13. MASTER PLAN OF CHIRIQUI PORT

13.1 Development Scenario

13.1.1 Rationale

In the process of the elaboration of the master plan of a new port in Chiriqui development, the following factors have been taken into considerations.

(1) The Socio-Economic Activities in Chiriqui Province

Next to Panama Province, Chiriqui Province is the second largest in population and in GDP: in 2024, the shares in population and GDP were 12.9% and 10.3%, respectively. The province is rich in agricultural products. It is also rich in tourist destinations. David, provincial capital is growing as the logistic center in Chiriqui and Bocas del Toro Provinces.

Since the withdrawal of U.S. based banana industry, the province wants to recover the job opportunities. The government of Panama has been focusing the promotion of agro-industry in this province. The Baru Free Zone has been established to promote activities of various sectors. In 2024, the population and the GDP of the province are expected to grow 463,000 (21% larger than the population in 2000) and USD 2.1 billion (double that in 2000), respectively. Accordingly per capita GDP will be increasing from USD 2,760 (in 2000, 1996 price) to USD 4,530 (in 2024, 1996 price).

Thus, as the second largest province in terms of population, the economic activities of the province will be expanding to a considerable scale.

The Petro-terminal of Panama resumed the petroleum distribution and the transshipment services through its pipeline system between the Pacific and the Atlantic sides. It is also about to start tuna farming near their port facilities in Charco Azule.

(2) Existing Ports in Chiriqui

There are two existing ports in Chiriqui: Pedregal Port and Puerto Armuelles Ports. Both ports have restrictions: Pedregal Port has draft limits, while Puerto Armuelles is not usable for heavy cargo handling. Pedregal Port is used for fertilizer import and sugar export by general cargo ships having about 2,000 GT, while, recent years, Puerto Armuelles Port has been called by a number of tuna boats for bunker and water supply, and for chandler services. None of the two ports can accommodate ocean-going cargo vessels larger than 10,000 DWT.

(3) The Traffic Expected in the Future

The Study Teams’ forecast indicates the fertilizer import at Pedregal Port will increase to 60,000 tons in 2024. However, this forecast assumed that almost the same amount of fertilizer should be imported from Costa Rica and that all the export and import container cargoes generated in Chiriqui should be transported overland up to the container terminals at Balboa or Colon. Panama City.

(4) Opinion of the Port Users

In the workshop held in Chiriqui, many participants mentioned of the restrictions of the exiting ports due to the water depth of the navigation channel at Pedregal Port as well as dilapidated port structure in Puerto Armuelles Port and the disadvantage of the local industries with the additional transportation cost to and from the ports in the Canal area. In addition, the largest concern of the port users was the absence of the plan of the government to deal with these problems of the existing two ports.

The representatives of the Baru Free Zone Authority repeatedly mentioned that a deep draft port is very necessary in the region for the support of the regional development of Chiriqui as well as the promotion of the Baru Free Zone, and that the local industries should be fully aware of the importance of the logistics.

It seemed that a consensus opinion of the participants was to develop a deep draft port for the international trade export and import of the local industries in the region.

(5) Existing Problems and Issues

1) Difficulties in the Expansion of the Existing Port Facilities

Pedregal Port is located in the estuary formed by a system of rivers, and there is heavy siltation at the entrance. At present the water depth below Law Water Level is zero. There are sand bars at the entrance of the estuary. Thus, the widening and deepening of the navigational channel to accommodate large draft ships and the maintenance dredging of the channel seems to be very costly and impractical.

Thanks to the topography, the Puerto Armuelles Port has no draft restriction. However, the area is exposed to the waves in the open sea and the water depth is too large to construct breakwaters. Above all, the port infrastructure is seriously deteriorated and the structure type that was originally designed for Banana export no longer suitable for tuna boats, which are the major users of the port at present.

2) Access to Puerto Armuelles

There is no direct access road from David to Puerto Armuelles. Heavy trucks should take Pan-American Highway up to Paso Canoa, the border on Costa Rica, then go down to Puerto Armuelles (the distance from David, the provincial capital, is about 80 km). Thus, to be fully promoted as the gateway of Chiriqui Province, a new by-pass highway is needed to shorten the travel time between Puerto Armuelles and David City. Possible routes for the by-pass highway are shown in Figure 13.1.1. These routes have been selected so that the new construction should be minimized, while the existing road should be improved.

Since the development of the new access road is also benefited by the communities in coastal areas of Chiriqui, the cost of the access road development should be implemented as a separate project from the New Chiriqui Port development, which should be funded from other source.

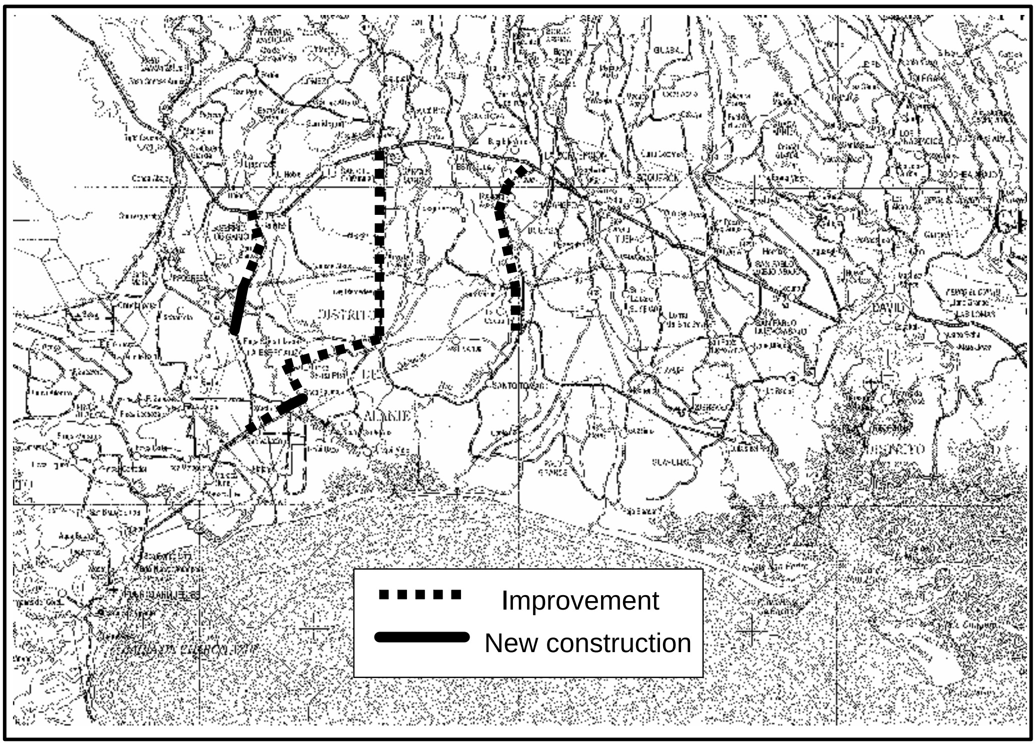


Figure 13.1.1 Possible Route for the New Access Road to the New Chiriqui Port

3) General Cargo Berth Proposed by PTP

Petro Terminal of Panama has a plan to develop a multi-purpose wharf that can accommodate tuna reefer ships and bulk carriers in their oil terminal complex at Charco Azule. Though the location is very suitable to construct deep draft wharves, the area is exposed to the waves from southeast and the construction of breakwater is practically impossible because of the deep water depth: incidentally, the wave observation done by a U.S. consultant at just off Puerto Armuelles Port shows that southeast waves often occur in October.

4) Need port development plan

It was discussed among the participants of workshop in David that Chiriqui wanted a port development plan. Thus, many current port users have been wondering how the port in Chiriqui could be improved. Some private companies might have been suspending their investment for new business, because the direction of the port development there has not been clearly given. Thus, the port master plan, when it is disseminated, may attract and promote private investments.

In consideration with above mentioned situation, it has been identified that Chiriqui has a potential for the development of a new port. It was also identified that AMP is the key agency to materialize the project.

13.1.2 Development Scenario

(1) Roles and functions of the port

The new port must have the following roles and functions:

1) Import of consumable good for local consumption

Located in the middle of the province rich in agricultural products, Pedregal Port has been exporting sugar and importing fertilizer. Besides these commodities, various commodities are consumed in the province.

Taking into considerations of the fact that the population and the GDP of the province are expected to grow up to substantial amount as described in Chapter 7.3, the cargo volume originated from Chiriqui also will grow.

The volumes of dry bulk cargoes i.e. wheat, maize and soy beans, which grain distributors assume to handle at Cristobal Port, include the amount to be consumed in Chiriqui. If proper port facilities are provided, some portion of these commodities will be imported directly at the new port. This may reduce the transportation cost. Likewise, fertilizer currently imported overland from Costa Rica will shift to sea routes. In addition, the container destined to and originated from Chririqui will be handled at the new port (cargo volumes in 2024 is forecasted in Section 13.2).

2) Export of agricultural products

Agricultural products such as fruits, coffee and etc. are the major export commodities of Panama and substantial amount of them are produced in Chiriqui. Lack of the port facilities that can accommodate container ships, these products are transported to Panama City for export. The new port will provide the local industries with a direct access to the world market. This facilitates the export of the local products: faster delivery with less transportation cost. With the new port the competitiveness of agriculture sector in the province will be strengthened.

3) Promotion of the Baru Free Zone

Though the Baru Free Zone Authority has been established, the authority still has the difficulties in the implementation of their development plan. One of the causes of the delay may be the project sites are not attractive enough to the private firms because of its accessibility to the world market due to the lack of sufficient transport system. Since the concept of establishing the Baru Free Zone is to attract foreign and local investors on various commercial activities in the area taking advantage of the accessibility to the world markets by air and sea as well as the tax incentives. The ports that accommodate the container carriers are needed as the basic transport infrastructure for both Pacific and Atlantic sides.

The new port will provide the Free Zone with an access to and from the Pacific side.

4) Expansion of the services for existing port users

At present, foreign tuna boats are regularly docking at Puerto Armuelles Port for supply of fuel, water and others, for the proximity from the tuna fishing area and the bunkering service provided by the Petro-Terminal of Panama. At present, these tuna boats are not unloading tuna at the port, because of the insufficient port facilities for tuna unloading and the lack of access to the international port for export. Thus, these tuna boats have to call on ports in Costa Rica for unloading.

The Petro-Terminal of Panama is planning to expand their services and has a facility development plan for the tuna boats However, the plan has not implemented yet due to the difficulty in financing the project.

The new port can provide unloading and supply facilities to tuna boats and reefer ships.

In the light of the socioeconomic situation in Chiriqui, the new port in Chiriqui has a potential to have a new port that accommodate oceangoing ships including dry bulk ships and container feeder vessels as well as tuna boats.

(2) Selection of project site

On the basis of above discussion, it has been concluded that Chiriqui economy needs a deep draft port. It has been also concluded that the expansion of Pedregal Port by deepening the access channel is technically and financially difficult. Though Puerto Armuelles Port and Charco Azul Port have large water depths, but both ports are exposed to open sea where large waves are observed during the rainy season, especially October. The construction of breakwaters is practically impossible due to the topography of the sea bed.

Thus, the study team has made site reconnaissance survey along the coast of Chiriqui Gulf. It was the assessment of the study team through the survey that the almost all the portions coast line except the vicinity of Puerto Armuelles and the peninsula are not suitable for heavy siltation or huge sand dunes. The study "Study of the National Ports of Panama, Phase 2, Western Panama Port Development, October, 1997" carried out by MEF proposed the development plan of a sea port in the middle of the sandy beach stretching between Majagual and Punta Boca de Hacha. The study team, however, assessed that the port would encounter a difficulty to protect the access navigation channel against the heavy sand drift. In addition and that the construction of a port in the middle of a long-stretching sandy beach would stop the longshore movement of sand drift and, in turn, would cause heavy sedimentation in one side of the port while serious beach erosion would occur on the other side.

Thus, it was concluded that the potential project site should be between Puerto Armuelles and the mouth of Rio Palo Blanco. This is because there is no large river that supplies sediments and the location is on the edge of the continental shelf adjacent to the deep sea area.

APN cerrird out a sediment survey along Chiriqui coat between Majagual and Quebrada del Fraile in 1981. The result showed that the medium diameter of sediments at station No.2 that is near the mouth of Rio Palo Blanco was the smallest and it increased towards both the north and the south (see Figures. 13.1.2 and 13.1.3).

The change of the medium diameter of the sediments shows that the direction of the sediment movements is toward Station No. 2 from both sides Majagal and Petro Terminal. Thus, it is assessed that the location near Station No. 2 is recommended for the project site, for the area the movement of sediments is small and the change due to the construction of port would be less than other locations.

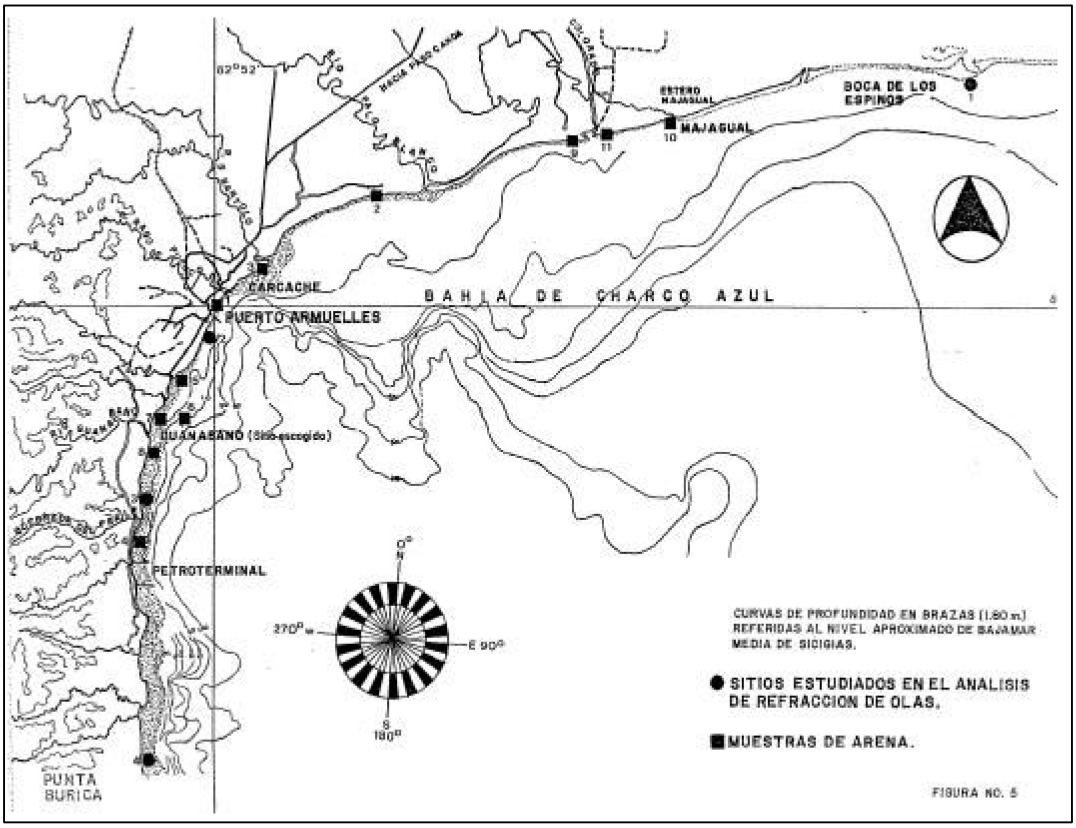


Figure 13.1.2 Location of the Sampling of Sediments

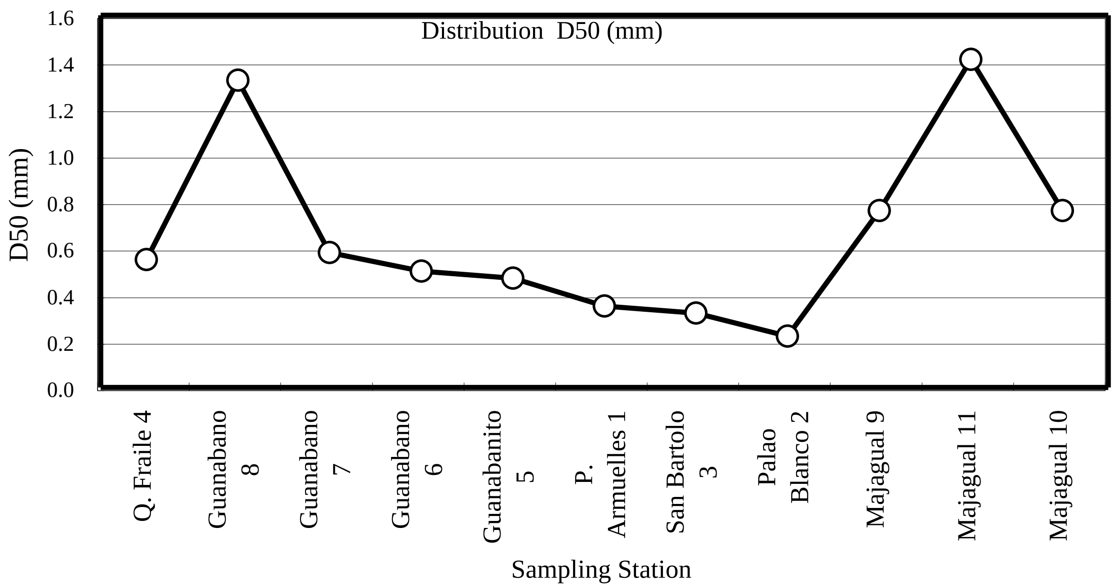


Figure 13.1.3 Medium Diameter of the Sediments along the Coast

(3) Facility requirements

In order to fulfill its roles and functions, the New Chiriqui Port must have the following facilities, among others.

