. The estimated equipment cost is shown in Table 7.

Table 5 Breakdown of Construction Cost (Phase-1)

Description of Works	Quantity	Unit	Unit Price					Amount		
			Local Portion		Foreign Portion		Total	Local Portion	Foreign Portion	Total
			(N$)	%	(N$)	%	(N$)	(N$)	(N$)	(N$)
CIVIL WORKS COST										
1.General: (including mobilization, demobilization, temporary works, benchmarks, preparation works, testing laboratory and submittals)	5	%	9,336,590	70%	4,001,396	30%	13,337,985	46,682,948	20,006,978	66,689,925
Subtotal 1:								46,682,948	20,006,978	66,689,925
2. Dredging, Reclamation & Revetment										
(1) Mobilization & Demobilization of dredging and reclamation equipment including installation and dismantling of equipment	1	LS	13,390,000	10%	120,510,000	90%	133,900,000	13,390,000	120,510,000	133,900,000
(2) Dredging and reclamation by CSD	2,081,000	m3	7	10%	66	90%	73	15,191,300	136,721,700	151,913,000
(3) Dredging and reclamation by	1,218,000	m3	8	10%	68	90%	76	9,256,800	83,311,200	92,568,000
(4) Dredging and disposal by TSHD	720,000	m3	5	10%	46	90%	51	3,672,000	33,048,000	36,720,000
(5) Revetment	349,000	m3	600	100%	0	0%	600	209,400,000	0	209,400,000
Subtotal 2:								250,910,100	373,590,900	624,501,000
3. Quay Wall (550m long)										
(1) Piling (cast-insitu bored pile, 1400mm dia, 50m long)	480	No.	89,100	20%	356,400	80%	445,500	42,768,000	171,072,000	213,840,000
(2) Deck concrete including re-bars, foremworks and scaffoldings and all associated works.	34,000	m3	3,518	70%	1,508	30%	5,025	119,595,000	51,255,000	170,850,000
(3) Paving concrete including re-bars and formworks and all associated	1,650	m3	2,100	70%	900	30%	3,000	3,465,000	1,485,000	4,950,000
(4) Dredging under Quay Wall	231,000	m3	30	20%	122	80%	152	7,022,400	28,089,600	35,112,000
(5) Quay Wall Fittings (Crane rail, fenders, bollards, etc)	1	LS	4,313,600	20%	17,254,400	80%	21,568,000	4,313,600	17,254,400	21,568,000
Subtotal 3:								177,164,000	269,156,000	446,320,000
4. Terminal Yard										
(1) Interlocking paving including drainage and preparation	140,500	m2	565	100%	0	0%	565	79,382,500	0	79,382,500
(2) Concrete slabs for RTG lanes	5,300	m3	4,000	100%	0	0%	4,000	21,200,000	0	21,200,000
(3) Yard lighting	8	No.	100,000	20%	400,000	80%	500,000	800,000	3,200,000	4,000,000
(4) Fencing with gates	1,250	m	1,400	100%	0	0%	1,400	1,750,000	0	1,750,000
(5) Utility facilities, excluding power supply facilities	1	LS	3,626,400	80%	906,600	20%	4,533,000	3,626,400	906,600	4,533,000
Subtotal 4:								106,758,900	4,106,600	110,865,500
5. Access Causeway										
(1) Road and footpath	43,000	m2	360	90%	40	10%	400	15,480,000	1,720,000	17,200,000
(2) Railway	3,500	m	3,150	90%	350	10%	3,500	11,025,000	1,225,000	12,250,000
(3) Landscaping and Irrigation	7,500	m2	297	90%	33	10%	330	2,227,500	247,500	2,475,000
Subtotal 5:								28,732,500	3,192,500	31,925,000
6. Building Works (9,245㎡)										
(1) Security Office (RC/1F)	15	m2	18,360	90%	2,040	10%	20,400	275,400	30,600	306,000
(2) Terminal Office (RC/5F+PH)	5,100	m2	6,660	90%	740	10%	7,400	33,966,000	3,774,000	37,740,000
(3) Maintenance Shop (S/partly 2F)	2,500	m2	6,390	90%	710	10%	7,100	15,975,000	1,775,000	17,750,000
(4) Checking Gate (1F w/catwalk)	580	m2	9,180	90%	1,020	10%	10,200	5,324,400	591,600	5,916,000
(5) Amenity Building (RC/2F)	1,250	m2	6,030	90%	670	10%	6,700	7,537,500	837,500	8,375,000
(6) Car Shed	20	No.	4,500	90%	500	10%	5,000	90,000	10,000	100,000
Subtotal 6:								63,168,300	7,018,700	70,187,000
7. Power Supply facilities, including substations	1	LS	40,000,000	80%	10,000,000	20%	50,000,000	40,000,000	10,000,000	50,000,000
Subtotal 7:								40,000,000	10,000,000	50,000,000
Total (1～7)								713,416,748	687,071,678	1,400,488,425
Engineering and Head Office Expenses (15% of Total): (including Administration Cost and Engineering Fee)										210,073,264
Grand Total for Civil Works Cost including O/H and Profit										**1,610,561,689**

Source: JICA Study Team

Table 6 Breakdown of Construction Cost for Yard Expansion

Description of Works	Quantity	Unit	Unit Price					Amount		
			Local Portion		Foreign Portion		Total	Local Portion	Foreign Portion	Total
			(N$)	%	(N$)	%	(N$)	(N$)	(N$)	(N$)
CIVIL WORKS COST										
1.Mobilization, Demobilization, Temporary Works, etc.	5	%	287,375	70%	123,161	30%	410,535	1,436,873	615,803	2,052,675
Subtotal 1:								1,436,873	615,803	2,052,675
2. Terminal Yard										
(1) Interlocking paving including drainage and preparation	32,500	m2	565	100%	0	0%	565	18,362,500	0	18,362,500
(2) Concrete slabs for RTG lanes	2,200	m3	4,000	100%	0	0%	4,000	8,800,000	0	8,800,000
(3) Yard lighting	1	No.	100,000	20%	400,000	80%	500,000	100,000	400,000	500,000
(4) Fencing with gates	250	m	1,400	100%	0	0%	1,400	350,000	0	350,000
(5) Utility facilities, excluding power supply facilities	1	LS	832,800	80%	208,200	20%	1,041,000	832,800	208,200	1,041,000
Subtotal 2:								28,445,300	608,200	29,053,500
3. Power Supply facilities, including substations	1	LS	9,600,000	80%	2400000	20%	12,000,000	9,600,000	2,400,000	12,000,000
Subtotal 3:								9,600,000	2,400,000	12,000,000
Total (1～3)								39,482,173	3,624,003	43,106,175
Engineering and Head Office Expenses (15% of Total)										6,465,926
Grand Total for Civil Works Cost including O/H and Profit										49,572,101

Source: JICA Study Team

Table 7 Breakdown of Equipment Procurement and Maintenance Costs

(for Year 1 – 15) (N$)