1) Breakwaters

It is one of the key elements to attract container regular service to the new port. The non-traditional agriculture products and tuna, as well as the cargoes to and from Baru Free Zone must be container cargoes. Therefore, the berth should be operational for container handling all the time, because container carriers should arrive and depart on schedule. It must be almost always available for a container ship.

According to the wave observation that was carried out off Puerto Armuelles Coast, the probability of wave height occurrence is given as shown in Table 13.1.1. In the Table those wave directions that do not propagate into Puerto Armuelles Coast are indicated in the column of ‘Other”. As seen in the Table, in the off-shore sea area waves the probability of the occurrence of calm sea is 30%, that of those waves propagate other directions is 32 % and that of those waves that proceed to Puerto Armuelles Coast is the rest of 38%. Incidentally, the probability of occurrence of waves higher than 0.5 meters is 70% off Purto Armuelles Coast.

Table 13.1.1 Probability of Occurrence of Ocean Waves off Chiriqui Coast

Unit : %

Wave Height Range (m)	Offshor wave Direction SE	SSE	S	SSW	SW	Other	Calm	Total
0.0 - 0.49	0.12	0.39	4.28	20.01	13.11	32.08	30.01	100.00
0.5 - 0.99	0.12	0.39	4.28	20.01	13.11	32.08	-	69.99
1.0 - 1.49	0.03	0.15	3.03	16.50	9.13	19.35	-	48.19
1.5 - 1.99	0.01	0.00	1.60	9.95	3.43	7.52	-	22.51
2.0 - 2.49	-	-	0.68	4.21	1.01	1.63	-	7.53
2.5 - 2.99	-	-	0.12	0.69	0.12	0.38	-	1.31
3.0 - 3.49	-	-	0.01	0.06	0.01	0.03	-	0.11
3.5 Over	-	-	-	0.00	0.00	0.00	-	0.00
Direc. Total	0.12	0.39	4.28	20.01	13.11	32.08	30.01	100.00

Source: PTP Survey Report (N050°0', W082°00')

As waves propagate into the shore, the waves change their direction and heights due to the refraction caused by the sea bead topography. For the case of Puerto Armuelles coast, waves decrease the heights. The refraction coefficient Kr, i.e. the ratio of wave heights at the site on the offshore (or deep sea) wave height are 0.72 for the offshore wave directions of SE and SSW, 0.606 for S, 0.451 for SSW and 0.297 for SW.

Thus, the wave height range of Table 13.1.1 has been modified by multiplying the Refraction Coefficients to obtain the probability of occurrence wave heights at the project site (See Table 13.1.2).

Table 13.1.2 Modification of Probability of Occurrence Employing the Refraction Effects

%

Height (m)	**SE**	**SSE**	Height (m)	**S**	Height (m)	**SSW**	Height (m)	**SW**	Total
	Kr= 0.72			**0.606**		**0.451**		**0.297**	
0.00	0.12	0.39	0.00	4.28	0.00	20.01	0.00	13.11	37.91
0.36	0.12	0.39	0.30	4.28	0.23	20.01	0.15	13.11	37.91
0.72	0.03	0.15	0.61	3.03	0.45	16.50	0.30	9.13	28.84
1.08	0.01	0.00	0.91	1.60	0.68	9.95	0.45	3.43	14.99
1.44	-	-	1.21	0.68	0.90	4.21	0.59	1.01	5.90
1.80	-	-	1.52	0.12	1.13	0.69	0.74	0.12	0.92
2.16	-	-	1.82	0.01	1.35	0.06	0.89	0.01	0.08
2.52	-	-	2.12	-	1.58	-	1.04	-	-

Rearranging the Wave height range, the Probability of wave height occurrence at Puerto Arnuelles coast for those offshore wave directions that proceed to the coast has been obtained as Table 13.1.3.

Table 13.1.3 Probability of Occurrence of Wave Height at the Project Site

%

Height (m)	Offshor Wave Direction **SE**	**SSE**	**S**	**SSW**	**SW**	Total
0.0	0.12	0.39	4.28	20.01	13.11	37.91
0.5	**0.08**	**0.30**	**3.47**	**15.08**	**2.54**	**21.46**
1.0	0.01	0.03	1.33	2.68	0.01	4.07
1.5	-	-	0.14	0.01	-	0.15
2.0	-	-	-	-	-	-
2.5	-	-	-	-	-	-
3.0	-	-	-	-	-	-
3.5	-	-	-	-	-	-

As Table 13.1.3 shows, the rate of occurrence of waves larger than 0.5 meters is 21.5%. It is the general recognition that the container handling at the wharf often suspended when the wave height exceed 0.5 meters. This implies that one out of five container ships calling at Puerto Armuelles coast have to suspend their cargo handling operation due to the wave. Since large waves are observed during the rainy seasons especially in October while sea is rather calm in dry seasons, the probability of the occurrence of large waves must be much higher than 20% in October. Therefore, without breakwater, the Chiriqui new port is practically unable to ensure the scheduled operation of container ships.

2) Wharves for Commercial and Tuna Ships

The wharf for commercial vessels should accommodate the container feeder ship plying along the Central American coast. Likewise, these dry bulk carriers serving Central American coast should be accommodated at the same berth. Therefore, the wharf should be large enough to accommodate cargo ships having 25,000 DWT. In addition to tuna boats, tuna reefer ships having 1,400 GT also will be calling the port.

3) Other Facilities

Bunkering and water supply facilities

Land spaces for processing and logistic industries

13.2 Demand

13.2.1 Import Cargo

(1) Dry Bulk Cargo

1) Wheat

Imported volume of wheat in the new Chiriqui Port is calculated based on the assumption that the future imported volume will be consumption volume of wheat in the Chiriqui, Bocas del Toro and Veraguas provinces, which is estimated in proportion of population in these area to the whole country.

Table 13.2.1 shows regional distribution of population in Panama in 2024.

Table 13.2.1 Regional Distribution of Population in 2024

(Unit: person)

	Chiriqui	Bocas del Toro	Veraguas	Sub-total of 3 Provinces	Whole Country
Population	465,280	157,416	230,685	853,381	4,238,907
Ratio (%)	11.0	3.7	5.4	20.1	100

Source: Contraloria General de la Republica, Direccion de Estadistica y Censo

According to “Chapter 8 Demand Forecast of Port Traffic of Panama”, the total imported volume of wheat in 2024 is estimated to be 210,000 tons. Based on the above assumption, the imported volume of wheat in the new Chiriqui Port will be 42,000 tons in 2024.

2) Maize and Soybean

Imported volume of maize and soybean in the new Chiriqui Port is calculated based on the assumption that the future imported volume will be the consumption volume of maize and soybean in the Chiriqui, Bocas del Toro and Veraguas provinces, which is estimated in proportion of chicken, roosters and hens in these area to the whole country.

Table 13.2.2 shows regional distribution of chicken, roosters and hens in Panama in 2024.

Table 13.2.2 Regional Distribution of Chicken, Roosters and Hens

(Unit: no)

No. of Livestock	Chiriqui	Bocas del Toro	Veraguas	Sub-total of 3 Provinces	Whole Country
1997	818,900	54,200	1,168,400	2,041,500	9,245,100
1998	751,800	54,200	1,251,800	2,057,800	12,549,100
1999	739,100	54,200	1,312,600	2,105,900	11,792,500
2000	937,400	54,200	1,425,500	2,417,100	14,151,300
2001	1,291,314	61,001	1,480,052	2,832,367	14,131,519
Ratio (%)				18.7	

Source: Ministry of Agricultural Development (MIDA)

According to "Chapter 8 Demand Forecast of Port Traffic of Panama", the total imported volume of maize and soybean in 2024 is estimated to be 1,035,000 tons. Based on the above assumption, the imported volume of maize and soybean in the new Chiriqui Port will be 194,000 tons in 2024.

3) Fertilizer

According to Fertica, which is one of the biggest fertilizer distributor in Panama, the fertilizer consumption volume in Panama was 95,000 tons in 2003 and fertilizer consumption in the Chiriqui area was as follows.

Table 13.2.3 Fertilizer Consumption in the Chiriqui Area in 2003

Company name	Plant/ Office Location	Type of Cargo	Volume (ton)	Shear (%)
Fertica	David	Bulk	12,846	24
Fertizantes Superiores	Aguadulce	Bulk	8,180	16
Fertitec	Almirante	Bag	12,800	24
Agrofertil	Costa Rica	Bag	2,499	5
Melo	Almirante	Bag	4,700	8
Biotecnica	Colombia	Bag	550	1
Catesa	Costa Rica	Bag	500	1
Abopac	Costa Rica	Bag	9,100	17
Fertica CR	Costa Rica	Bag	1,266	2
Others		Bag	794	2
Total			53,235	100
Share of the Chiriqui Area			(56.0%)	
Whole Country			95,000	

Source: Fertica

The above consumption volume in the Chiriqui area does not include that of the Veraguas province, so a 60 % share of the total handling volume will be allocated to the new Chiriqui Port, based on the assumption that fertilizer from Costa Rica now transported by trucks will be unloaded in the new Chiriqui Port.

According to “Chapter 8 Demand Forecast of Port Traffic of Panama”, the total imported volume of fertilizer in 2024 is estimated to be 213,000 tons. Based on the above assumption, the imported volume of fertilizer in the new Chiriqui Port will be 128,000 tons in 2024.

(2) Container Cargo

The projected volume of imported container cargo in Panama will be 1,544,000 tons in 2024 (refer to Chapter 8.1.3).

Reference is made to Table 13.2.4, Table 13.2.5 and Table 13.2.6. Future imported container cargo volume in the new Chiriqui Port is calculated based on the assumption that:

① Consumption of container cargoes in a province is proportional to the GDP share of the province,

② Countries located at the Pacific coast have great potentialities to bring a ship call at the new Chiriqui Port.

Table 13.2.4 shows that GDP share of the Chiriqui Area is 15 % on an average. Based on the above assumption ①, the container cargo brought from Panama City to Chiriqui province is estimated to be 231,000 tons (=1,544,000x0.15) in 2024.

Table 13.2.4 GDP Share of the Chiriqui Area

(Unit: Million USD)

	Chiriqui	Bocas del Toro	Veraguas	Total of Chiriqui Area	The Whole of Panama	Share of Chiriqui Area (%)
2000	1,051	160	469	1,680	10,192	16.5
2005-2009	1,253	198	496	1,947	12,186	16.0
2010-2014	1,383	240	547	2,170	15,186	14.3
2015-2019	1,601	320	608	2,529	19,015	13.3
2020-2024	1,980	423	738	3,141	24,385	12.9

Source: JICA Study Team

Main commodities in the imported containerizable cargoes (container and breakbulk cargoes) to Panama are consumer products such as food products, beverages, paper and textile manufactures, machinery and electrical goods, and metal manufactures. Therefore, it is taken notice that direct deliveries of consumer products to the consumed area are more economical due to saving of the land transportation cost from Panama City.

Main origins of these imported containerizable cargoes are shown in Table 13.2.5.

Table 13.2.5 Main Origins of the Imported Containerizable Cargoes

(Unit: 1,000 tons)

	1998	1999	2000	2001	2002
USA	337	342	284	232	283
Colombia	83	29	49	43	77
Mexico	161	149	78	37	56
Costa Rica	70	71	58	52	61
Japan	112	110	53	49	46
South Korea	89	56	56	59	76
Spain	21	34	28	47	17
Total	873	791	606	519	616

Source: Contraloría General de la Republica; Dirección de Estadística y Censo

Table 13.2.6 shows the imported containerizable cargo volume from countries located at the Pacific coast, which is calculated based on the assumption that 5 % of cargo in USA and 30 % of cargo in Mexico and Costa Rica will come from the west coast.

Table 13.2.6 Imported Containerizable Cargo from Countries located at the Pacific Coast

(Unit: x 1,000 tons)

	1998	1999	2000	2001	2002
USA x 5 %	17	17	14	12	14
Mexico x 30 %	48	45	23	11	17
Costa Rica x 30 %	21	21	17	15	18
Japan x 100 %	112	110	53	49	46
South Korea x 100 %	89	56	56	59	76
Total	287	249	163	146	171
Share from Pacific Side (%)	32.9	31.5	26.9	28.1	27.8

Source: JICA Study Team

Based on the assumption ②, the potential container cargo volume to be handled at the new Chiriqui Port in 2024 is estimated as follows:

231,000 ton x 0.3 = 70,000 tons

where, 231,000 tons: Container cargo brought from Panama City to Chiriqui province in 2024

0.30: Share (30 %) of cargo from the Pacific side to the whole of cargoes in Panama, which is calculated as an average from 1998 to 2002 on Table 13.2.6

Out of the above potential container cargoes to be handled at the new Chiriqui Port, some of the cargoes, the majority of which are imported as LCL container cargoes, will be unloaded at ports in the Canal Area. Therefore, it is assumed that 70 % of the potential container cargoes will be directly transported to the new Chiriqui Port. As a result, the imported container cargo volume at the new Chiriqui Port in 2024 is estimated to be 50,000 tons.

13.2.2 Export Cargo

(1) Dry Bulk Cargo

1) Sugar

The past history of sugar exports at Panamanian ports is shown in Table 13.2.7.

Table 13.2.7 Sugar Exports at Panamanian Ports

(Unit: ton)

	1998	1999	2000	2001	2002
Aguadulce	36,229	26,794	38,896	30,689	20,527
Pedregal	29,425	19,442	33,840	6,059	11,007
Share of Pedregal (%)	44.8	42.0	46.5	16.5	34.9

Source: Panama Maritime Authority (AMP)

The above table shows that approximately 40 % of the total exported sugar volume was unloaded in Pedregal Port in the Chiriqui province.

According to "Chapter 8 Demand Forecast of Port Traffic of Panama", the total imported volume of sugar in 2024 is estimated to be 50,000 tons. Based on the above assumption, the imported volume of sugar in the new Chiriqui Port will be 20,000 tons in 2024.

(2) Breakbulk Cargo (General Cargo)

1) Banana

Table 13.2.8 shows exported volume of bananas from Panama.

Table 13.2.8 Banana Exports from Panama

(Unit: ton)

	1995	1996	1997	1998	1999	2000	2001	2002
Banana	690,017	631,951	607,954	462,415	593,364	489,284	426,081	403,923

Source: Ministry of Agricutural Development (MIDA)

Traditional Products such as bananas, sugar and coffee have shown a constant decline over the last years. Expectations are that this trend will continue and the latest data of the sector released by the Panamanian statistics bureau confirms this assumption. Based on the above, it is assumed that the future banana export volume will be stable with a maximum quantity of 400,000 tons.

Exported volume of bananas in the new Chiriqui Port is calculated based on the assumption that: ① the future exported volume will be a part of products in Chiriqui and Bocas del Toro, where major product areas of bananas in Panama exist, and ② 5 % of the total volume will be exported to the west coast of USA.

Based on the above assumption, exported volume of bananas in the new Chiriqui Port will be 20,000 tons in 2024.

(3) Container Cargo

It is expected that main commodities exported as container cargo in the Chiriqui area will be agricultural products and agro-processing products. The following table shows the exported volume of such products in Panama, which are also produced in the Chiriqui area.

Table 13.2.9 Exported Agricultural and Agro-processed Products in Panama

(Unit: ton)

	1995	1996	1997	1998	1999	2000	2001	2002
Melon&Watermelon	27,980	18,199	49,665	55,002	34,381	34,317	49,778	59,998
Melon				41,002	24,400	22,956	25,630	35,316
Watermelon				13,980	9,981	11,361	24,148	24,682
Pumpkin	9,101	17,587	21,417	20,221	17,164	16,562	18,226	21,046
Plantain	10	21	287	1,646	3,536	521	936	1,957
Name	184	39	128	369	163	360	2,756	6,201
Yuca	19	0	151	1,402	348	122	660	293
Otoe	1,078	2,843	2,139	2,970	1,847	1,871	2,619	2,926
Café	10,945	8,412	7,538	8,465	7,895	7,424	7,006	5,415
Cattle (Meat)	1,521	3,398	6,108	5,812	6,911	7,830	10,763	8,483
Milk Products	2,180	7,421	8,348	7,007	5,804	6,687	6,681	7,323
Egg	285	785	547	804	317	556	1,325	1,505

Source: Ministry of Agricultural Development (MIDA)

1) Melon & Watermelon

Export of melon & watermelon mainly to Europe (67 % in 2001) and USA (28 % in 2001) has increased remarkably for the eight years from 1995 to 2002 with an average growth rate of 11.5 %/year.

The future exported volume of melon & watermelon is estimated using an elastic value which is calculated based on the difference of the growth rate between the export volume and GDP Agriculture Sector in Panama from 1995 to 2002.

Table 13.2.10 Past and Future Exported Volume of Melon & Watermelon

	1995	1996	1997	1998	1999	2000	2001	2002	2024
GDP (Mil.Balboa)	469.7	533.0	548.5	551.5	592.6	593.1	544.2	542.6	1,487.5
Export (ton)	27,980	18,119	49,665	55,002	34,381	34,317	49,778	59,998	302,000

Source: JICA Study Team

Accordingly the future exported volume of melon and watermelon will be 302,000 tons (melon 193,000 tons and watermelon 109,000 tons). The exported volume of melon and watermelon in the new Chiriqui Port is calculated based on the assumption that: ① the future exported volume will be a part of products in the Chiriqui, Bocas del Toro and Veraguas provinces, which are estimated in proportion of volume produced in these area to the whole country, and ② 10 % of the total volume will be exported to the west coast of USA and Asia.

Production rate and share to the whole country in these area is as follows.

Table 13.2.11 Regional Production Rate of Melon & Watermelon

(Unit: qq)

	Whole Country	Chiriqui	Bocas del Toro	Veraguas	3 Province Total	Share of 3 Province (%)
(Melon)						
1996	809,819	68,000	0	11,606	79,606	9.8
1997	1,377,340	341,090	0	71,400	412,490	29.9
1998	1,408,851	210,218	0	35,960	246,178	17.5
1999	979,121	100,043	0	72,360	172,403	17.6
2002	1,294,380	185,249	0	44,392	229,641	17.7
Average in 5 years						18.5
(Watermelon)						
1998	314,018	20,954	0	93,992	114,946	36.6
1999	261,136	59,854	0	88,240	148,094	56.7
2000	247,090	46,800	0	56,783	103,583	41.9
2001	399,450	67,970	0	71,957	139,927	35.0
2002	466,876	77,361	0	133,842	211,203	45.2
Average in 5 years						43.1

Source: Ministry of Agricutural Development (MIDA)

Based on the above assumption, the exported volume of melon and watermelon in the new Chiriqui Port is calculated as follows:

Exported Volume = 302,000 tons x 10 % = 30,000 tons

Accordingly, the exported volume of melon and watermelon in the new Chiriqui Port is estimated to be 30,000 tons (melon 19,000 tons and watermelon 11,000 tons) in 2024.

2) Pumpkin

Export of pumpkin has trended to increase for eight years from 1995 to 2002 with an average growth rate of 12.7 %/year.

The future exported volume of pumpkin is estimated using an elastic value which is calculated based on the difference of the growth rate between the export volume and GDP Agriculture Sector in Panama from 1995 to 2002.

Table 13.2.12 Past and Future Exported Volume of Pumpkin

	1995	1996	1997	1998	1999	2000	2001	2002	2024
GDP (Mil.Balboa)	469.7	533.0	548.5	551.5	592.6	593.1	544.2	542.6	1,487.5
Export (ton)	9,101	17,587	21,417	20,211	17,164	16,562	18,226	21,064	114,000

Source: JICA Study Team

Accordingly, the future exported volume of pumpkin estimated to be 114,000 tons. The exported volume of pumpkin in the new Chiriqui Port is calculated based on the assumption that: ① the future exported volume will be a part of products in the Chiriqui, Bocas del Toro and Veraguas provinces, which are estimated in proportion of volume produced in these area to the whole country, and ② 10 % of the total volume will be exported to the west coast of USA and Asia.

The production rate and share to the whole country in these areas are as follows:

Table 13.2.13 Regional Production Rate of Pumpkin

(Unit: qq)

	Whole Country	Chiriqui	Bocas del Toro	Veraguas	3 Province Total	Share of 3 Province (%)
(Pumpkin)						
1998	138,000	24,600	4,000	3,262	31,862	23.1
1999	243,903	60,775	0	22,343	83,118	34.1
2000	137,530	16,181	0	6,559	22,740	16.5
2001	219,087	25,572	0	3,555	29,127	13.3
2002	209,234	34,020	0	11,250	45,270	21.6
Average in 5 years						21.7

Source: Ministry of Agricultural Development (MIDA)

Based on the above assumption, the exported volume of pumpkin in the new Chiriqui Port will be 11,000 tons in 2024.

3) Plantain, Name, Yuca and Otoe

Export of plantain, name, yuca and otoe has increased remarkably for eight years from 1995 to 2002 with an average growth rate of 36.5 %/year, and name, yuca and otoe were mainly exported to USA (80~100 % in 2001), while plantain was exported to Germany (56 % in 2001) and USA (44 % in 2001).

The future exported volume of plantain, name, yuca and otoe is estimated using an elastic value which is calculated based on the difference of the growth rate between the export volume and GDP Agriculture Sector in Panama from 1995 to 2002.

Table 13.2.14 Past and Future Exported Volume of Plantain, Name, Yuca and Otoe

	1995	1996	1997	1998	1999	2000	2001	2002	2024
GDP (Mil.Balboa)	469.7	533.0	548.5	551.5	592.6	593.1	544.2	542.6	1,487.5
Export (ton)	1,291	3,203	2,705	6,387	5,874	2,874	6,971	11,377	236,000

Source: JICA Study Team

Accordingly, the future exported volume of plantain, name, yuca and otoe is estimated to be 236,000 tons (plantain 61,000 tons, name 68,000 tons, yuca 19,000 tons and otoe 88,000 tons). The exported volume of plantain, name, yuca and otoe in the new Chiriqui Port is calculated based on the assumption that: ① the future exported volume will be a part of products in the Chiriqui, Bocas del Toro and Veraguas provinces, which are estimated in proportion of volume produced in these area to the whole country, and ② 10 % of the total volume will be exported to the west coast of USA.

The production rate and share to the whole country in these areas are as follows.

Table 13.2.15 Regional Production Rate of Plantain, Name, Yuca and Otoe

(Unit: qq)

	Whole Country	Chiriqui	Bocas del Toro	Veraguas	3 Province Total	Share of 3 Province (%)
(Plantain)						
1998	1,344,333	914,970	6,716	0	921,686	68.6
1999	1,995,221	1,063,250	390,000	0	1,453,250	72.8
2000	2,298,003	969,228	371,400	0	1,340,628	58.3
2001	2,182,275	1,340,400	360,000	0	1,700,400	77.9
2002	2,563,222	1,512,900	251,100	0	1,764,000	68.8
Average in 5 years						69.3
(Name)						
1998	382,221	15,978	10,500	28,789	55,267	14.5
1999	141,566	44,460	0	9,110	53,570	37.8
2000	450,299	57,234	0	35,575	92,809	20.6
2001	381,518	16,713	0	51,630	68,343	17.9
2002	575,807	17,000	63,000	24,629	104,629	18.2
Average in 5 years						21.8
(Yuca)						
1998	241,117	30,182	0	136,500	166,682	69.1
1999	627,238	395,640	0	49,725	445,365	71.0
2000	695,349	339,100	0	129,676	468,776	67.4
2001	377,367	229,000	0	34,250	263,250	69.8
2002	447,685	253,043	0	43,125	296,168	66.2
Average in 5 years						68.7
(Otoe)						
1998	93,803	5,244	30,600	42,000	77,844	83.0
1999	101,431	10,265	25,000	18,405	53,670	52.9
2000	155,925	5,090	36,000	23,848	64,938	41.6
2001	168,076	19,665	27,000	28,620	75,285	44.8
2002	271,230	6,950	49,200	8,393	64,543	23.8
Average in 5 years						49.2

Source: Ministry of Agricultural Development (MIDA)

Based on the above assumption, the exported volume of plantain, name, yuca and otoe in the new Chiriqui Port are estimated to be 24,000 tons (plantain 6,000 tons, name 7,000 tons, yuca 2,000 tons and otoe 9,000 tons) in 2024.

4) Coffee

Export of coffee has trended to decline for eight years from 1995 to 2002 with 10,945 tons in 1995 and 5,415 tons in 2002. Expectations are that this trend will continue and the latest performance of the sector released by the Panamanian statistics bureau confirms this assumption. Based on the above, it is assumed that the future coffee export volume will be stable with a maximum quantity of 5,000 tons.

Exported volume of coffee in the new Chiriqui Port is calculated based on the assumption that: ① the future exported volume will be a part of products in the Chiriqui, Bocas del Toro and Veraguas provinces, which are estimated in proportion of volume produced in these area to the whole country, and ② 20 % of the total volume will be exported to the west coast of USA and Asia.

The production rate and share to the whole country in these areas are as follows.

Table 13.2.16 Regional Production Rate of Coffee

(Unit: qq)

	Whole Country	Chiriqui	Bocas del Toro	Veraguas	3 Province Total	Share of 3 Province (%)
(Coffee)						
1997	218,100	164,000	800	10,000	174,800	80.1
1998	238,100	181,300	800	10,900	193,000	81.1
1999	251,100	202,800	800	9,800	213,400	85.0
2000	212,100	172,300	800	8,700	181,800	85.7
2001	307,118	230,036	2,242	11,119	243,397	79.3
Average in 5 years						82.2

Source: Ministry of Agricultural Development (MIDA)

Based on the above assumption, the exported volume of coffee in the new Chiriqui Port is estimated to be 1,000 tons in 2024.

5) Cattle (Meat)

Export of cattle meat has trended to large increase for eight years from 1995 to 2002 with an average growth rate of 27.8 %/year.

The future exported volume of cattle meat is estimated using an elastic value which is calculated based on the difference of the growth rate between the export volume and GDP Agriculture Sector in Panama from 1995 to 2002.

Table 13.2.17 Past and Future Exported Volume of Cattle

	1995	1996	1997	1998	1999	2000	2001	2002	2024
GDP (Mil.Balboa)	469.7	533.0	548.5	551.5	592.6	593.1	544.2	542.6	1,487.5
Export (ton)	1,521	3,398	6,108	5,812	6,911	7,830	10,763	8,483	112,000

Source: JICA Study Team

Accordingly, the future exported volume of pumpkin is estimated to be 112,000 tons. The exported volume of cattle meat in the new Chiriqui Port is calculated based on the assumption that: ① the future exported volume will be a part of products in the Chiriqui, Bocas del Toro and Veraguas provinces, which are estimated in proportion of volume produced in these area to the whole country, and ② 50 % of the total volume will be exported to the countries in Central America.

The production rate and share to the whole country in these areas are as follows.

Table 13.2.18 Regional Production Rate of Cattle

(Unit: head)

	Whole Country	Chiriqui	Bocas del Toro	Veraguas	3 Province Total	Share of 3 Province (%)
(Cattle)						
1997	1,362,000	288,900	35,400	251,200	575,500	42.2
1998	1,382,200	306,400	35,400	271,600	613,400	44.4
1999	1,359,800	292,500	35,400	260,000	587,900	43.2
2000	1,342,400	297,300	35,400	255,900	588,600	43.8
2001	1,531,716	338,747	41,063	251,654	631,464	41.2
Average in 5 years						43.0

Source: Ministry of Agricultural Development (MIDA)

Based on the above assumption, the exported volume of cattle in the new Chiriqui Port is estimated to be 56,000 tons in 2024.

6) Dairy Products and Eggs

Export of dairy products and eggs has been stable for eight years from 1995 to 2002 with 8,206 tons in 1996 and 8,828 tons in 2002. They were mainly exported to the countries in Central America (79 % in 2001), with a big share to Costa Rica transported by trucks (48 % in 2001).

Expectations are that this trend will continue. Based on the above, it is assumed that the future export volume of dairy products and eggs will be stable with a maximum quantity of 10,000 tons.

Exported volume of dairy products and eggs in the new Chiriqui Port is calculated based on the assumption that: ① the future exported volume will be a part of products in the Chiriqui, Bocas del Toro and Veraguas provinces, which are estimated in proportion of volume produced in these area to the whole country, and ② 30 % of the total volume will be exported to the countries excluding Costa Rica in Central America.

Table 13.2.18 is referred to concerning the regional shear of cattle, and based on the above assumption, the exported volume of dairy products and eggs in the new Chiriqui Port are estimated to be 3,000 tons in 2024.

7) Future Export of Agricultural and Agro-processing Products

The future exported volumes of agricultural and agro-processing products are shown in Table 13.2.19.

Table 13.2.19 Export of Agricultural and Agro-processing Products in 2024

Commodities	Ton	TEU
Melon and Watermelon	30,000	3,150
Pumpkin	11,000	1,150
Plantain, Name, Yuca and Otoe	24,000	2,500
Coffee	1,000	100
Cattle	56,000	5,900
Dairy Products and Eggs	3,000	300
Total	125,000	13,100

(3) Summary

The future cargo volumes to be handled in the new Chiriqui Port are summarized in Table 13.2.20.

Table 13.2.20 Future Cargo to be handled in the New Chiriqui Port

Cargo Items	Year 2024
1. Import Cargo	
(1) Dry Bulk Cargo	
Wheat	42,000 tons
Maize and Soybean	194,000 tons
Fertilizer	128,000 tons
Sub-total	364,000 tons
(2) Container Cargo	50,000 tons
	5,000 TEUs
2. Export Cargo	
(1) Dry Bulk Cargo	
Sugar	20,000 tons
(2) Breakbulk Cargo	
Banana	20,000 tons
Sub-total	40,000 tons
(3) Container Cargo	
Tonnage	125,000 tons
TEU	13,100 TEUs

13.3 Natural Conditions

This section describes natural conditions about Chiriqui (Armuelles) Port, focusing topographic and bathymetric conditions, oceanographic conditions and subsoil conditions for the master plan study.

13.3.1 Topographic and Bathymetric Conditions

Topographic and bathymetric surveys were conducted in order to get detail current information, more than existing maps and/or charts around existing ports on the following conditions: that Datum elevation was referenced to the MLWS based on tide observation related to the Port of Balboa, the geographic coordinates used Mercator's Universal System (UTM), grid zone No.17 and the spheroid was based on Clark 1866 on the survey maps.

Chiriqui (Armuelles) Port : The results of topographic and bathymetric surveys are shown in Figure 13.3.1. Two benchmarks indicated in the figure were established as shown below.

BM Description	Coordinates		Elevation	
	E	N	Datum	(m)
1	295,670.02	915,281.57	MLWS	3.35
2	295,241.76	914,495.91		5.05

The landside around existing Armuelles Port is also flat but the seawall exists along the boundary of between the land and the sea for protection from waves attacking from outer sea and big tide rages. The residences and other private lots are well marked off, and access roads to the seaside are almost paved except for a part of beach areas. Seabed configuration is regularly parallel to the boundary between land and sea up to -10 m and its gradient is about 1/40 to 1/80. There is a submarine canyon shaped mortar about 1 km east from existing pier and –100 m contour line appears on the same position.

13.3.2 Oceanographic Conditions

Generally oceanographic conditions on Chiriqui (Armuelles) Port are summarized in Table 13.3.1. The information is referenced from the existing publication[4], design and survey reports[5] or drawing having been conducted by AMP.

At this port, there is no permanent tide observation spot and authorized tide relation, although predicted tide data by harmonic analysis is disclosed from public or private sectors in publications or internet website just for reference. The following correction coefficients with the tide of Balboa Port are extracted from the publication.