Project Year			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Calendar Year			2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
	Usage																
	(year)																
QGC	**18**	**To procure**	**3**			**1**		**1**									
NAD 80,000,000		To replace															
		Required	3	3	3	4	4	5	5	5	5	5	5	5	5	5	5
Procurement Cost			240,000,000	0	0	80,000,000		80,000,000									
Maintenance Cost			9,600,000	9,600,000	9,600,000	12,800,000	12,800,000	16,000,000	16,000,000	16,000,000	16,000,000	16,000,000	16,000,000	16,000,000	16,000,000	16,000,000	16,000,000
RTG	**15**	**To procure**	**8**	**2**		**1**	**1**	**3**	**1**								
NAD 17,500,000		To replace															
		Required	8	10	10	11	12	15	16	16	16	16	16	16	16	16	16
Procurement Cost			140,000,000	35,000,000	0	17,500,000	17,500,000	52,500,000	17,500,000	0		0		0	0		
Maintenance Cost			5,600,000	7,000,000	7,000,000	7,700,000	8,400,000	10,500,000	11,200,000	11,200,000	11,200,000	11,200,000	11,200,000	11,200,000	11,200,000	11,200,000	11,200,000
Tractor Head	**7**	**To procure**	**17**	**6**	**2**	**2**	**3**	**2**	**2**	**17**	**8**	**2**	**2**	**3**	**2**	**2**	**17**
NAD 1,000,000		To replace								17	6	2	2	3	2	2	17
		Required	17	23	25	27	30	32	34	34	36	36	36	36	36	36	36
Procurement Cost			17,000,000	6,000,000	2,000,000	2,000,000	3,000,000	2,000,000	2,000,000	17,000,000	8,000,000	2,000,000	2,000,000	3,000,000	2,000,000	2,000,000	17,000,000
Maintenance Cost			680,000	920,000	1,000,000	1,080,000	1,200,000	1,280,000	1,360,000	1,360,000	1,440,000	1,440,000	1,440,000	1,440,000	1,440,000	1,440,000	1,440,000
Trailer Chassis	**8**	**To procure**	**20**	**7**	**2**	**2**	**4**	**2**	**2**		**22**	**2**	**2**	**4**	**2**	**2**	
NAD 550,000		To replace									20	2	2	4	2	2	
		Required	20	27	29	31	35	37	39	39	41	41	41	41	41	41	41
Procurement Cost			11,000,000	3,850,000	1,100,000	1,100,000	2,200,000	1,100,000	1,100,000	0	12,100,000	1,100,000	1,100,000	2,200,000	1,100,000	1,100,000	0
Maintenance Cost			440,000	594,000	638,000	682,000	770,000	814,000	858,000	858,000	902,000	902,000	902,000	902,000	902,000	902,000	902,000
Reach Stacker	**10**	**To procure**	**3**										**3**				
NAD 6,600,000		To replace											3				
		Required	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Procurement Cost			19,800,000										19,800,000				
Maintenance Cost			792,000	792,000	792,000	792,000	792,000	792,000	792,000	792,000	792,000	792,000	792,000	792,000	792,000	792,000	792,000
Folk Lift with Side Spreader	**10**	**To procure**	**2**	**1**			**1**		**1**			**1**	**2**	**1**			**1**
NAD 3,500,000		To replace											2	1			1
		Required	2	3	3	3	4	4	5	5	5	6	6	6	6	6	6
Procurement Cost			7,000,000	3,500,000			3,500,000		3,500,000			3,500,000	7,000,000	3,500,000			3,500,000
Maintenance Cost			280,000	420,000	420,000	420,000	560,000	560,000	700,000	700,000	700,000	840,000	840,000	840,000	840,000	840,000	840,000
Folk Lift Multi-purposed	**15**	**To procure**	**3**			**1**											
NAD 400,000		To replace															
		Required	3	3	3	4	4	4	4	4	4	4	4	4	4	4	4
Procurement Cost			1,200,000			400,000											
Maintenance Cost			48,000	48,000	48,000	64,000	64,000	64,000	64,000	64,000	64,000	64,000	64,000	64,000	64,000	64,000	64,000
Terminal Operation System	**1**	**To procure**	**1**														
NAD 15,000,000		To replace															
		Required	1														
Procurement Cost			15,000,000														
Maintenance Cost			600,000														
Procurement Cost Total			451,000,000	48,350,000	3,100,000	101,000,000	26,200,000	135,600,000	24,100,000	17,000,000	20,100,000	6,600,000	29,900,000	8,700,000	3,100,000	3,100,000	20,500,000
Maintenance Cost Total			18,040,000	19,374,000	19,498,000	23,538,000	24,586,000	30,010,000	30,974,000	30,974,000	31,098,000	31,238,000	31,238,000	31,238,000	31,238,000	31,238,000	31,238,000
Procurement & Maintenance Cost Total			469,040,000	67,724,000	22,598,000	124,538,000	50,786,000	165,610,000	55,074,000	47,974,000	51,198,000	37,838,000	61,138,000	39,938,000	34,338,000	34,338,000	51,738,000

(for Year 16 – 30) (N$)