4 International Marine, Tide Tables 2003 West Coast of North and South America, McGraw Hill Press, 2002
US Defence Mapping Agency & Admiralty, UK, Chart

5 Autiridad Portuaria National (APN), Estudio de Factibilidad Tecnico Economico Para Un Puerto Armuelles, 1981

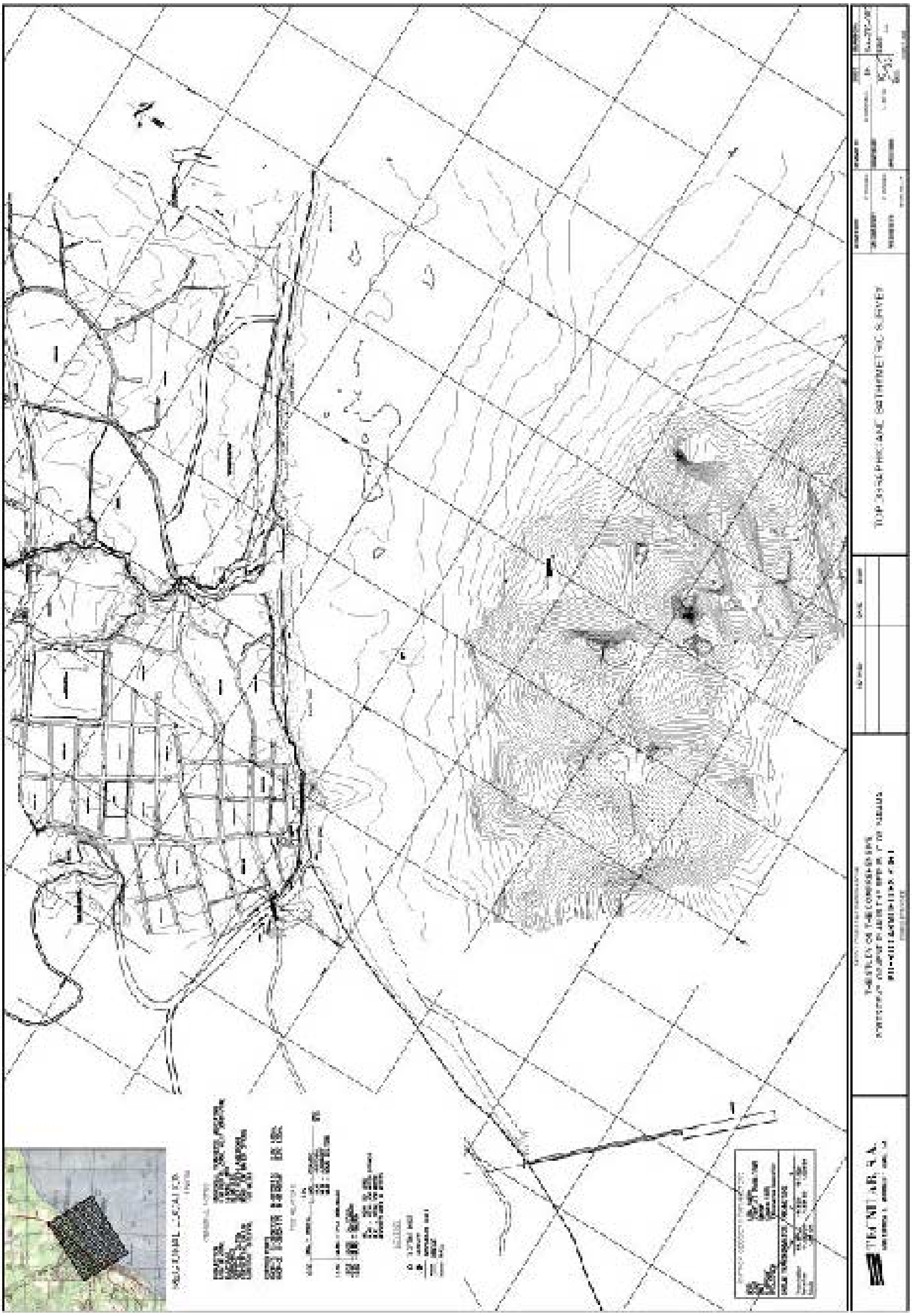


Figure 13.3.1 Survey Map at Chiriqui (Armuelles) Port

Table 13.3.1 Summary of Oceanographic Conditions

Name of Port	Tide							Current (m/sec)	Waves (Annual Max.)		Referred Nearest TidePoint
	Ref. Port	Difference from Reference Port				Tidal Range (m)	MLWS		Height	Period	
		Time (HH:MM)		Height (m)			from MSL (Pacific)		$H_{1/3}$ (m)	T (sec)	
		HWL	LWL	HWL	LWL						
Chiriqui Port (Armuelles Port)	Balboa	0:00	-0:09	× 0.63	× 0.47	<4.5	-1.50	< 1.6	< 2.5	n/a	Isla Parida

Note
1) Tide information to each port in the list is referred from nearest reference place authorized in official publication.
2) Difference such as time and height for HWL and LWLshould be added or multiplied with correspnded level of referred nearest point.
3) Asterisked values of current and waves mean figure by interview and chart.

Tidal Range is less than 4.5 m, larger than the Atlantic side. Experimentally MLWS on the port seems to define -1.50 m from the MSL on the Pacific Ocean officially established in using the tide data observed on Balboa Port, based on temporary tide observation or tide study.

Annual maximum wave height on Chiriqui (Armuelles) Port is less than 2.5 m because the area around the port faces the Pacific Ocean without any shielding like off-islands or protective facilities. Detail wave conditions on this port should be referenced from APPENDIX B; the characteristic is that the incident wave direction to the area is dominant for S direction (from S to N direction) by the influence of submarine canyon and the long period waves sometime attacks to the area from the outer sea. Other information concerning waves for structural design and harbor calmness with new plan having been proposed as described in APPENDIX B.

Current of the area is maximum 1.6 m/sec based on existing survey report and current observation results conducted on this study. The current might be included and mixed with coastal current, tidal current and ocean current, caused by waves deformed on shoaling water and tidal range.

13.3.3 Subsoil Conditions

Soil investigations were conducted in order to get detail information for the target points around existing port.

Chiriqui (Armuelles) Port : Figure 13.3.2 shows borehole locations. Subsoil profiles along representative sections were assumed based on the boring logs and SPT-N values as presented in Figure 13.3.3.

This site is located on Las Lajas Formation, composed of alluvion, consolidated sediments, sandstone, coral, mangrove, conglomerate, carbonaceous shale, and delta deposition.

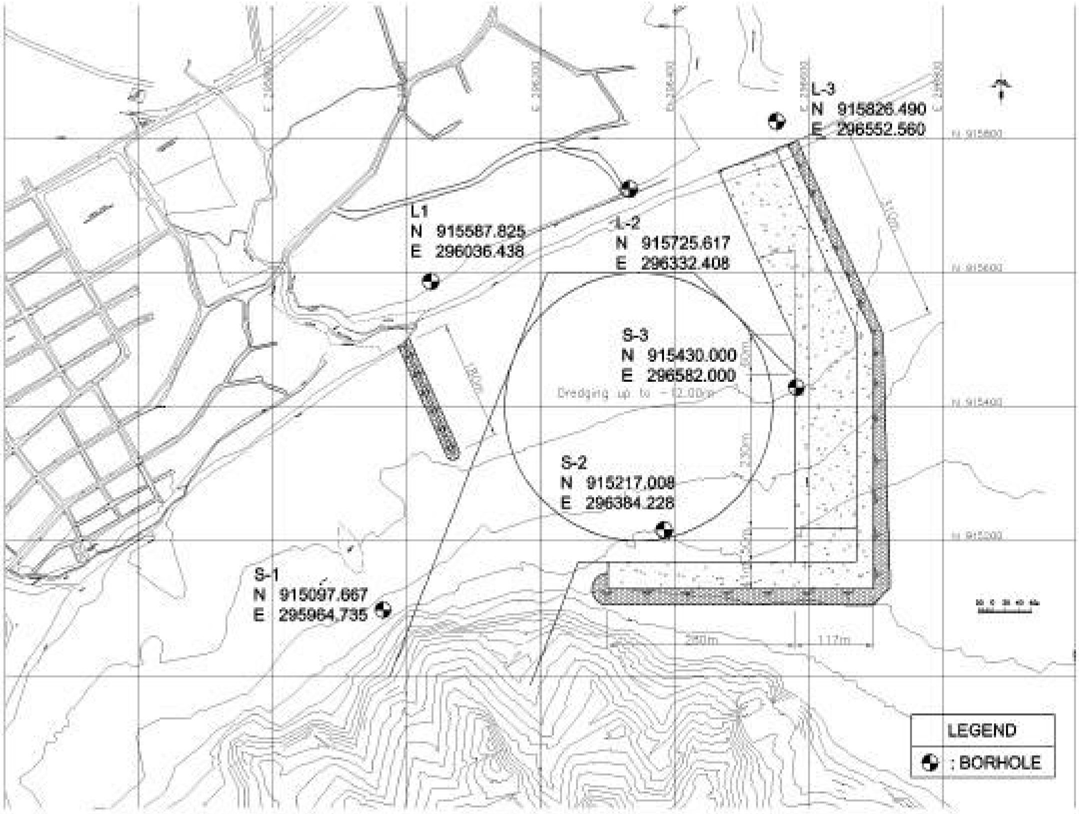


Figure 13.3.2 Location Map of Soil Investigations

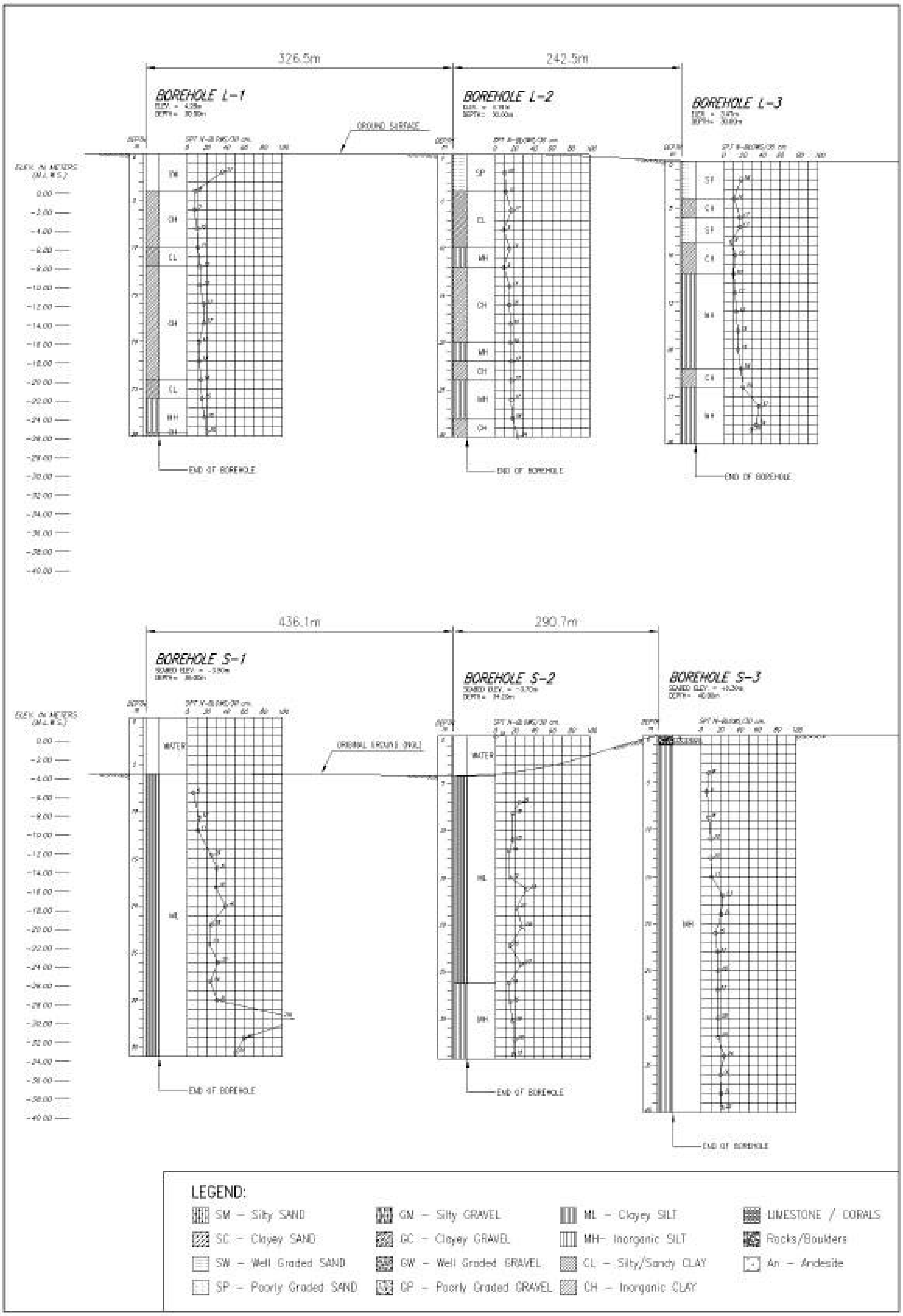
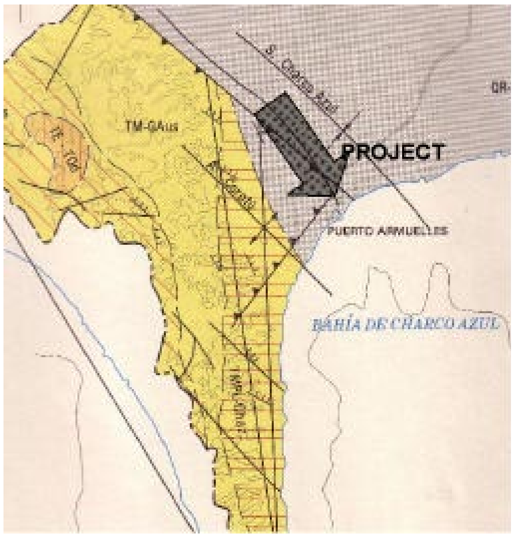


Figure 13.3.3 Boring Logs at Chiriqui (Armuelles) Port

Boreholes L-1, L-2 and L-3: In the borehole L-1 the first strata consists of Well Graded Sand (SW), loose to dense compactness, non plastic, low natural water content. In L-2 and L-3, subsoil layers form from Poorly Graded Sand (SP), medium compactness, non plastic, low natural water content; in the next layers were found stratas of Inorganic Clay (CH – CL), firm to very even consistency, medium to low plasticity, medium to high natural water content; Inorganic Silt (MH), consistent to very even consistency, low to medium plasticity, high to medium natural water content.



Boreholes S-1, S-2 and S-3: In the boreholes S-1, S-2, the first stratum found consists of Inorganic Silt (ML), firm to hard consistency, low plasticity, medium natural water content. In S-2 the strata changes to Inorganic Silt of high plasticity (MH), starting at 26.20 m depth until end of boring, consistent to very even consistency, medium plasticity, medium natural water content.

In Borehole S-3, the first strata, from 0 until 1.0 m depth, consisted of boulders; at low tide they were removed by the use of shovel, the water sea level was observed at the 0.3 m depth from the surface of the barge. The next strata until end of boring consists of Inorganic Silt (MH), firm to very even consistency, medium plasticity, medium natural water content.

13.4 Environmental Condition

13.4.1 Water Environment

The coastal water environmental condition at the planned new Chiriqui port area was studied, similar to those ports of Bocas Del Toro and Almirante as dealt with in Section 12.4, by conducting sampling and analysis of both water and seabed material (sediment) at 4 locations. The water quality sampling were conducted two times once each during low tidal and high tidal condition, while sediment sampling was conducted only once during low tidal condition.

Water quality sampling and analysis were conducted both at field, for simple parameters, and in laboratory. The field parameters measured included water temperature, water turbidity, pH, transparency and DO (dissolved oxygen). The laboratory parameters measured included DO, COD (chemical oxygen demand), total nitrogen (TN), total phosphorus (TP), fecal coliform (FC) and extractive substance in normal-hexane (oil content).

The seabed material parameters analyzed in laboratory included, total oil content (total hydrocarbon/THC) and the 10 heavy metals of Cu (copper), Zn (zinc), Be (beryllium), Cr (chromium), Ni (nickel), V (Vanadium), Cd (Cadmium), Hg (Mercury), Pb (Lead) and As (Arsenic).

(1) Coastal Water Quality

The water quality parameters measured are essentially indicators of organic, nutrient, bacterial and oil pollution. In overall, the analytical results indicated no chronic water quality deterioration attributed to organic pollutants in the coastal waters of the planned Chiriqui port, which was also evident from visual site inspection in the coastal water areas.

As per bacterial pollution, as the indicator of contamination due to recent discharge of human (anthropogenic) wastes of fecal origin, extremely high fecal coliform (FC) levels even up to 35,000 No./100ml were measured in the coastal waters. Accordingly, untreated disposal of wastes of anthropogenic origin is prevalent and to be dealt with. Still the overall good water quality of the coastal waters is attributed to the favorable topographic and oceanographic condition of the area that is open to Pacific Ocean with high tidal range and currents.

Concerning oil pollution that should be attributed to water vessels of direct port operational activity, very significant oil pollution level exceeding even 10 mg/l was measured at least once each during both instances of high tide and low tide sampling in the coastal waters. Accordingly, oil pollution level in the coastal waters is assessed as very significant.

(2) Coastal Sediment Quality

The sediment (seabed material) quality was evaluated for potential heavy metal and oil contamination level using the Dredged Material Quality Standards of Netherlands (1987), as given in the World Bank Technical Paper No.126 (1990) on “Environmental Considerations for Port and Harbor Developments”. It is noted that this standards is used under the presumption that unpolluted sediment quality representing metal and oil contents in natural sediments would be same as that in Netherlands. It is further noted that this Standards of Netherlands does not include two of the heavy metallic elements measured, namely, beryllium (Be) and Vanadium (V). Accordingly, the sediment quality was evaluated with respect to the remaining 8 heavy metallic elements and total oil content (total hydrocarbon/THC) measured in the seabed.

The results of evaluation indicated no heavy metallic contamination in the seabed of the coastal waters. Also no significant oil content (total hydrocarbon/THC) was measured. Accordingly, the seabed is assessed as non-contaminated and hence any dredged material due to the construction of the new port is amenable for open deep sea water disposal including any suitable beneficial use.

(3) Conclusions

In overall, based on the results of water quality analysis, the coastal water environment of the planned Chiriqui port is assessed as satisfactory with no chronic organic pollution. Still significant oil pollution in the coastal waters is noted, implying the requirement for strict oil pollution control measures by AMP concerned to vessel and ship movements.