Project Year			16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Calendar Year			2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043
	Usage																
	(year)																
QGC	**18**	**To procure**				**3**			**1**		**1**						
NAD 80,000,000		To replace				3			1		1						
		Required	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Procurement Cost			0		0	240,000,000		0	80,000,000		80,000,000						
Maintenance Cost			16,000,000	16,000,000	16,000,000	16,000,000	16,000,000	16,000,000	16,000,000	16,000,000	16,000,000	16,000,000	16,000,000	16,000,000	16,000,000	16,000,000	16,000,000
RTG	**15**	**To procure**	**8**	**2**		**1**	**1**	**3**	**1**								
NAD 17,500,000		To replace	8	2		1	1	3	1								
		Required	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16
Procurement Cost			140,000,000	35,000,000	0	17,500,000	17,500,000	52,500,000	17,500,000	0		0		0	0		
Maintenance Cost			11,200,000	11,200,000	11,200,000	11,200,000	11,200,000	11,200,000	11,200,000	11,200,000	11,200,000	11,200,000	11,200,000	11,200,000	11,200,000	11,200,000	11,200,000
Tractor Head	**7**	**To procure**	**8**	**2**	**2**	**3**	**2**	**2**	**17**	**8**	**2**	**2**	**3**	**2**	**2**	**17**	**8**
NAD 1,000,000		To replace	8	2	2	3	2	2	17	8	2	2	3	2	2	17	8
		Required	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36
Procurement Cost			8,000,000	2,000,000	2,000,000	3,000,000	2,000,000	2,000,000	17,000,000	8,000,000	2,000,000	2,000,000	3,000,000	2,000,000	2,000,000	17,000,000	8,000,000
Maintenance Cost			1,440,000	1,440,000	1,440,000	1,440,000	1,440,000	1,440,000	1,440,000	1,440,000	1,440,000	1,440,000	1,440,000	1,440,000	1,440,000	1,440,000	1,440,000
Trailer Chassis	**8**	**To procure**	**2**	**22**	**2**	**2**	**4**	**2**	**2**		**2**	**22**	**2**	**2**	**4**	**2**	**2**
NAD 550,000		To replace	2	22	2	2	4	2	2		2	22	2	2	4	2	2
		Required	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41
Procurement Cost			1,100,000	12,100,000	1,100,000	1,100,000	2,200,000	1,100,000	1,100,000	0	1,100,000	12,100,000	1,100,000	1,100,000	2,200,000	1,100,000	1,100,000
Maintenance Cost			902,000	902,000	902,000	902,000	902,000	902,000	902,000	902,000	902,000	902,000	902,000	902,000	902,000	902,000	902,000
Reach Stacker	**10**	**To procure**						**3**									
NAD 6,600,000		To replace						3									
		Required	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Procurement Cost								19,800,000									
Maintenance Cost			792,000	792,000	792,000	792,000	792,000	792,000	792,000	792,000	792,000	792,000	792,000	792,000	792,000	792,000	792,000
Folk Lift with Side Spreader	**10**	**To procure**		**1**			**1**	**2**	**1**			**1**		**1**			**1**
NAD 3,500,000		To replace		1			1	2	1			1		1			1
		Required	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
Procurement Cost				3,500,000			3,500,000	7,000,000	3,500,000			3,500,000		3,500,000			3,500,000
Maintenance Cost			840,000	840,000	840,000	840,000	840,000	840,000	840,000	840,000	840,000	840,000	840,000	840,000	840,000	840,000	840,000
Folk Lift Multi-purposed	**15**	**To procure**	**3**			**1**											
NAD 400,000		To replace	3			1											
		Required	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
Procurement Cost			1,200,000			400,000											
Maintenance Cost			64,000	64,000	64,000	64,000	64,000	64,000	64,000	64,000	64,000	64,000	64,000	64,000	64,000	64,000	64,000
Terminal Operation System	**1**	**To procure**															
NAD 15,000,000		To replace															
		Required															
Procurement Cost																	
Maintenance Cost																	
Procurement Cost Total			150,300,000	52,600,000	3,100,000	262,000,000	25,200,000	82,400,000	119,100,000	8,000,000	83,100,000	17,600,000	4,100,000	6,600,000	4,200,000	18,100,000	12,600,000
Maintenance Cost Total			31,238,000	31,238,000	31,238,000	31,238,000	31,238,000	31,238,000	31,238,000	31,238,000	31,238,000	31,238,000	31,238,000	31,238,000	31,238,000	31,238,000	31,238,000
Procurement & Maintenance Cost Total			181,538,000	83,838,000	34,338,000	293,238,000	56,438,000	113,638,000	150,338,000	39,238,000	114,338,000	48,838,000	35,338,000	37,838,000	35,438,000	49,338,000	43,838,000

(Total) (N$)

Procurement & Maintenance Cost	30 Years
Procurement Cost Total	1,747,350,000
Maintenance Cost Total	884,090,000
Procurement & Maintenance Cost Total	2,631,440,000

Source: JICA Study Team

11 Terminal Operator

In administering and managing the new container terminal, Namport has three alternatives: (a) to administer and operate by itself, (b) introduce private operators, or (c) contract management and operation out to operating companies. In this study, the financial feasibility of the project was estimated based on the following two scenarios:

Scenario A: Namport constructs the container terminal and operates the terminal by itself. Namport will gain income from the users.

Scenario B: Namport constructs the container terminal and entrusts the terminal operation to a private operator. Namport will gain income from the operator as concessions.

Meanwhile, there are various concession contracts, responsibilities, profits, and risks for Namport and the private operator, which directly affect the result of the FIRR. All are different depending on each clause of the contract in the case of Scenario B. At this stage, the feasibility of the project was analyzed under the simplest condition that Namport gives a concession to a private operator to cover only the necessary cost of this project. The assumptions and results of this part of the study are preliminary and tentative so they are likely to be subject to change in the following works.

12 Operation and Maintenance Cost

(1) Operation Cost

Unit price for each item of the operation cost of the new container terminal was estimated based on a study, "Design, Feasibility and Tender Berth 0/1 Concepts and Feasibility for Ship Repair for Ship Repair Hub & Dedicated Fish Terminal, INROS LACKNER AG" conducted by Namport in June 2008. The increased number of Namport staff to operate the new container terminal is shown in Table 8. The result of the estimate and the unit price directly used from the study are as described in Tables 9 and 10.

Table 8 Number of Staff Necessary for the Container Terminal Operation

Stages / Department	1 2015	2 16	3 17	4 18	5 19	6- 20-
Management	8	8	8	8	8	8
Administration	134	134	134	134	134	134
Operation	224	239	254	254	254	254
Total	366	381	396	396	396	396

Source: JICA Study Team

Table 9 Average Annual Salary of Staff at Namport

Class	Average Annual Cost (N$)
Management	1,606,013
Administration	264,346
Operation (Cargo Services)	184,715

Source: Namport

Table 10 Energy Consumption

Item	Amount	Unit
Electricity	1.70	N$/ton
Fuel and Lubrication	2.23	N$/ton

Source: JICA Study Team

(2) Maintenance Cost

Cost for maintenance and repair is estimated based on the following assumptions:

- Annual cost of maintenance and repair of cargo handling equipment is 4% of original purchase price. This cost includes the cost of necessary IT support and spare parts.
- Annual cost of maintenance and repair of civil works, infrastructure, and buildings is 1.5% of their original cost.

(3) Cost of General Administration

The cost of general administration will increase as the handled containers increase. Therefore, the administration cost is estimated based on the following assumptions:

- General office cost: N$ 2.1/TEU
- Telecommunication expenses: N$ 0.8/TEU
- Bank charge and legal expenses: N$ 0.8/TEU
- Insurance cost: N$ 4.0/TEU
- Marketing cost: N$ 1 million for the first year of operation and N$ 0.5 million for the other years

13 Operating Income

Incomes generated by the new container terminal consist basically of those chargeable on calling vessels and those from container handling. The port dues on calling vessels and tariffs on container handling were estimated as follows based on “Namibian Ports Authority Tariffs 2009”.

Dues for one call of a hypothetical 27,400 GT container vessel are tabulated below.

Table 11 Port Dues of Hypothetical 27,400 GT Container Vessel

<table>
<tr><th>Item</th><th>Unit</th><th>Rate (N$)</th><th>Quantity</th><th>Amount</th></tr>
<tr><td>Port Dues</td><td>100GT</td><td>88.0</td><td>274</td><td>24,112.00</td></tr>
<tr><td>Light Dues</td><td>100GT</td><td>16.5</td><td>274</td><td>4,521.00</td></tr>
<tr><td>Berthing Dues</td><td>6 hours 100GT</td><td>28.1</td><td>11.1</td><td>14,243.89</td></tr>
<tr><td rowspan="2">Tugs/craft assistance and/or attendance</td><td>25,000GT</td><td>18,535.0</td><td>2.0</td><td rowspan="2">38,318.00</td></tr>
<tr><td>100GT above 25,000GT</td><td>26.0</td><td>24</td></tr>
<tr><td>Berthing Services</td><td>25,000 to 30,000GT</td><td>3,779.0</td><td>2</td><td>7,558.00</td></tr>
<tr><td>Pilotage Services</td><td>25,000 to 30,000GT</td><td>9,595.0</td><td>2</td><td>19,190.00</td></tr>
<tr><td>Channel Levy</td><td>m of ship length</td><td>8.0</td><td>250</td><td>2,000.00</td></tr>
<tr><td>Total per container vessel</td><td></td><td></td><td></td><td>109,942.89</td></tr>
</table>

Source: Estimated based on “Namibian Ports Authority Tariffs 2009” by JICA Study Team

Table 12 Simplified Tariffs on Container Handling

(in N$)

Type of Containers		Land/Ship	Extra Storage Per Day	Reefer Storage Per Day	Base Tariff
Import/Export	20ft	715	66	32	2,563
	40ft	927	132	65	3,429
Transhipment	20ft	1,362	66	32	0
	40ft	2,145	132	65	0
Transit Inbound/Outbound	20ft	1,745	66	32	0
	40ft	3,203	132	65	0

Source: Namibian Ports Authority Tariffs 2009

14 Financial Analyses

(1) Result of Financial Analysis

The cost and revenues of Namport from the new container terminal project in scenarios A and B are calculated based on the result of the demand forecast, estimated unit incomes, construction and equipment costs, and operation and maintenance costs. In addition, 10% of construction cost is added as a physical contingency, as with administration cost. The total project cost estimated is N$ 2,748.75 million. Then, FIRR is analysed in a 35 year project evaluation period, including 5 years for construction. Based on an opportunity cost of 10.5%, which is the interest rate of the longest term bond of Namibian government called “GC24”, the result of the calculation for Scenarios A and B are as follows.

Scenario A: FIRR = 11.52 %
NPV = N$ 192.16 million
B/C = 1.06
Scenario B: FIRR = 3.98 %

Obviously, FIRR in Scenario A is larger than the opportunity cost of capital, 10.5%, while that in Scenario B is not. Scenario B was analysed assuming Namport gives a concession to a private operator to cover only the necessary costs of this project. However, again, this assumption is preliminary and tentative so it should not be interpreted as conclusive.

Table 144 shows cost and revenue in the case of Scenario A.

(2) Sensitivity Analysis

For the results of FIRR in the case of Scenario A, a sensitivity analysis was conducted. The results are shown in the following tables. In this analysis, the cost and revenue changed from 80% (a 20% decrease) to 120% (a 20% increase) by 5% respectively.

Table 13 Results of Sensitivity Analysis (FIRR of Scenario A)

		Cost								
		−20%	**−15%**	**−10%**	**−5%**	**0%**	**5%**	**10%**	**15%**	**20%**
Income	**20%**	18.97%	17.75%	16.63%	15.61%	14.67%	13.80%	12.99%	12.23%	11.52%
	15%	18.11%	16.91%	15.83%	14.83%	13.91%	13.06%	12.26%	11.52%	10.81%
	10%	17.23%	16.07%	15.01%	14.03%	13.13%	12.30%	11.52%	10.78%	10.09%
	5%	16.33%	15.20%	14.17%	13.22%	12.34%	11.52%	10.75%	10.02%	9.34%
	0%	15.42%	14.32%	13.31%	12.38%	11.52%	10.71%	9.95%	9.24%	8.57%
	−5%	14.49%	13.41%	12.43%	11.52%	10.67%	9.88%	9.13%	8.43%	7.76%
	−10%	13.53%	12.48%	11.52%	10.62%	9.79%	9.01%	8.28%	7.58%	6.92%
	−15%	12.54%	11.52%	10.57%	9.70%	8.88%	8.11%	7.39%	6.69%	6.04%
	−20%	11.52%	10.52%	9.59%	8.73%	7.93%	7.17%	6.44%	5.76%	5.10%

Source: JICA Study Team

Cells in blue indicate feasible cases for the project.

Table 14 Cost and Revenue by Year (FIRR of Scenario A)

Operaton Year						1	2	3	4	5	6	7	8	9	10	11	12
Calender Year	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**
Cost																	
Initial Investment, Expansion	0.00	8.77	167.27	816.50	1584.34	171.88	0.00	0.00	0.00								
O&M Expenses						160.26	165.65	169.86	175.36	178.04	185.29	187.53	188.89	190.46	192.15	193.81	196.47
Additional Investment						55.60	3.57	116.15	30.13	155.94	27.72	19.55	23.12	7.59	34.39	10.01	3.57
Total Cost	-	8.77	167.27	816.50	1,584.34	387.74	169.21	286.01	205.49	333.98	213.00	207.08	212.00	198.05	226.54	203.81	200.03
Revenue																	
Base Tariff						26.10	30.84	35.80	40.97	46.38	52.04	56.80	61.73	66.84	72.14	77.63	86.45
Land/Ship						239.57	257.25	277.15	299.57	324.88	353.47	372.85	393.63	415.95	439.91	465.64	506.95
Extra Storage						57.48	58.53	59.64	60.80	62.01	63.25	64.44	65.71	67.05	68.48	70.00	72.44
Reefer						12.76	13.02	13.30	13.61	13.93	14.28	14.57	14.88	15.21	15.55	15.92	16.51
Port Dues						51.56	53.52	55.68	58.08	60.74	63.70	65.83	68.09	70.50	73.06	75.78	80.16
Total Revenue	0.00	0.00	0.00	0.00	0.00	387.48	413.16	441.57	473.04	507.95	546.74	574.49	604.04	635.55	669.14	704.98	762.52
NET INCOME	-	(8.77)	(167.27)	(816.50)	(1,584.34)	(0.26)	243.95	155.56	267.55	173.97	333.74	367.41	392.04	437.49	442.60	501.16	562.49