The seabed material (sediments) is assessed as not significantly contaminated with respect to the measured heavy metallic elements and oil (total hydrocarbon) content.

13.4.2 Coastal Ecology

The significant coastal marine ecosystems of the planned new Chiriqui port area are sandy littorals and rocky littorals, which also include the marine littoral and sub-littoral zones. It is emphasized that there are no coral reefs, seaweeds (marine grass) or mangrove woods that are ecologically important in the nearby areas.

The sandy and rocky littoral is inhabited by a great variety of marine invertebrate fauna such as mollusks (snails and shells), polychaete worms, crustaceans (isopods, shrimps, crabs), and others. In the pelagic oceanic zone there is a dominance of pelagic fish species, such as tuna, sail fish, *dorado*, and *wahoo*, while in the deep sea there are important invertebrates such as the giant squids *(Dosidiscus gigas)* and lobsters *(Pamulisu gracilis).*

13.4.3 Social Environmental Aspects

The social environmental aspects principally targeting the population living around the planned new Chiriqui port area, which is the urban center of Puerto Armuelles, was studied using available data as well as focused interview surveys. The basic social environmental condition of the population along with perception of the population concerning the port development is delineated below.

The total population of Puerto Armuelles is 13,676 inhabitants (Year 2000 census) with an index of masculinity of 97.7%. The potentially economically active population from 15 to 64 years of age is 61.5%.

Of the potentially economically active population, 4,100 are employed, of which 476 work in agricultural sector. The unemployment ratio is 21%, which is very high. The median income of the working population is USD (Balboa) 329.8, while the median family income being USD 331. The main economic activity of the area is banana cultivation for export. Other significant economic activities include fishing and commerce followed with agriculture. It is noted that a small portion of fish caught is exported overseas. The major agricultural products are rice, plantains and oil palm.

The population of Puerto Armuelles identified the living environmental condition as normal, and hence satisfactory. Concerning the construction of the port as per the master plan, the population does not perceive any significant adverse environmental effects. In fact the perception of the population is that port development is very necessary to alleviate the prevailing high unemployment rate in Puerto Armuelles.

13.5 Facility Planning and Layout

13.5.1 Requirements of the Ports

On the basis above discussion, requirements of the port facilities of Chiriqui Port are as follows:

1) Calling ships

The port should accommodate container carriers plying in the feeder service routes along Central American Coast and bulk carriers. Taking into consideration of the bulk carriers employed in the dry bulk import in Panama and the container liner ships employed in the feeder services to Central American coast, the maximum ship size among the calling ships is assumed to be 25,000 DWT.

The port should accommodate tuna ships having 150 GT and tuna reefer ships having 1,400 GT.

2) Operational conditions

To accommodate a container liner ship, the deep draft wharf should be operational 24 hours a day and 365 days a year. Thus, the wharf should be well protected from the intruding waves.

3) The potential cargo volumes

The port should have a capacity to handle the following cargo traffic:

Fertilizer	:	128,000	tons:
Wheat	:	42,000	tons;
Maize and Soy beans	:	194,000	tons;
Sugar	:	20,000	tons;
Import containers	:	50,000	tons (approximately 5,000 TEUs);
Export Containers	:	125,000	tons (approximately 13,000 TEUs);
Total Volumes	:	559,000	ton.

The port also has facilities to accommodate tuna boats for the supply and unloading the production. About 30 tuna boats and reefer ships will be the regular users of the port.

13.5.2 Berth Requirements

In order to accommodate the potential cargoes and the tuna boats, taking into considerations of the size and type of the calling vessels, it seems to be practical to plan two wharves: a wharf for cargo ship (large vessels) and another for tuna and reefer ships (smaller ships).

The number of calling ships and the berth occupancies by these ships are summarized in Tables 13.5.1 and 13.5.2. It was assumed that the maximum size of container ships should be 25,000 DWT and the dry bulk cargoes should be also carried by ships having 25,000 DWT, except sugar that would be carried by smaller size ships.

Table 13.5.1 Port Calls and Berth Occupancy of Cargo Ships

Commodities	Cargo Volume	Ship size	Average load per ship	calls/year	Days at berth	Berth day
Fertilizer	128,000 ton	25,000 DWT	10,000 ton	12.8	3	38.4
Wheat	42,000 ton	25,000 DWT	10,000 ton	4.2	3	12.6
Maize and Soy beans	194,000 ton	25,000 DWT	25,000 ton	7.76	6	46.56
Sugar	20,000 ton	6,000 DWT	2,000 ton	10	3	30.0
Import containers	50,000 ton	25,000 DWT				
	5,000 TEU		100 TEU	50		
Export Containers	125,000 ton	25,000 DWT				
	13,000 TEU		300 TEU	43.3333333	0.5	21.7
Total	559,000 ton			84.76		127.56

Source: Study Team

Table 13.5.2 Port Calls and Berth Occupancy of Tuna Boats and Reefer Ships

Fishing boats	Ship size	Calls	Mooring period	Berth day
Tuna boat	140 GT	300	3 day	900
Reefer ship	1,400 GT	20	3 day	60
Total		320		960

Source: Study Team

Thus, the port requires one multi-purpose berth and one reefer ship berth and two tuna boat berths.

The dimensions of these three berths are as follows:

Multi-purpose wharf	Length: 250m,	Depth: -12m
Fishing boat wharf		
Reefer ship	Length: 110 m,	Depth: -6.5m
Tuna boat	Length: 60m x 2,	Depth: -5.5m.

The layout plan is shown in Chapter 13.4.

13.5.3 Breakwater Alignment and Harbor Calmness

In this Section, the Calmness in the new Chiriqui port was examined by the numerical simulation, which analyzes the wave on the basis of the equilibrium equation of wave energy (Takayama's model). The incident waves at the opening of the breakwater are assumed based on the wave analysis which discussing in the APPENDIX B.

The breakwater was arranged in accordance with the following understandings.

a. The predominant waves' direction is SE - S, and these directions are accounting more than 95 % of the intended waves to the port.

b. Sea bed is rapidly become deeper after -9m depth in front of the planned port area, therefore, economical depth of the breakwater construction is maximum -9m.

c. To create a calmed basin in the port, multi-purpose quay (L=250m) shall be covered by isometric length (L=280m) of the breakwater which arranged at right angles. The tuna-quays (L=60m×2) and the reefer carrier quay (L=110m) are also laid out along the behind of the breakwater.

d. To protect the siltation along the beach side, a groin (L=180m) is laid out at the west end of the port.

(1) Conditions for Wave Simulation

1) Wave Direction and Period at the Opening of the Breakwater

The wave occurrence at the opening of the breakwater of Chiriqui Port is expected as shown in APPENDIX B, and the conditions employed in the calmness simulation are chosen as follows:

Wave direction;	SE, SSE, S, SSW and SW
Wave height at the opening of the breakwater;	0.24 - 2.24 m
Wave period at the opening of the breakwater;	4.5, 8.5, 12.5 sec.

2) Boundary Conditions (Layout of the Wharves and the Wave Reflection Coefficients)

The wave simulation was carried out for the master plan case.

The reflection coefficients are chosen in accordance with the type of the structures as shown in Table 13.5.3.

Table 13.5.3 Structure Type and Wave Reflection Coefficient

Type of Structure	Ref. Coefficient
Vertical wall, such as sheet piled fisheries quay	0.9
Rubble mounded slope under the multi-purpose quay	0.7
Natural beach	0.1

3) Area Covered by the Numerical Model

The numerical model covers the port basin only which surrounded by the breakwater and the groin. The grid size of the computation is 25m.

4) Requirement of the Calmness for Each Type of Ship

According to a standard for ports and harbors*, the calmness of a specified level, which can be loading / un-loading operation without troubles, is prescribed as shown in Table 13.5.4.

Table 13.5.4 Threshold Wave Height for Cargo Handling*

Ship Size	Threshold wave height for cargo handling ($H_{1/3}$)
Small-sized ship	0.3 m
Medium and largesized vessels	0.5 m
Very large vessels	0.7 - 1.5 m

Note: Small-sized ships are vessels smaller than about 500 GT that mainly use the basins for small craft, and very large ships are vessels larger than about 50,000 GT that mainly use large dolphins and offshore berths. Medium and large-sized ships are vessels that do not belong to the small-sized and very large ship categories.

Based on the above specified limited wave height and wave occurrence probability, rate of cargo handling operation is calculated and indicated in percent.

(2) Results of the Simulation

The results of the simulation are exhibited in the figures as shown in APPENDIX B. The rate of cargo handling operation of each quay, in the master plan case, is summarized as shown in Table 13.5.5.

Minimum requirement of the rate of cargo handling operation is 97.5% for container ships, and the other type of ships. The rate on exposed sea is approx. 59.1 %, and it is improved and satisfied the requirement by construction of the breakwater as shown on the table.

Table 13.5.5 The Results of the Simulation (Master Plan Case)

Purpose for Use	Threshold Wave Height H_T (m)	Item	Offshore Wave Direction					Total
			SE	SSE	S	SSW	SW	
Harbor Entrance (-10m depth)	0.3	Wave Height Ratio	0.720	0.720	0.606	0.451	0.297	
		EOP (%)	0.4	1.4	39.1			40.9
		Non EOP (%)	99.6	98.6	60.9	100.0	100.0	**59.1**
	0.5	Wave Height Ratio	0.720	0.720	0.606	0.451	0.297	
		EOP (%)	0.4	1.3	29.9			31.6
		Non EOP (%)	99.6	98.7	70.1	100.0	100.0	**68.4**
Reefer (berth_1)	0.5	Wave Height Ratio	0.156	0.171	0.154	0.116	0.076	
		EOP (%)		0.0	0.0	0.0		0.0
		Non EOP (%)	100.0	100.0	100.0	100.0	100.0	**100.0**
Tuna (berth_2)	0.3	Wave Height Ratio	0.106	0.119	0.107	0.080	0.053	
		EOP (%)			0.3			0.3
		Non EOP (%)	100.0	100.0	99.7	100.0	100.0	**99.7**
Multi-Purpose (berth_3)	0.5	Wave Height Ratio	0.112	0.124	0.113	0.085	0.056	
		EOP (%)						0.0
		Non EOP (%)	100.0	100.0	100.0	100.0	100.0	**100.0**
Multi-Purpose (berth_4)	0.5	Wave Height Ratio	0.114	0.131	0.124	0.094	0.062	
		EOP (%)						0.0
		Non EOP (%)	100.0	100.0	100.0	100.0	100.0	**100.0**
Reserved Area (berth_5)	0.3	Wave Height Ratio	0.120	0.153	0.164	0.125	0.083	
		EOP (%)		0.1	2.4	2.0		4.5
		Non EOP (%)	100.0	99.9	97.6	98.0	100.0	**95.5**
natural beach_1 (Covered)	0.3	Wave Height Ratio	0.157	0.228	0.265	0.204	0.135	
		EOP (%)		0.3	5.8	14.6	0.7	21.4
		Non EOP (%)	100.0	99.7	94.2	85.4	99.3	**78.6**
natural beach_2 (Opened)	0.3	Wave Height Ratio	0.383	0.533	0.510	0.383	0.252	
		EOP (%)	0.1	0.9	7.7	25.4	6.8	40.9
		Non EOP (%)	99.9	99.1	92.3	74.6	93.2	**59.1**

Note : EOP means " Exceeding Occurrence Probability
Non EOP means "Non Exceeding Occurrence Probability

13.6 Preliminary Design of Facilities

13.6.1 Design Concept

The new port facilities planed at Chiriqui Port are mainly "Multi-purpose Berth," "Reefer Ship Berth," "Tuna Berth" and "Breakwater."

The design concepts for the marine facilities are as follows:

- To accommodate three kinds of vessels at any time
- To maintain the calmness in harbors and facilitate cargo loading/unloading
- To be easy for ship maneuvering
- To be easy for maintenance
- To minimize the dredging and reclamation volume
- To consider the future development plan of the port
- To be safe against natural adversities.

The general layout plan at Chiriqui Port is shown in Figures 13.6.4 and 13.6.5. The layout of the breakwaters is determined by the environmental conditions such as topographic and bathymetric conditions, current and wave conditions. The layout of each berth is determined so that the ship maneuvering is easy for berthing/deberthing. The structural types of berth are selected open pile type for multi-purpose berth and steel sheet pile type for reefer ship and tuna berth to adapt the subsoil conditions and economic aspects. The structural type of breakwaters is selected concrete block type of sloping breakwater in consideration of wave heights and economic aspects.

13.6.2 Design Conditions

(1) Natural Conditions

1) Tide

The following tide levels at Chiriqui Port are determined by referring to Armuelles Port.

Table 13.6.1 Tide Levels at Chiriqui Port

HHW (Higher High Water Level)	+3.50 m
MHW (Mean High Water Level)	+2.80 m
MSL (Mean Sea Level)	+1.40 m
MLWS (Mean Low Water Spring)	±0.00 m

Source: JICA Study Team

2) Wave

The following dimensions of the design wave are set in accordance with wave analysis.

Equivalent Deepwater Wave Height before Breakwater: H'_0 = 3.8 m
Significant Wave Height before breakwater: $H_{1/3}$ = 4.4 m

Significant Wave Height in the harbor: $H_{1/3}$ = 0.3 m
Significant Wave Period: $T_{1/3}$ = 13.2 sec
Wave Length L = 271.8 m

3) Subsoil Conditions

According to the result of subsoil investigations, the typical subsoil conditions at site is as shown in Figures 13.6.1 and 13.6.2.

▽Existing Sea Bed

Inorganic Silt N=10, c=5tf/m^2, γ '=0.6tf/m^3

▽-16.4 m (below MLWS)

Inorganic Silt N=20, c=10tf/m^2, γ '=0.6tf/m^3

Figure 13.6.1 Typical Soil Conditions for Multi-purpose Berth

Source: JICA Study Team

▽Existing Sea Bed

Clayer Silt N=15, c=10tf/m^2, γ '=0.6tf/m^3

▽-16.0 m (below MLWS)

Clayer Silt N=25, c=10tf/m^2, γ '=0.6tf/m^3

▽-25.0 m (below MLWS)

Inorganic Silt N=18, c=10tf/m^2, γ '=0.6tf/m^3

Figure 13.6.2 Typical Soil Conditions for Reefer Ship Berth and Tuna Berth

Source: JICA Study Team

4) Seismic Coefficient

Seismic coefficient of effective peak acceleration at Chiriqui Port is 0.24 according to the Regulation of Structural Design for the Republic of Panama 1994.

(2) Usage Conditions

1) Target Vessels

The proposed maximum dimensions of the target vessels are shown in the following table:

Table 13.6.2 Dimensions of Target Vessels

	Container ship	General Cargo ship	Reefer ship	Tuna boat
Tonnage (DWT)	25,000	25,000	3,000	150 (GT)
Length overall (m)	180	180	94	50
Breadth (m)	30	27	14.6	7.2
Draught (m)	11.0	11.0	6.0	4.2

Source: Estimate by JICA Study Team

2) Surcharge

- Multi-purpose Berth and Reefer Ship Berth
  Surcharge for normal condition: W=3.0 tf/m^2
  Surcharge for seismic condition: W=1.5 tf/m^2

- Tuna Berth
  Surcharge for normal condition: W=1.0 tf/m^2
  Surcharge for seismic condition: W=0.5 tf/m^2

3) Live Load

- Multi-purpose Berth and Reefer Ship Berth
  Mobile crane truck: 40 tons capacity
  Forklift truck: 25 tons capacity
  Truck: 20 tons
  Tractor-trailer: 40 foot container

- Tuna Berth
  Truck: 20 tons

4) Width of Multi-purpose Berth: 50.0 m
Width of Reefer Ship Berth: 20.0 m
Width of Tuna Berth: 20.0 m

5) Lifetime: 50 years

13.6.3 Design of Multi-purpose Berth Facilities

(1) Crown Heights of Berth

The crown heights of berth are determined by the following formula and in consideration of existing ground level and facilities.

Crown Height of Berth = MHW (+2.80 m) + 1.0 m = +3.80 m , say <u>+4.0 m</u>

(2) Required Depth of Berth

The required depth of berth is determined by the following formula and in consideration of existing seabed level and facilities.

Required Depth of Berth = MLWS (±0.00 m) – Draught (11.0 m) – 0.5*$H_{1/3}$(0.3 m) = -11.15 m, say <u>-12.0 m</u>

(3) Required Berth Length

The required berth length is determined by the following formula.

Required Berth Length = Ship Length (200 m) × 1.15 × 1 berth = 230 m
say <u>230 m</u>

(4) Selected Structural Type

The multi-purpose berth is planned with open pile type RC deck structure supported by the vertical steel pipe piles. Based on the soil investigation for the site, an inorganic silt layer uniformly exists until –35 m below MLWS. Thus, steel pipe piles are to be driven into this layer to secure the bearing force.