Year	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
	2027	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**	**2036**	**2037**	**2038**	**2039**	**2040**	**2041**	**2042**	**2043**	**2044**
Cost																		
Initial Investment, Expansion																		
O&M Expenses	196.47	196.47	196.47	196.47	196.47	196.47	196.47	196.47	196.47	196.47	196.47	196.47	196.47	196.47	196.47	196.47	196.47	196.47
Additional Investment	3.57	23.58	172.85	60.49	3.57	301.30	28.98	94.76	136.97	9.20	95.57	20.24	4.72	7.59	4.83	20.82	14.49	0.00
Total Cost	200.03	220.04	369.31	256.96	200.03	497.77	225.45	291.23	333.43	205.67	292.03	216.71	201.18	204.06	201.30	217.28	210.96	196.47
Revenue																		
Base Tariff	86.45	86.45	86.45	86.45	86.45	86.45	86.45	86.45	86.45	86.45	86.45	86.45	86.45	86.45	86.45	86.45	86.45	86.45
Land/Ship	506.95	506.95	506.95	506.95	506.95	506.95	506.95	506.95	506.95	506.95	506.95	506.95	506.95	506.95	506.95	506.95	506.95	506.95
Extra Storage	72.44	72.44	72.44	72.44	72.44	72.44	72.44	72.44	72.44	72.44	72.44	72.44	72.44	72.44	72.44	72.44	72.44	72.44
Reefer	16.51	16.51	16.51	16.51	16.51	16.51	16.51	16.51	16.51	16.51	16.51	16.51	16.51	16.51	16.51	16.51	16.51	16.51
Port Dues	80.16	80.16	80.16	80.16	80.16	80.16	80.16	80.16	80.16	80.16	80.16	80.16	80.16	80.16	80.16	80.16	80.16	80.16
Total Revenue	762.52	762.52	762.52	762.52	762.52	762.52	762.52	762.52	762.52	762.52	762.52	762.52	762.52	762.52	762.52	762.52	762.52	762.52
NET INCOME	562.49	542.48	393.21	505.56	562.49	264.75	537.07	471.29	429.09	556.85	470.49	545.81	561.34	558.46	561.22	545.24	551.56	566.05
FIRR	**11.52%**																	

Source: JICA Study Team

15 Economic Analyses

Indicators for Economic Evaluation: Based on economic benefits and cost, the economic evaluation is conducted by the indicators for the economic internal rate of return (EIRR) and the net present values (NPV) which is the difference of the economic benefits and the economic cost and the economic benefits cost ratio (B/C).

Result of Evaluation: The indicators for the economic evaluation are figured in the cash flow of the economic cost and benefits during the project evaluation period from 2015 to 2044 as shown in the table below. The EIRR is 12.1% and the NPV and the B/C to be discounted by 12% indicate N$ 19.6 million and 1.01, respectively.

Conclusion: The EIRR is higher than 12% to consider the project feasible. The NPV and the B/C show that the present values of the economic benefits are higher than the present values of the economic cost.

Table 15 Disbursement Schedule of Initial Investment (Financial Price)

(Unit : 1,000 N$)

Items of Cost	2011	2012	2013	2014	2015	Total
A. Consulting Service	6,931	9,518	16,810	16,519	3,318	53,095
B. Civil Works Cost						
1.Local Currency Portion						
(1).Material&Equipment		40,986	211,843	351,767	77,911	682,507
(2).Labour						
(Skilled)		8,515	42,693	76,699	18,754	146,661
(Unskilled)		2,129	10,673	19,175	4,689	36,665
subtotal		10,644	53,366	95,874	23,443	183,327
Total		51,630	265,209	447,640	101,354	865,834
2.Foreign Portion Portion						
(1) Material&Equipment		62,661	324,681	301,810	27,544	716,696
(2).Labour						
(Skilled)		7,262	35,273	31,995	3,074	77,604
(Unskilled)		0	0	0	0	0
subtotal		7,262	35,273	31,995	3,074	77,604
Total		69,923	359,954	333,805	30,618	794,300
Civil Works Total		121,553	625,164	781,445	131,972	1,660,134
C. Equipment Cost						
1.Local Currency Portion						
(1) Material		0	0	0	0	0
(2) Labour						
(Skilled)		0	0	15,800	0	15,800
(Unskilled)		0	0	3,950	0	3,950
subtotal		0	0	19,750	0	19,750
Total		0	0	19,750	0	19,750
2.Foreign Portion Portion						
(1) Material		0	0	431,250	0	431,250
(2) Labour						
(Skilled)		0	0	0	0	0
(Unskilled)		0	0	0	0	0
subtotal		0	0	0	0	0
Total		0	0	431,250	0	431,250
Equipment Total		0	0	451,000	0	451,000
Total (A+B+C)	6,931	131,070	641,974	1,248,964	135,290	2,164,229
Tax (15%)	1,040	19,661	96,296	187,345	20,294	324,634
Contingency (10%	797	15,073	73,827	143,631	15,558	248,886
Total	8,768	165,804	812,097	1,579,939	171,142	2,737,750
D. Administration Fee	0	1,467	4,400	4,400	733	11,000
Grand Total	8,768	167,271	816,497	1,584,339	171,875	2,748,750

Source : JICA Study Team

Note: The contingency is assumed to be 10% of total of civil works and equipment.

Table 16 Cash Flow of Economic Cost and Benefits for the Walvis Bay Container Terminal Development Project

(Unit : Million N$)

No.	Year	Economic Cost				Economic Bensefits							Net Benefits
		Capital Cost	Additional Investment Cost	O&M Cost	Total	Cost Savings for Conatiner Ship to Handle at Berth	Time Savings for Conatiner Cargo to Handle at Berth	Time Savings for Conatiner Cargo by Trailer in Container Yard	Time Savings for Conatiner Cargo to Handle in Container Yard	Scale Economy by Big Size Ship	Increase of Revenues from Captured Deamnd	Total	
1	2011	7.6			7.6							0.0	-7.6
2	2012	141.3			141.3							0.0	-141.3
3	2013	687.9			687.9							0.0	-687.9
4	2014	1,339.5			1,339.5							0.0	-1,339.5
5	2015	141.1	48.3	144.6	334.0	8.5	5.6	0.6	1.4	48.4	346.3	410.7	76.8
6	2016		3.1	149.5	152.6	8.5	5.8	0.6	1.4	50.6	364.4	431.4	278.8
7	2017		100.8	153.3	254.1	8.5	6.1	0.6	1.4	52.9	385.0	454.6	200.5
8	2018		26.2	158.2	184.4	8.5	6.4	0.7	1.5	55.3	408.3	480.6	296.2
9	2019		135.3	160.7	296.0	8.5	6.7	0.7	1.6	57.8	434.7	509.8	213.9
10	2020		24.1	167.2	191.3	8.5	7.0	0.7	1.6	60.4	464.5	542.7	351.4
11	2021		17.0	169.2	186.2	8.5	7.2	0.7	1.7	62.6	466.6	547.3	361.1
12	2022		20.1	170.4	190.5	8.5	7.5	0.8	1.8	64.8	468.9	552.2	361.7
13	2023		6.6	171.9	178.5	8.5	7.8	0.8	1.8	67.2	471.3	557.3	378.9
14	2024		29.9	173.4	203.3	8.5	8.1	0.8	1.9	69.6	473.9	562.7	359.4
15	2025		8.7	174.9	183.6	8.5	8.4	0.9	2.0	72.1	476.6	568.3	384.8
16	2026		3.1	177.3	180.4	8.5	8.7	0.9	2.0	74.7	481.0	575.7	395.3
17	2027		3.1	177.3	180.4	8.5	8.7	0.9	2.0	74.7	481.0	575.7	395.3
18	2028		20.5	177.3	197.8	8.5	8.7	0.9	2.0	74.7	481.0	575.7	377.9
19	2029		150.0	177.3	327.3	8.5	8.7	0.9	2.0	74.7	481.0	575.7	248.4
20	2030		52.5	177.3	229.8	8.5	8.7	0.9	2.0	74.7	481.0	575.7	345.9
21	2031		3.1	177.3	180.4	8.5	8.7	0.9	2.0	74.7	481.0	575.7	395.3
22	2032		261.5	177.3	438.8	8.5	8.7	0.9	2.0	74.7	481.0	575.7	137.0
23	2033		25.2	177.3	202.5	8.5	8.7	0.9	2.0	74.7	481.0	575.7	373.3
24	2034		82.3	177.3	259.6	8.5	8.7	0.9	2.0	74.7	481.0	575.7	316.2
25	2035		118.9	177.3	296.2	8.5	8.7	0.9	2.0	74.7	481.0	575.7	279.5
26	2036		8.0	177.3	185.3	8.5	8.7	0.9	2.0	74.7	481.0	575.7	390.4
27	2037		82.9	177.3	260.2	8.5	8.7	0.9	2.0	74.7	481.0	575.7	315.5
28	2038		17.6	177.3	194.9	8.5	8.7	0.9	2.0	74.7	481.0	575.7	380.8
29	2039		4.1	177.3	181.4	8.5	8.7	0.9	2.0	74.7	481.0	575.7	394.3
30	2040		6.6	177.3	183.9	8.5	8.7	0.9	2.0	74.7	481.0	575.7	391.8
31	2041		4.2	177.3	181.5	8.5	8.7	0.9	2.0	74.7	481.0	575.7	394.2
32	2042		18.1	177.3	195.4	8.5	8.7	0.9	2.0	74.7	481.0	575.7	380.3
33	2043		12.6	177.3	189.9	8.5	8.7	0.9	2.0	74.7	481.0	575.7	385.8
34	2044		0.0	177.3	177.3	8.5	8.7	0.9	2.0	74.7	481.0	575.7	398.4
Total		2,317.4	1,294.4	5,161.8	8,773.6	254.0	241.5	24.5	56.5	2,081.2	13,899.0	16,556.8	7,783.2