For the horizontal force of the berth such as vessel berthing, mooring force and seismic force of the berth, the whole vertical piles are to be sustained. Based the alignment of the piles and loads on the berth, the adopted size of the piles are 1,300 mm in diameter. The corrosion control methods are taken by employing the coating method and the cathodic protection method. The coating method, such as inorganic lining, is applied to the sections above the depth 1.0 m below the mean monthly-lowest water level (LWL).

The RC deck for the berth consists of RC pile cap, RC beam on the piles and RC slab.

Based on the design vessel size, berth accessories such as mooring bollards and fenders are determined. The capacities of accessories are planned 100-ton bollard and cell-type 1000H fenders. The mooring bollards are installed at 12 m intervals and the curbs are installed between the bollards.

The typical structural drawing is shown in Figure 13.6.6.

13.6.4 Design of Reefer Ship Berth Facilities

(1) Crown Heights of Berth

The crown heights of berth are determined by the following formula and in consideration of existing ground level and facilities.

Crown Height of Berth = MHW (+2.80 m) + 1.0 m = +3.80 m , say <u>+4.0 m</u>

(2) Required Depth of Berth

The required depth of berth is determined by the following formula and in consideration of existing seabed level and facilities.

Required Depth of Berth = MLWS (±0.00 m) – Draught (6.0 m) – 0.5*$H_{1/3}$(0.3 m) = -6.15 m,
say <u>-6.5 m</u>

(3) Required Berth Length

The required berth length is determined by the following formula.

Required Berth Length = Ship Length (94 m) × 1.15 × 1 berth = 108 m
say <u>110 m</u>

(4) Selected Structural Type

The reefer ship berth is planned with steel sheet pile type quay wall equipped with anchorage of H-section steel piles. Based on the soil investigation for the site, a clayey silt layer (N value > 15) uniformly exists until –35 m below MLWS. Thus, steel sheet piles are to be embedded into this layer to secure an appropriate level of safety factor.

For the horizontal force of the berth such as earth pressure, water pressure, earthquake forces, tractive forces and berthing forces of vessels, the steel sheet piles are to be sustained. The adopted size of the steel sheet piles is type-5L and 18 m long, and H-section steel pile for the anchorage is 400 x 400 mm and 15 m long. The size of tie rod is 50 mm diameter and the type of materials is high-tension steel 690 (HT690). The wales are placed to make the sheet piles and tie rods resist together and carry the horizontal force uniformly to the tie rods. The size of wale steel channels is 200 x 80 mm.

Coping concrete is designed to be safe against the earth pressure behind the wall, the tractive forces of vessels and the berthing forces of vessels.

Based on the design vessel size, berth accessories such as mooring bollards and fenders are determined. The capacities of accessories are planned 25-ton bollards and V-type 300H fenders. The mooring bollards are installed at 20 m intervals and the curbs are installed between the bollards.

The typical structural drawing is shown in Figure 13.6.7.

13.6.5 Design of Tuna Berth Facilities

(1) Crown Heights of Berth

The crown heights of berth are determined by the following formula and in consideration of existing ground level and facilities.

Crown Height of Berth = MHW (+2.80 m) + 0.6 m + 0.5 m = +3.90 m , say <u>+4.0 m</u>

(2) Required Depth of Berth

The required depth of berth is determined by the following formula and in consideration of existing seabed level and facilities.

Required Depth of Berth = MLWS (±0.00 m) – Draught (4.2 m) – 0.5*$H_{1/3}$(0.3 m) = -4.35 m,
say <u>-5.0 m</u>

(3) Required Berth Length

The required berth length is determined by the following formula.

Required Berth Length = Ship Length (50 m) × 1.15 × 2 berths = 115 m, say <u>120 m</u>

(4) Selected Structural Type

The tuna berth is planned with steel sheet pile type quay wall equipped with anchorage of H-section steel piles. Based on the soil investigation for the site, a clayey silt layer (N value > 15) uniformly exists until –35 m below MLWS. Thus, steel sheet piles are to be embedded into this layer to secure an appropriate level of safety factor.

For the horizontal force of the berth such as earth pressure, water pressure, earthquake forces, tractive forces and berthing forces of vessels, the steel sheet piles are to be sustained. The adopted size of the steel sheet piles is type-4 and 15 m long, and H-section steel pile for the anchorage is 400 x 400 mm and 14.0 m long. The size of tie rod is 48 mm diameter and the type of materials is high-tension steel 690 (HT690). The wales are placed to make sheet piles and tie rods resist together and carry the horizontal force uniformly to tie rods. The size of wale is steel channels 200 x 80 mm.

Coping concrete is designed to be safe against the earth pressure behind the wall, the tractive forces of vessels and the berthing forces of vessels.

Based on the design vessel size, berth accessories such as mooring bollards and fenders are determined. The capacities of accessories are planned 10-ton bollards and V-type 300H fenders. The mooring bollards are installed at 15 m intervals and the curbs are installed between the bollards.

The typical structural drawing is shown in Figure 13.6.8.

13.6.6 Design of Breakwater

(1) Assumption of Crown Heights of Breakwater

The assumption of crown heights of breakwater is determined by the following formula or greater above the mean monthly highest water level.

Assumed Crown Height = MHW (+2.80 m) + 0.6*$H_{1/3}$(4.37 m) = +5.42 m , say +5.5 m

(2) Permissible rate of Water over-topping

The permissible rate of over-topping depends on factors such as the structural type of breakwater, the situation with regard to land use behind seawall and the capacity of drainage facilities. The following table gives a standard of the permissible rate of wave overtopping in line with the importance of the facilities behind the seawall.

Table 13.6.3 Permissible Rate of Water Overtopping (m^3/s/m)

Areas where there is a high concentration of houses, public facilities etc. behind the seawall, and so it is anticipated that flooding due to overtopping or spray would cause particularly serious damage	About 0.01
Other important areas	About 0.02
Other areas	0.02 ~ 0.06

Source: Technical Standards and Commentaries for Port and Harbour Facilities in Japan, January 2002

The following table gives the values for the damage limit rate of overtopping based on past cases of disasters.

Table 13.6.4 Damage Limit Rate of Overtopping (m^3/s/m)

Type	Covering	Rate of overtopping (m^3/m·s)
Revetment	Apron paved Apron unpaved	0.2 0.05
Levee	Concrete on front slope, crown, and back slope Concrete on front slope and crown, but no concrete on back slope Concrete on front slope only	0.05 0.02 0.005 or less

Source: Technical Standards and Commentaries for Port and Harbour Facilities in Japan, January 2002

Considering above tables, the permissible rate of overtopping is determined as 0.05 m^3/s/m.

The rate of overtopping is estimated using Figure 13.6.4.

Where,

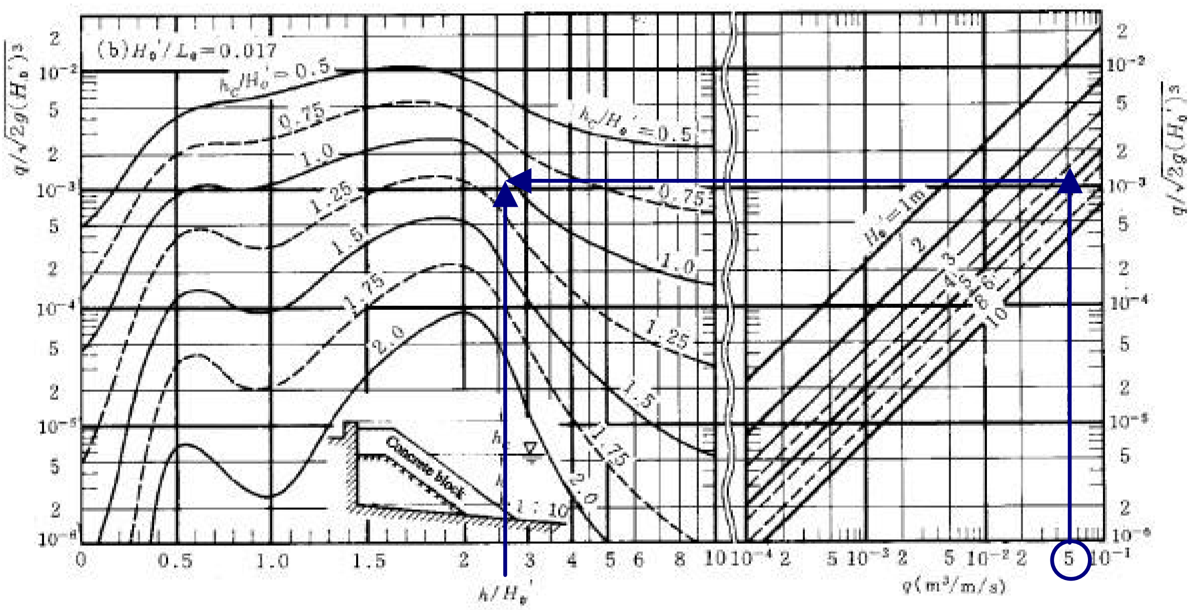
H'_0/L_0 = 3.8/271.8 = 0.014

h/H'_0 = (6.5 + 3.5)/3.8 = 2.63

By means of diagram, hc/H'_0 = 1.1

Therefore, hc = 1.1 x 3.8 = 4.2 m

The required crown height: hc (4.2 m) + H.H.W (+3.5 m) = 7.7 m, say +8.0 m



Source: Technical Standards and Commentaries for Port and Harbour Facilities in Japan, January 2002

Figure 13.6.3 Graphs for Estimating the Rate of Overtopping

(3) Design Crown Heights of Breakwater

The crown heights of breakwater calculated from the rate of wave overtopping is +8.00 m, while the assumption of crown heights is +5.5 m. Design crown heights given to the breakwaters to be newly constructed should be decided as +8.00 m above MLWS.

(4) Mass of Armor Stones and Concrete Blocks

The mass of armor stones or concrete blocks necessary to cover the front slope of a rubble mound type breakwater is calculated by the following formula.

$$M = \rho_r H^3/[N_s^3(S_r - 1)^3]$$

Where,

M: minimum mass of rubble stones or concrete blocks (t)

ρr: density of rubble stones or concrete blocks (t/m3)

H: wave height used in the stability calculation (m)

Ns: stability number

S_r: specific gravity of rubble stones or concrete blocks relative to seawater

Assuming the front slope is 1:1.5 for armor stones and 1:4/3 for concrete blocks, and K_D value is 4 for armor stones and 8.3 for concrete blocks, the parameters in the above formula and minimum mass are decided as follows.

- Armor stones
  ρ_r = 2.65 ton/m^3, H = 4.4 m, $N_s^3 = K_D$ x cot α = 4 x 1.5 = 6.0, S_r = 2.65 /1.03 = 2.57
  M = 2.65x4.4^3/[6x(2.57-1)^3] = 9.52 ton

- Concrete blocks
  ρ_r = 2.3 ton/m^3, H = 4.4 m, $N_s^3 = K_D$ x cot α = 8.3 x 4/3 = 11.1, S_r = 2.3 /1.03 = 2.23
  M = 2.3x4.4^3/[11.1x(2.23-1)^3] = 9.29 ton

12.5-ton type concrete block (Tetra pod; 11.5 ton/unit) can be recommended for armor layer of breakwater.

(5) Selected Structural Type

The structural type is a deformed concrete block (12.5-ton type) type of rubble mound sloping breakwater. The slope of concrete blocks is planned with a single-gradient as 1:4/3. The layers of concrete blocks are two, and the crown width is 6.4 m that is equal to three blocks or more.

The typical section of breakwater is shown in Figure 13.6.9.

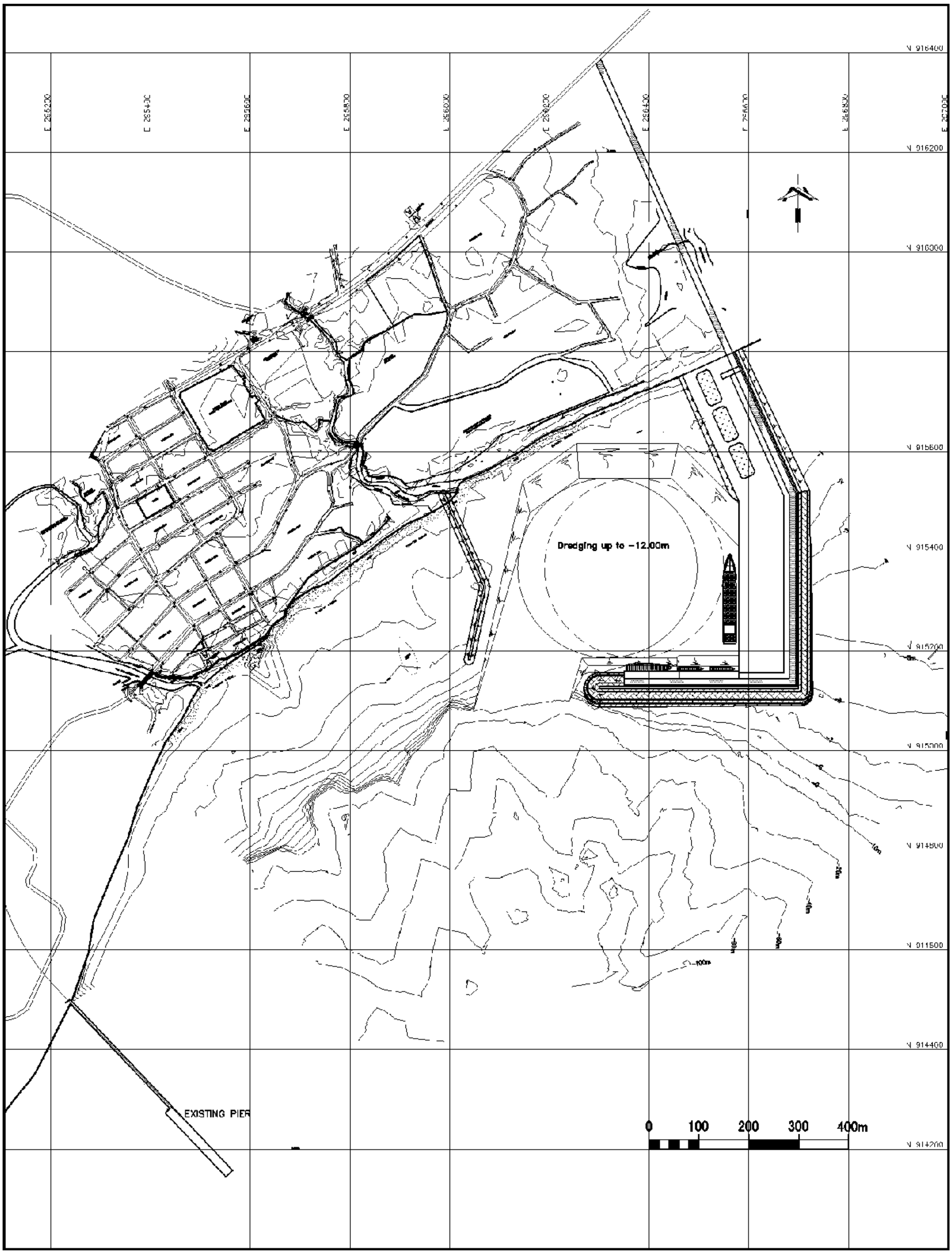


Figure 13.6.4 General Plan of Chiriqui Port

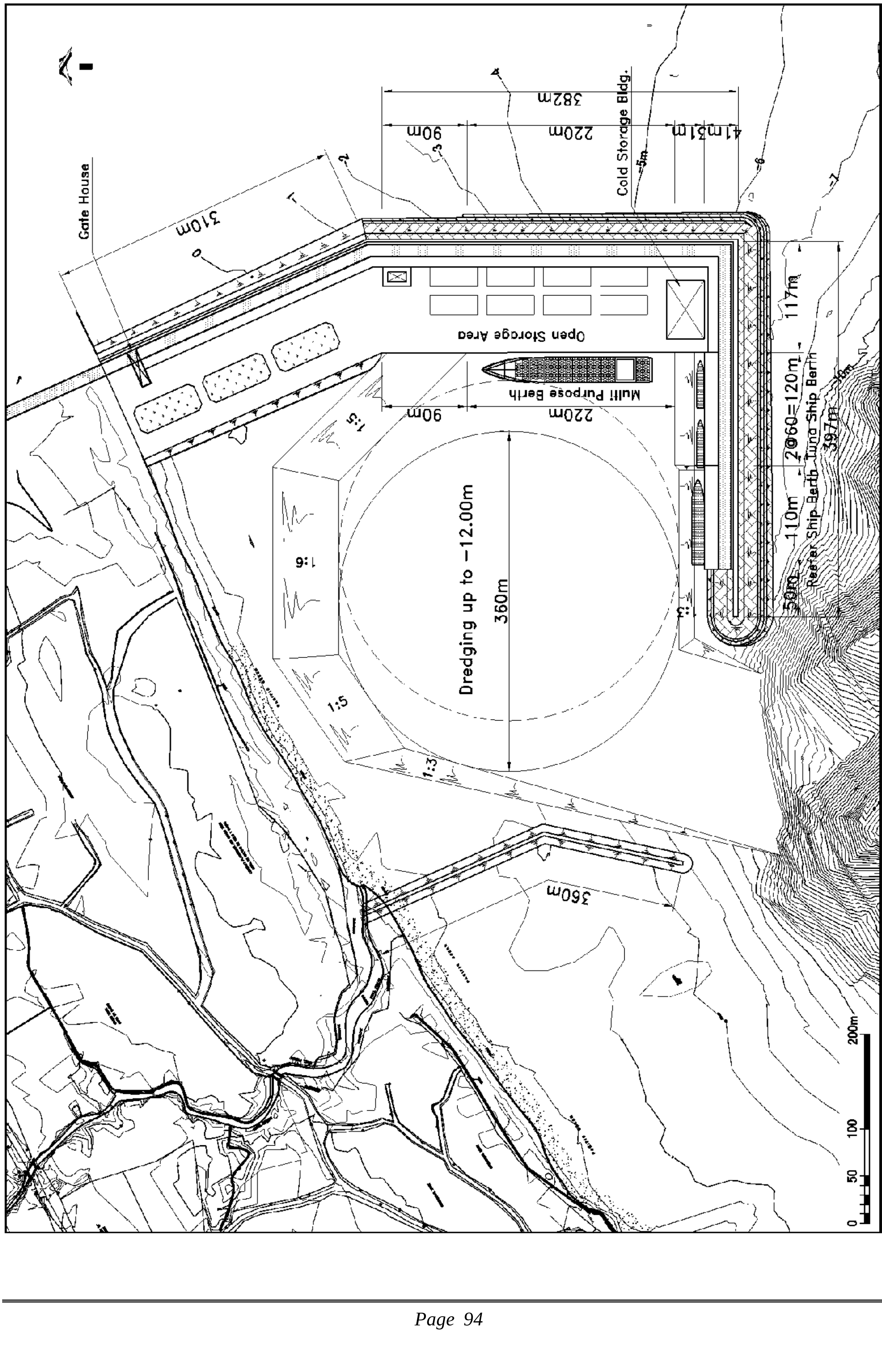


Figure 13.6.5 General Layout Plan of Marine Facilities

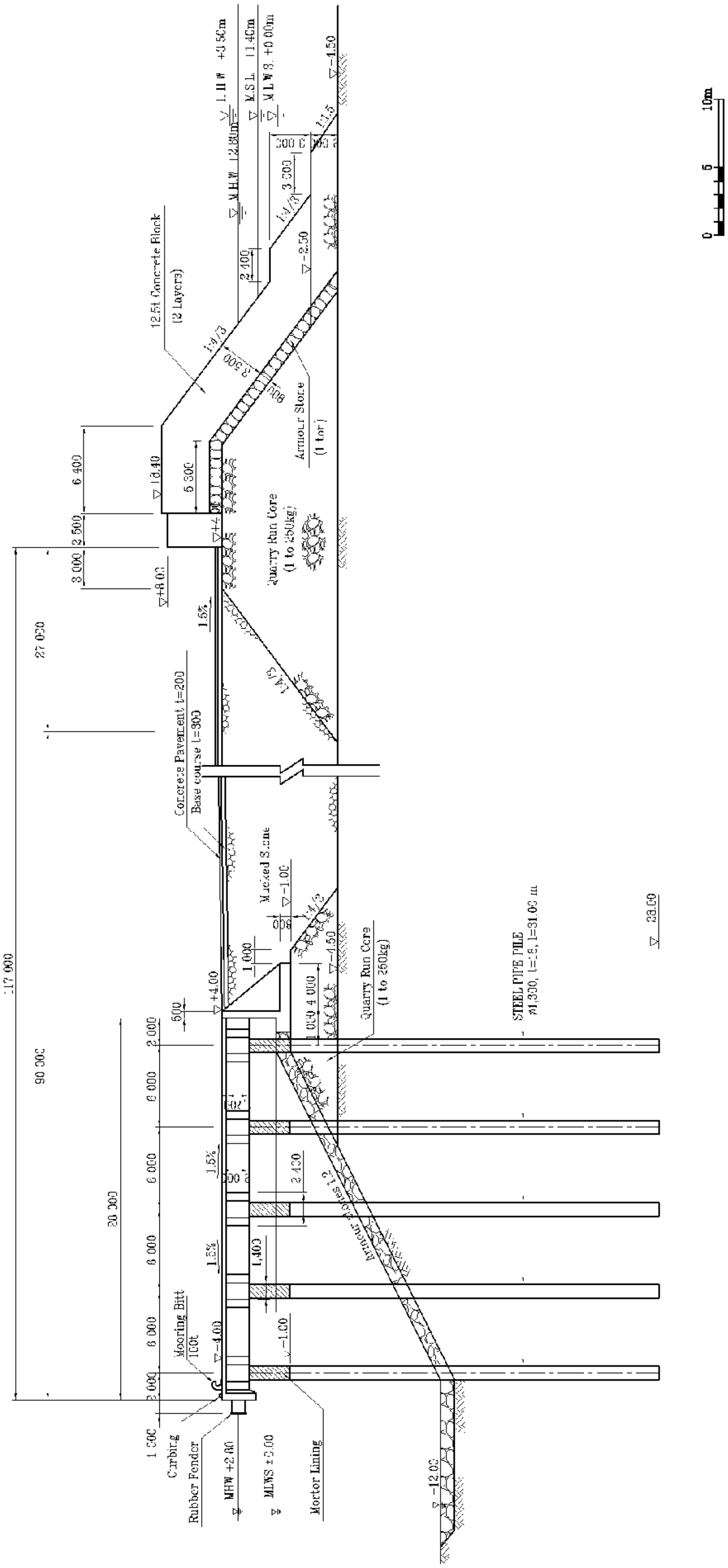


Figure 13.6.6 Typical Section of Multi-purpose Berth

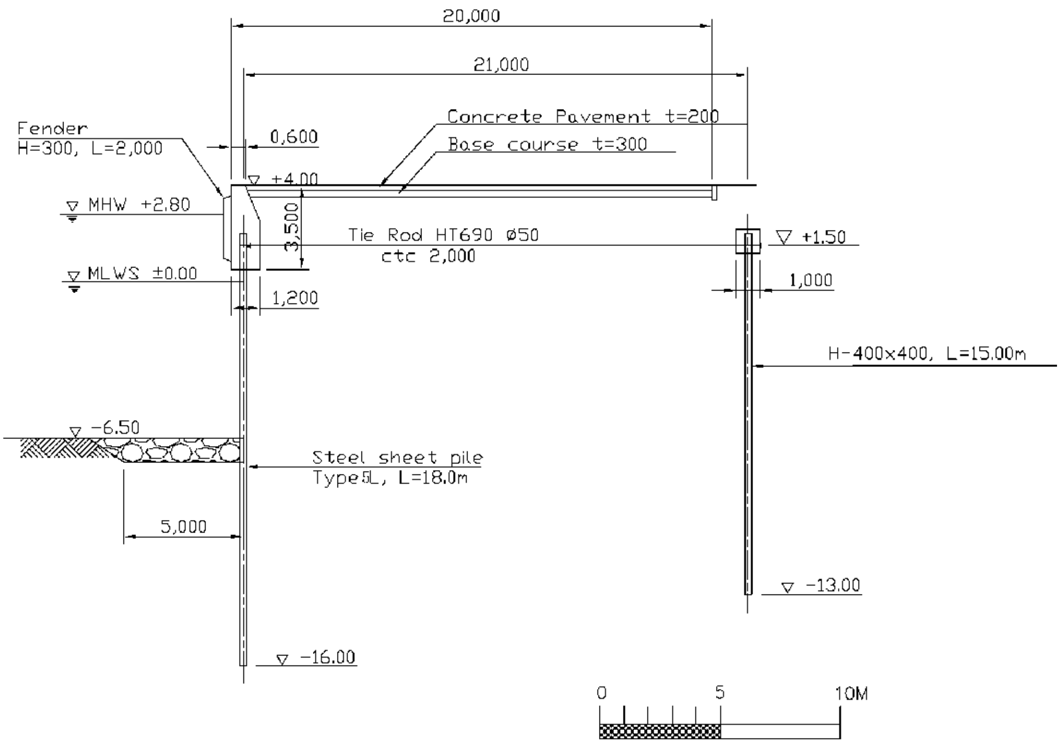


Figure 13.6.7 Typical Section of Reefer Berth

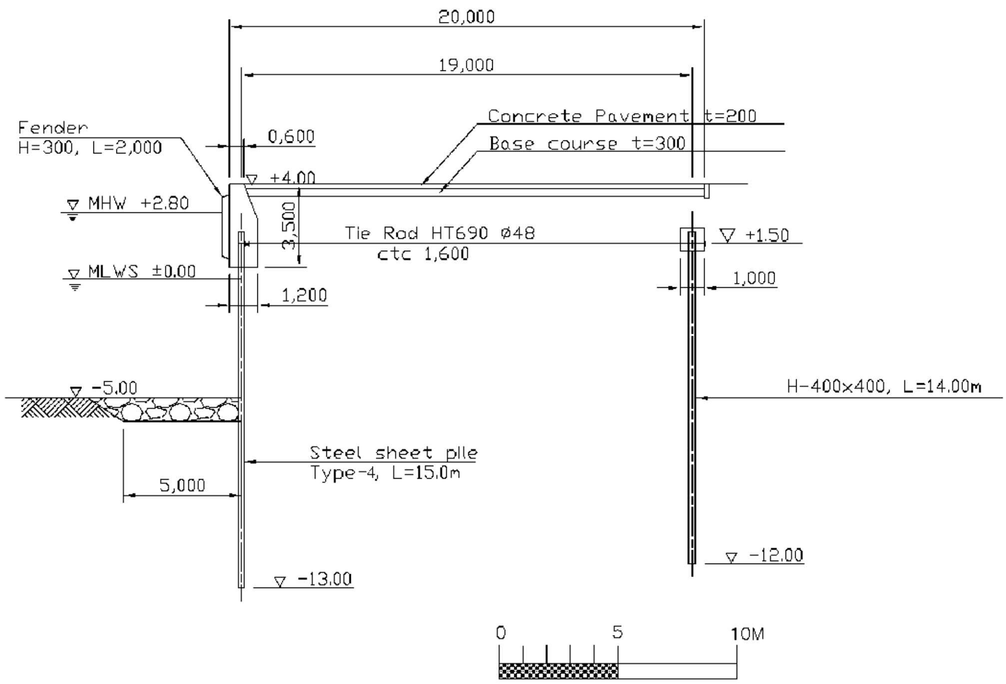


Figure 13.6.8 Typical Section of Tuna Berth

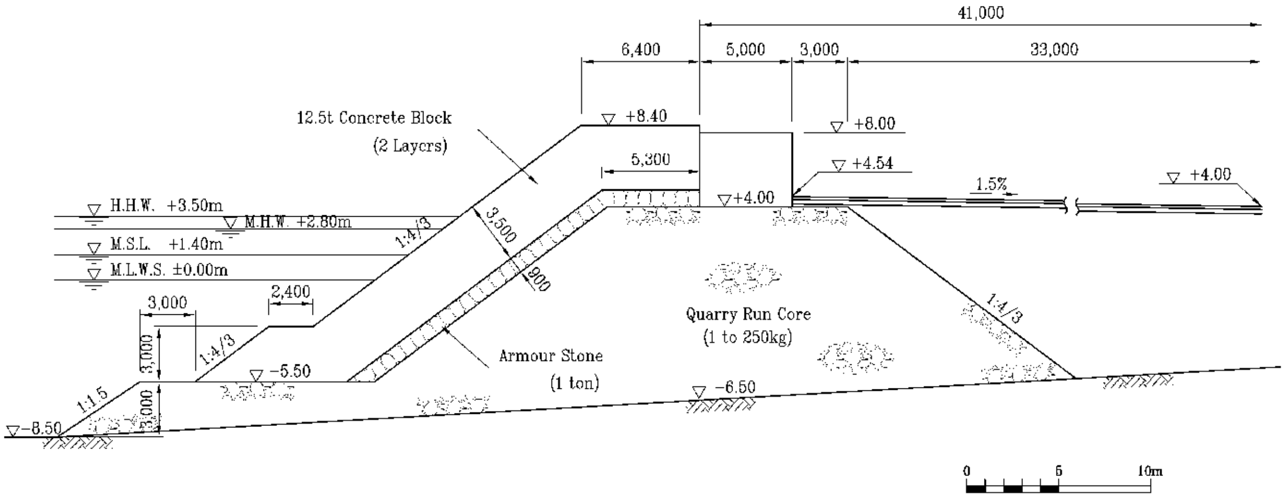


Figure 13.6.9 Typical Section of Breakwater

13.7 Project Implementation

In this section, major construction methods, procurement of construction materials and construction equipment are discussed. The information on the procurement conditions below is based on the market investigations and interviews from the construction companies and suppliers, etc.

13.7.1 Project Site

Puerto Armuelles is located approx. 80 km southwest of David, capital of Chiriqui province, and connected to David by Pan-American Highway, through the Paso Canoas border crossing. The project site is centrally located on the beach of Charco Azul Bay, and sandwiched between two river mouths. The shallow beach is extending approx.400m to the offshore side. There is an existing steel made jetty on the west. It was constructed in1938, damaged by earthquake in September 2002, and is being rehabilitated by AMP now.

13.7.2 Construction Method for the Major Facilities

(1) Berthing Facilities: Steel Pipe Pile supported Shore Bridge (-12m) and Steel Sheet Pile type Quaywall (-6.5, 5.5m)

1) Piling

Steel pipe piles (Dia.1,300, t=16, L=33 m) will be driven by D-80 or an equivalent pile driver for the -12m berth and, also, steel sheet piles (SSP-IV and VL type or equivalent) will be driven by a vibro-hammer for -6.5, -5.5m quay from seaside.

2) Concreting

Total concrete volume is estimated at 60,000 cu.m including breakwater blocks and apron pavement. Ready mixed concrete is available along Pan-American Highway in David.

(2) Dredging Works

The original seabed consisted of sand and medium clay will be dredged by a cutter suction dredger up to -12 m. The capital dredging volume is estimated at 2,057,600 cu.m, based on the most recent bathymetric survey map. The dredged material is to be transported by discharge pipeline and discharged to the clough in the sea, located approx.500 m offshore side. The discharge outlet to be fixed approx. 10m below the sea surface by using of floaters and sinkers, to minimize turbidity on the sea.

(3) Civil Works

1) Breakwater, Revetment

A 230 m length of breakwater, consisting of 10-250 kg/pc size core stone and 12.5 ton/pc of concrete blocks, is to be constructed preventing waves coming from southeast to south direction. Reclaimed shoreline on east boundary is protected by armor stone, 1ton / pc.

2) Groin

A stone mound 180 m groin is to be constructed on west boundary of the new port to protect port basin from siltation.

3) Pavement

Roads in the port area are to be paved with 8 m width by asphalt. Approx. 4,000cu.m of hot mixed asphalt is to be supplied from mixing plants along Pan-American Highway.

(4) Yard / Building

An RC-concrete made, 250 sq.m of the management office is to be constructed.

(5) Utilities

1) Electricity

Required electricity will be supplied to the substation in the port through city line operated by the private company.

2) Water

The city line will be connected to the reservoir in the port by IDAAN, and required water will be supplied to all the port.

(6) Entrance Road

A 100m length of entrance road will be constructed in the bushed land along San Bartolo river.

13.7.3 Purchase of the Materials

(1) Fine Aggregates

River sand is to be supplied in the vicinity of Armuelles.

(2) Stone

1) Coarse Aggregates

Sieved coarse aggregates are to be supplied from quarries located along Pan-American Highway.

2) Armor Stone

Armor stone, 1 ton/pc, will be supplied from Punta de Piedra locating 6km far from the site.

(3) Reclamation Material

Reclamation material is available in the neighboring towns of Armuelles. Approx.435,000 cu.m of reclamation material is to be transported by land. Dredged material consisting of silt and clay cannot be used for reclamation purpose.

(4) Others

1) Steel Pipe Pile, Cement, RC-bar etc.

The majority of construction materials shall be transported from Panama City through David by land.

2) Wood

Wooden artifacts and timber will be purchased at David.

3) Accessories

Mooring devices such as rubber fenders and mooring posts shall be imported or purchased through trade agents in Panama City.

13.7.4 Mobilization of the Construction Equipment

(1) Heavy Equipment

1) Bulldozer, Dump Truck, Roller etc.

Common equipment will be borrowed from David.

2) Mobile Crane

Mobile crane shall be mobilized from Panama City.

(2) Dredger, Piling Barge, Tug Boat and/or Work Boat

The dredger, piling barge with D-80 hammer is to be mobilized from Panama City or neighbor countries.

(3) Transportation of Construction Materials

A large volume of construction materials such as long pipe piles and sheet piles, can be mobilized by chartered barge from Panama City and unloaded at existing Armuelles port.

13.8 Project Costs and Capital Expenditure

13.8.1 Project Costs

(1) Introduction

In this section, the preliminary cost for the master plan was estimated based on the following method.