Source : JICA Study Team

EIRR= 12.1%
NPV= 19.6
B/C= 1.01
(Discount Rate : 12%

16 Environmental Issues

EIA Consultants submitted the final version of the Interim Report in October 2009 (dated September 2009). The EIA Interim Report covers a broad range of concerns about the original port expansion plan from environmental aspects to hydrodynamic analyses, ship manoeuvring simulation and impacts caused by dredging and reclamation works. During the course of the EIA study, it is found that heavy metals are naturally contained in the soil particles at the project site. EIA consultants are studying in more detail how to deal with the heavy metals to be encountered during the project implementation. The EIA Interim Report has confirmed the following environmental aspects:

- The new container terminal has negligible influence on the water levels in the bay and the lagoon.
- A large scale eddy will shift further to the north. Flow velocities will change only to smaller extent.
- The new container terminal will reduce water exchange rates in the lagoon. The water refreshment rate in the lagoon cannot be positively influenced by incorporation of an open piled causeway or by dredging the lagoon entrance.
- The sediment transfer only changes to minor extent. No significant erosion and accretion patterns have been observed.
- The suspension concentrations induced by dredging and reclamation activities will have effects locally and temporarily but in general they meet acceptable levels. Only in very early stages of reclamation do large concentrations occur in the lagoon.

Status of the environmental impact assessment (EIA) is as follows:

- Completed and for review:
  - ➢ <u>Traffic and roads</u>
  - ➢ <u>Noise</u>
  - ➢ <u>Socio-economic</u>
- Baseline description completed:
  - ➢ <u>Main ecology</u>: to be completed once options for dredge management and disposal have been finalized.
  - ➢ <u>Lagoon avifauna</u>: EIA Consultants recommended additional tasks such as analysis, estimate of energy consumption, demarcation of feeding area, evaluation of potential impact and assessment of potential impact.

17 Contingent Alternatives for Port Expansion

As mentioned above, Namport has engaged a consortium of consultants to undertake an environmental impact study (EIA study) on the development of the new container terminal at the south end of the existing port, the original project site. The major concern on the EIA Study process, raised at the public meeting, is a lack of screening procedures to choose the best project site among alternatives at the earlier stage in view of the natural and social environment. In this regard, after laying out the alternative expansion plans of the port, the JICA Study Team examined the impacts to the environment particularly to the mouth of the lagoon as well as taking into account the construction costs, workability of the berth, siltation on the approach channel and turning basin.

Potential alternatives are shown in Figures 7 through 9.

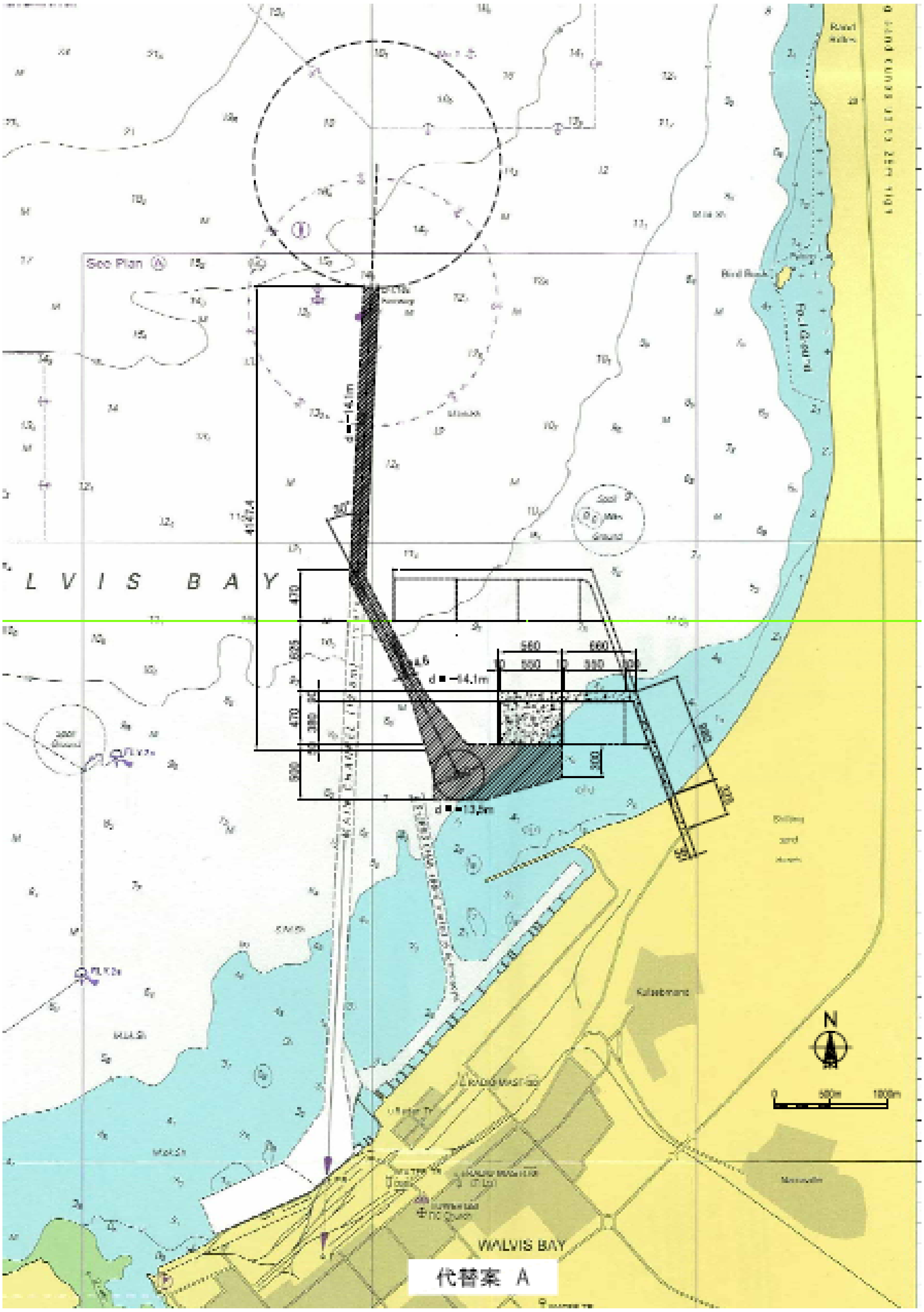


Figure 7 Contingent Expansion Plan Alternative A

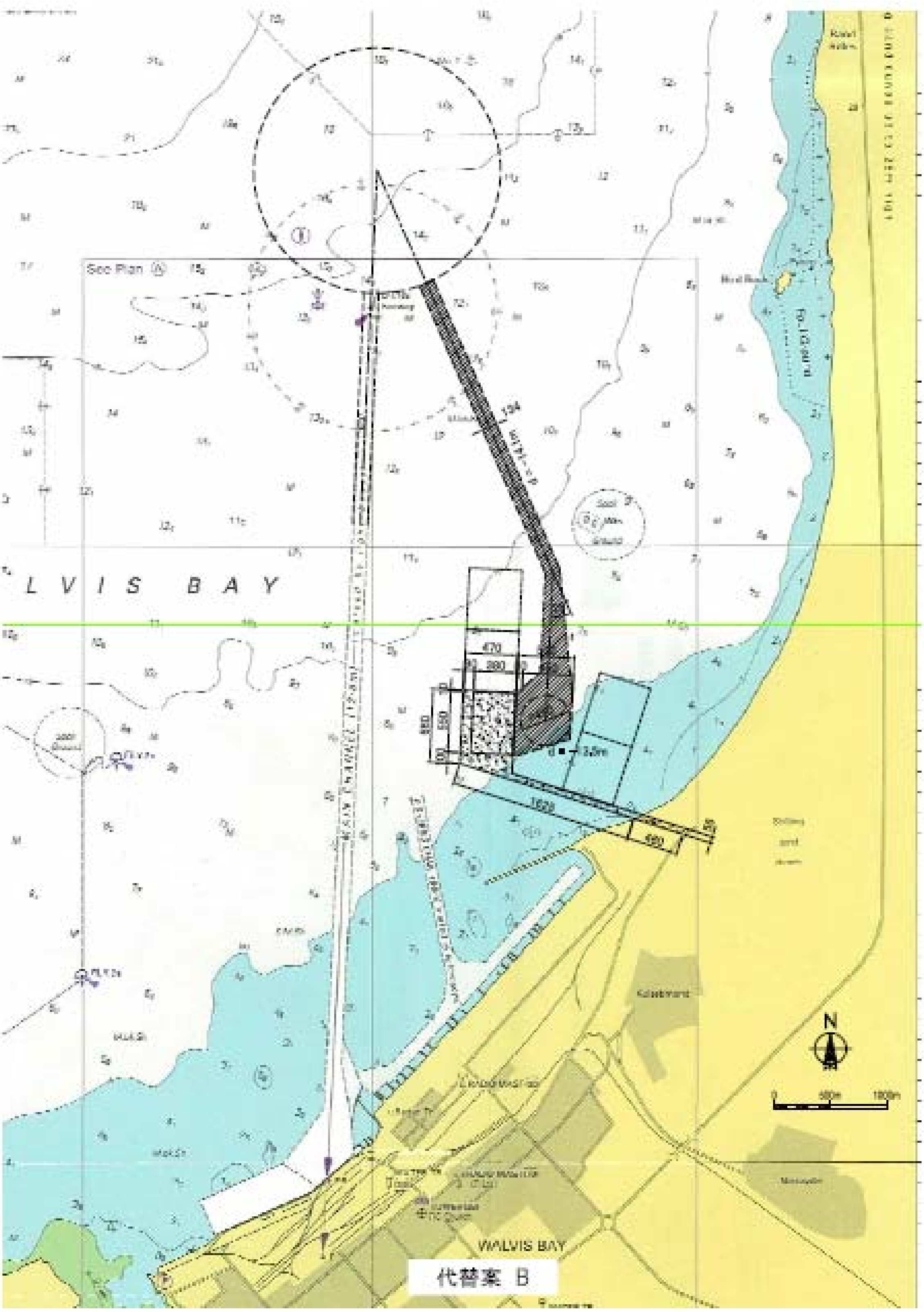


Figure 8 Contingent Expansion Plan Alternative B

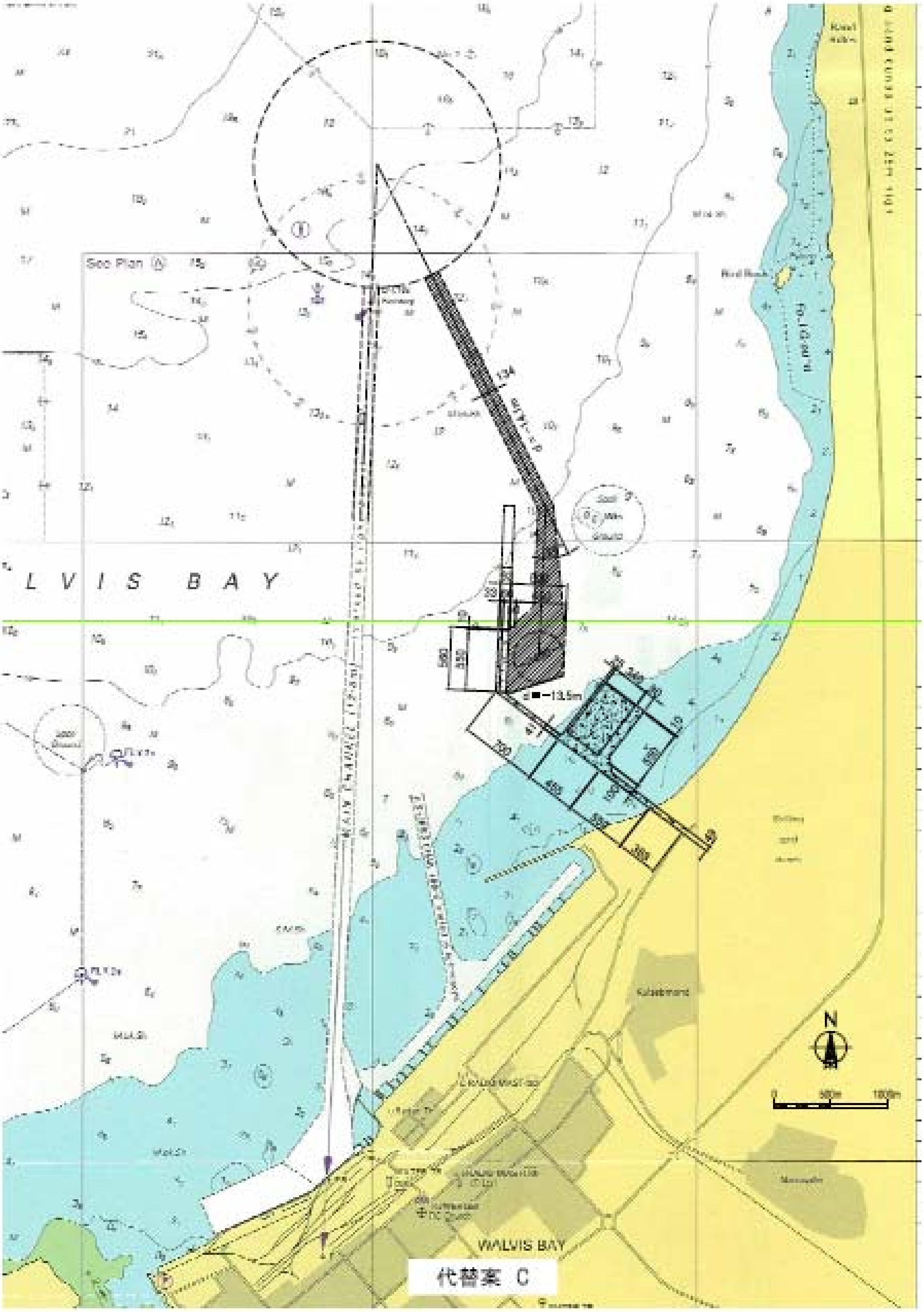


Figure 9 Contingent Expansion Plan Alternative C

The summary of the alternatives are summarized in Table 17 below:

Table 17 Evaluation on Alternative Expansion Plans

		Original Expansion	**Contingent Alternatives**		
			A	**B**	**C**
Layout	**Quay Wall and Reclamation**	Reclaim at the south of the bay offshore from the existing berths. The causeway is rather short.	Reclaim at the north of the bay. Berth alignment is on east-west. The causeway is long.	Reclaim at the north of the bay. Berth alignment is on north-south. The causeway is long.	Similar to B. But the berth is separated from the container yard.
	Navigation Channel	Use the existing approach channel by deepening and widening.	Divert to the southeast from the existing approach channel.	Excavate a new channel from the entrance to SSE direction.	Similar to B
	Access from Land	Extend the existing port road and rail tracks.	Use a land strip between Navy Base and "Up-market Residential" shown in the city plan.		
Construction Period and Remarks		Need 30 months. Use CSD and TSHD for dredging and 3 sets of drilling machines for cast-in-situ concrete piles.	35 months Need a temporary jetty , a pre-cast yard (2.0 ha) and gat barge for revetment works Others are same as Original plan.	38 months Similar to A except pre-cast yard (1.0 ha)	36 months Similar to B
Items to Evaluate	**Environmental Impact**	Augment the speed of tidal current at both the lagoon entrance and oyster farm.	Will not augment the speed of tidal current at the lagoon entrance but the oyster farm.	Will not augment the speed of tidal current at both the lagoon entrance and oyster farm.	May be similar to B (no numerical simulation is done).
	Siltation on Channel and Basin	Phase 1 497,000 m^3/year Master Plan 611,000 m^3/year	Phase 1 626,000 m^3/year Master Plan 402,000 m^3/year	Phase 1 774,000 m^3/year Master Plan 604,000 m^3/year	
	Navigation	Confirmed safe for ship maneuvering simulation.	Prevailing south winds may make turning and berthing comparatively difficult.	May be safer than A.	Similar to B.
	Harbour Calmness (Phase 1)	99.9% available for loading and unloading.	99.9% available for loading and unloading.	89.8% available for loading and unloading. Need a breakwater.	Similar to B.
	Access from Land	Extend the existing road and railway.	Require the consensus from the municipality government and Navy in laying out the causeway.		
Cost (Million N$)	**Civil Works**	1,660 (100%)	2,199 (133%)	1,930 (116%)	1,950 (117%)
	Breakwater to Satisfy Harber Calmness	Not necessary	Not necessary	Necessary Approx.386	Necessary Approx.390
	Equipment	451 (100%)	451 (100%)	451 (100%)	490 (109%)
	Total	2,111 (100%)	2,650 (126%)	2,767 (131%)	2,830 (134%)
Remarks		Cost for yard expansion is included		Cost for breakwater is included.	Cost for breakwater is included.

From the summary above, Alternative A is recommended in case the new container development at the original project site becomes negative in view of EIA study results.

18 Conclusions and Recommendations

The conclusions are as follows:

1. The port expansion project at the original site is technically feasible, for the following reasons:
    (a) The reclamation of the terminal yard can be done at a relatively low cost by use of dredged sand.
    (b) An open deck quay supported with cast-in-situ concrete piles can be built at a reasonable cost, where the subsoil has strength at about minus 47 m below CD.
    (c) A bridge at the causeway does not have positive influences on the environment.
    (d) The contingent alternative port expansion plans are found to be more expensive than the original plan.

2. The port expansion project at the original site is financially and economically feasible for the following reasons:
    (a) FIRR is estimated to be 11.52 %, larger than opportunity cost of capital (10.5%), Financial NPV is about N$ 192 million (>0), and Financial B/C about 1.06 (>1.0).
    (b) EIRR is estimated to be 12.1 % (>12% in general), NPV about 19.6 million N$ (>0), and B/C about 1.01 (>1.0).

3. The port expansion project at the original site will be environmentally feasible, as the EIA Interim Report concludes:
    (a) The new container terminal has negligible influence on the water levels in the bay and the lagoon.
    (b) Flow velocities will change only to a small extent.
    (c) The new container terminal reduced the water exchange rates in the lagoon.
    (d) Sediment transfer only changes to minor extent. No significant erosion and accretion patterns have been observed.
    (e) The suspension concentrations will be induced by dredging and reclamation activities locally and temporarily but in general at least meet acceptable levels.

The recommendations are as follows:

1. To consolidate the status as a gateway to landlocked inland countries and inland regions. To this end, to promote railway operation and cross boarder trades.
2. To plan a strategy to compete with Port of Durban and Port of Cape Town to capture transhipment containers originated from Asia and destined to the west coast of Africa.
3. To organize a Project Management Office to implement the project.