- For the purpose of estimation of the preliminary cost, unit prices of each element such as major construction materials, equipment and manpower cost are determined on the basis of the regional unit prices collected from contractors and suppliers on December 2003, in the field survey in the study area.
- The basic costs of imported products are estimated using the exchange rate on December 2003.
- The capacity and capability of the local contractors are checked with respect to their experience of marine construction works considering the size of each experience.

(2) Preliminary Cost

Based on the above conditions, preliminary cost for the master plan is estimated as shown in the following table.

Table 13.8.1 Preliminary Cost for Master Plan of Chiriqui Port

Chiriqui						Unit : USD
Item		Dimensions	Unit	Quantity	Unit Rate	Amount
1	Dredging	up to -12m	cu.m	1,938,000	2.0	3,876,000
2	Reclamation	up to +4m	cu.m	449,192	7.0	3,144,344
3	-12m Berth	Multi Purpose Berth	lin.m	250	47,935.2	11,983,804
4	-6.5m Berth	Refer Carrier Berth	lin.m	110	10,480.5	1,152,860
5	-5m Berth	Tuna Boat Berth incl. Approach	lin.m	120	9,558.3	1,146,992
6	Breakwater	South East Side	lin.m	780	29,281.7	22,839,690
7	Groin	West Side	lin.m	360	716.1	257,796
8	Revetment	East Side	lin.m	310	2,926.4	907,184
9	Building	RC-made, Flat Floor	sq.m	250	500.0	125,000
10	Pavement		sq.m	38,790	80.0	3,103,200
11	Fuel Supply	for Fishing Boat	l.sum	1	203,780.0	203,780
12	Outdoor Lighting		unit	95	1,250.0	118,750
13	landscaping		sq.m	32,760	3.0	98,280
14	Utilities	Supply line, Connection to city line	l.sum	1	835,764.0	835,764
Total						**49,793,444**

13.8.2 Capital Expenditure

The capital expenditure schedule assumptions are as follows for economic analysis purpose.

- Start detailed design and select the contractor in 2007.
- Construction in 2008 – 2010 (3 years).
- Life expiring facilities such as utilities, mooring devices and plant are to be renewed in 10th year.

Table 13.8.2 Capital Expenditure Schedule for Master Plan of Chiriqui Port

Chiriqui	USD 49,793,444

YR	Construction		0.97	Plant / Equipment		0.03	Engineering	Maintenance
	Foreign	Local	Sub Total	Foreign	Local	Sub Total	5%	1%
F : L	0.58	0.42	1.00	0.58	0.42	1.00		
2007							995,869	
2008	6,335,916	4,514,635	10,850,551	168,615	120,146	288,761	497,934	
2009	19,048,676	13,573,067	32,621,743	506,934	361,214	868,148	497,934	
2010	2,937,363	2,093,008	5,030,371	78,171	55,700	133,871	497,934	
2011								497,934
2012								497,934
2013								497,934
2014								497,934
2015								497,934
2016								497,934
2017								497,934
2018								497,934
2019				Renewal of Plant/Equipment (each 10years)				497,934
2020				753,720	537,060	1,290,780		497,934
2021								497,934
2021								497,934
2023								497,934
2024								497,934
Sub Total	28,321,955	20,180,710	48,502,665	1,507,439	1,074,121	2,581,560	-	-
Total	51,084,225						2,489,672	-
Grand Total	53,573,897							-

13.9 Administration and Management

13.9.1 Items to be taken into consideration of the planning

(1) Nature of the services of the port facilities

Chiriqui New Port is intended to provide two types of services: the public port services for the import of good for local consumption and the export of the local products, and the port services for tuna boats, i.e. a specific field of private businesses. While the demand for the latter service already exists, the whole view of the demand for the former service is still invisible. The key issue involved in the project is how AMP can incorporate the Master Plan with the port infrastructure development plan that is currently being prepared by public sector.

Since Chiriqui Province lacks of a deep draft port usable throughout a year, the import and export firms in the region have to rely on the land transportation all the way to and from those port in Canal Area or the international ports in Costa Rica with considerable transportation cost. However, due to the geographical and climatic conditions of Chiriqui, the coastal areas are either suffering heavy siltation or exposed to ocean waves in the Pacific Ocean. This makes it technically and then financially difficult to develop a deep draft port, because, a port free of the siltation problems requires breakwaters to ensure the year-round port services.

Thus, the project is intended to integrate the two types of port facilities, i.e., one for public use and the other for a specific use services functions, in order to maximize the benefit of the breakwaters.

(2) Consensus opinion among the stakeholders

The project is beneficial for almost all the industries in Chiriqui and adjacent provinces. The coordination among various ministries is vital for the realization of the project. It is thus important for AMP to make efforts on public relations disseminating the plan and to formulate supporting groups that are composed of the stakeholders who will lobby for the project.

Potential stakeholders are Baru Free Zone Authority (BFZA), Associations of the private firms of agro-industry, logistics and local government.

(3) Support from Petro-terminal of Panama and tuna fishing firms

The PTP has been carrying out a feasibility study of the fishing port for tuna unloading and supply. A fishing company has been contacting with the PTP for the construction of a wharf, and, at the same time, the company is looking for an alternative port in Costa Rica for the home port of their tuna boats. The PTP also has a plan to establish a land bridge service for dry bulk cargoes, which is the employment of the same concept of their current petr-terminal business.

The proposed new Chiriqui port development project is surely beneficial for these companies. Without their proactive participation, the realization of the project would be very difficult. Thus, collaboration with PTP and the timing of the implementation of the project is a vital element of the project.

(4) Development of highway connecting the new port to David,

The existing road directly connecting Puerto Armuelles, the project site, with David, the regional economic center, is in poor condition and need improvement for the faster and heavier road transportation.

13.9.2 Administration and management Plan

(1) Policy and strategy of the project

The scale of Chiriqui New Port Development is relatively large, and it is very necessary to have the project authorized by the government as a national project. To this end, AMP firstly needs to formulate supporting groups. The coordination and the collaboration with various agencies, industries and firms, including, BFZA, PTP and private firms are the first steps toward the realization of the project. This is not an easy and simple task, and a task force should be established in AMP for the preparatory work.

While AMP itself is approaching to MEF, Ministry of Public Works and other agencies for the coordination of this project, it should also make efforts to disseminate the plan to the public with an aim to organize the stakeholders of this project.

(2) Steps to be taken by AMP Head quarters

First of all, AMP should approve the project and then formulate task forces in its Headquarters and field office. The task force in the Headquarters coordinates with the agencies of the central governments for the authorization of the project. The task force should also take responsibility for the public relations, especially the propagation of the project proposal to the Maritime Chamber, in particular the terminal operators and transport logistics industries both based in Panama and in the world. One of the most important roles of the task force is to find private firms who are interested in participating in the business in the new Chiriqui port.

It is quite likely that the new Chiriqui port will be managed by a special port management body that would be jointly established by public and private. Therefore, the task force should make necessary preparation to establish the legal base to formulate such a special port management body.

(3) Steps taken by the field office

Presently, AMP has two local port offices at Pedregal and Puerto Armuelles. Because of the proximity of the location of its office to PTP and BFZA, the Administrator of Puerto Armuelles Port should play a role as the liaison between AMP and these institutions. It is also the responsibility of the Administrator of Puerto Armuelles Port to coordinate with the municipality and the communities, to interface the project with the urban development plan of the Municipality of Puerto Armuelles.

It is also vital to continue public relations with the local industries in whole Chiriqui Province, an additional field office should be established at David.

Administrator of Pedregal Port Office, with the collaboration with the Headquarters and the task force established in David, should start marketing of the new use of the existing Pedregal Port: when the new Chriqui Port start operation, the existing Pedregal Port can be used for other activities. Possible alternative roles of Pedregal Port are marinas for pleasure boats and home port of fishing boats.

13.10 Economic Analysis

13.10.1 Scope of the Economic Analysis

This is the completely new port construction project. As the "without case", Pedregal river port that accommodates up to 2-3,000 DWT is assumed. This is the basis of maritime tariff saving estimation. The facilities that will be constructed and operated by private business under concession are excluded.

13.10.2 Estimation of the Economic Cost

Table 13.10.1 summarizes the economic cost of the new Chiriqui Port Project.

The domestic portion of the construction cost is multiplied by SCF (standard Conversion Factor) in order to estimate the economic cost (i.e., true cost to the society).

Contingencies for the construction cost are estimated at 10 percent level.

Engineering fee is expected at five percent for the construction cost except machine and electric equipment. It should be noted that for other three projects Engineering fees have been assumed to be only 5% of the construction cost, while in other three ports 10% was employed. This is because the scale of the project of Chiriqui Port is fairly lager than others and the ratio of Engineering cost and the total project cost tends to become smaller for large scale projects.

Due to the difficulty of estimating long-term operation and maintenance cost (except for the personnel cost), we adapt the professional judgment of the engineers based on the construction cost.

As for the new Chiriqui port project, the number of the staff is expected to increase in accordance with the growth of the activities of the new port. It has been assumed that one regional coordinator be employed in the initial year of the project with the average salary of AMP staff in 2002 price and that, in accordance with the growth of the activities in the new port, more staff members should be employed for the administration of the port. Thus, the personnel cost is assumed to increase at a rate of three percent per year until 2024.

13.10.3 Estimation of the Benefit

Although there are tremendous expected direct and indirect economic benefits from the project, the following four groups of the economic benefits are considered.

(1) Reduction of land transportation cost of container cargoes

The cost of transporting a container box between Panama City and Chiriqui by truck is USD 650. If the container box will be handled at the new Chiriqui port, the land transportation cost will be reduced because the distance is much shorter while additional costs are required for the transshipment between feeder ships to mother vessels at base ports and non-base port surcharge.

It is estimated that the sum of these additional charges to be USD 200, the cost saving per container will be USD 450.

(2) Reduction of land transportation cost of dry bulk cargoes currently transported overland from Costa Rica

Without New Chiriqui Port, a substantial amount of fertilizer should be transported overland from Caldera Port in Costa Rica to Panama, while, with New Chiriqui Port, the land transportation cost will be deduced because the distance is considerably shortened, especially for the consumers in Chiriqui and Veraguas Provinces. Thus, it was assessed that the cost reduction should be USD 43 per ton.

(3) Reduction of sea transportation cost by the employment of larger vessels in fertilizer import

Because of the draft restriction at Pedregal Port, cargo ships having 2,000 DWT are employed for the importation of fertilizer at the port. With the deep draft wharf of the new Chiriqui Port, fertilizer can be imported by ships as large as 25,000 DWT. The employment of larger dry bulk carriers results in the cost reduction of USD 10 per ton.

In the same manner, those cargo ships having 2,000 DWT currently employed for sugar export can be replaced by ships as large as 6,000 DWT: those ships currently employed for the sugar export are calling both Pedregal and Aguadulce Ports in one voyage and thus the ship size is now restricted by the draft limit at Pedregal Port. The cost reduction attained by the employment of larger shipds for sugar export has been estimated to be USD 4 per ton.

(4) Expenditure by foreign tuna ships

The new Chiriqui Port is intended to provide foreign tuna boats with a sheltered base port where they will be able to be moored for unloading tuna and minor maintenance as well as supply of food and bunker oil. Thus, the tuna boats will stay at the port longer and both the ship owners and crew spend more while the boats stay in the port. Unloading tuna also generate a new business in the port.

The expenditure of tuna boats has been estimated to be USD 7,600 per boat: total expenditure by crew to be USD 6,600 per boat, i.e., 22 crew members x USD 300 per member, and tuna handling to be USD1,000.

Above four groups of the economic benefit are summarized in Table 13.10.2. The largest economic benefit comes from the container handling at the new port. The second largest economic benefit comes from the accommodation of 25000 DWT vessels.

Table 13.10.1 Overall Cost and EIRR of the New Chiriqui Port

USD

Year	Foreign Currency Total (Market Price)	Domestic Currency Total (Market Price)	Domestic Currency Total (Economic Price)	Total Construction Cost	Contingencies	Engineering Fee	Total Capital Investment	Operations & Maintenance (except Personnel)	The Saving of Pedregal Dredging Cost	Personnel Cost	Total O&M Cost	Overall Cost	Overall Benefit	Net Benefit
2005	0	0	0	0	0	0	0	0			0	0	0	0
2006	0	0	0	0	0	0	0	0			0	0	0	0
2007	0	0	0	0	0	995,869	995,869	0			0	995,869	0	(995,869)
2008	11,630,270	8,287,108	7,292,655	18,922,925	1,843,239	497,934	21,264,098	0			0	21,264,098	0	(21,264,098)
2009	8,722,702	6,215,331	5,469,491	14,192,193	1,382,429	497,934	16,072,557	0	0	0	0	16,072,557	0	(16,072,557)
2010	8,722,702	6,215,331	5,469,491	14,192,193	1,382,429	497,934	16,072,557	0	0	0	0	16,072,557	0	(16,072,557)
2011	0	0	0	0	0	0	0	497,934	(259,000)	11,614	250,548	250,548	7,728,000	7,477,452
2012	0	0	0	0	0	0	0	497,934	(259,000)	11,963	250,897	250,897	8,038,000	7,787,103
2013	0	0	0	0	0	0	0	497,934	(259,000)	12,322	251,256	251,256	8,409,333	8,158,077
2014	0	0	0	0	0	0	0	497,934	(259,000)	12,691	251,625	251,625	8,728,333	8,476,708
2015	0	0	0	0	0	0	0	497,934	(259,000)	13,072	252,006	252,006	10,350,667	10,098,660
2016	0	0	0	0	0	0	0	497,934	(259,000)	13,464	252,398	252,398	10,717,667	10,465,268
2017	0	0	0	0	0	0	0	497,934	(259,000)	13,868	252,802	252,802	11,074,667	10,821,864
2018	0	0	0	0	0	0	0	497,934	(259,000)	14,284	253,218	253,218	11,431,667	11,178,448
2019	0	0	0	0	0	0	0	497,934	(259,000)	14,713	253,647	253,647	11,788,667	11,535,019
2020	753,720	537,060	472,613	1,226,333	0	0	1,226,333	497,934	(259,000)	15,154	254,088	1,480,421	12,155,667	10,675,245
2021	0	0	0	0	0	0	0	497,934	(259,000)	15,609	254,543	254,543	12,513,667	12,259,123
2022	0	0	0	0	0	0	0	497,934	(259,000)	16,077	255,011	255,011	12,871,667	12,616,655
2023	0	0	0	0	0	0	0	497,934	(259,000)	16,559	255,493	255,493	13,229,667	12,974,173
2024	0	0	0	0	0	0	0	497,934	(259,000)	17,056	255,990	255,990	13,647,053	13,391,063
2025	0	0	0	0	0	0	0	497,934	(259,000)	17,057	255,991	255,991	13,647,053	13,391,062
2026	0	0	0	0	0	0	0	497,934	(259,000)	17,058	255,992	255,992	13,647,053	13,391,061
2027	0	0	0	0	0	0	0	497,934	(259,000)	17,059	255,993	255,993	13,647,053	13,391,060
2028	0	0	0	0	0	0	0	497,934	(259,000)	17,060	255,994	255,994	13,647,053	13,391,059
2029	0	0	0	0	0	0	0	497,934	(259,000)	17,061	255,995	255,995	13,647,053	13,391,058
2030	753,720	537,060	472,613	1,226,333	0	0	1,226,333	497,934	(259,000)	17,062	255,996	1,482,329	13,647,053	12,164,724
2031	0	0	0	0	0	0	0	497,934	(259,000)	17,063	255,997	255,997	13,647,053	13,391,056
2032	0	0	0	0	0	0	0	497,934	(259,000)	17,064	255,998	255,998	13,647,053	13,391,055
2033	0	0	0	0	0	0	0	497,934	(259,000)	17,065	255,999	255,999	13,647,053	13,391,054
2034	0	0	0	0	0	0	0	497,934	(259,000)	17,066	256,000	256,000	13,647,053	13,391,053
2035	0	0	0	0	0	0	0	497,934	(259,000)	17,067	256,001	256,001	13,647,053	13,391,052
2036	0	0	0	0	0	0	0	497,934	(259,000)	17,068	256,002	256,002	13,647,053	13,391,051
2037	0	0	0	0	0	0	0	497,934	(259,000)	17,069	256,003	256,003	13,647,053	13,391,050
2038	0	0	0	0	0	0	0	497,934	(259,000)	17,070	256,004	256,004	13,647,053	13,391,049
2039	0	0	0	0	0	0	0	497,934	(259,000)	17,071	256,005	256,005	13,647,053	13,391,048
2040	753,720	537,060	472,613	1,226,333	0	0	1,226,333	497,934	(259,000)	17,072	256,006	1,482,339	13,647,053	12,164,714
2041	0	0	0	0	0	0	0	497,934	(259,000)	17,073	256,007	256,007	13,647,053	13,391,046
2042	0	0	0	0	0	0	0	497,934	(259,000)	17,074	256,008	256,008	13,647,053	13,391,045
2043	0	0	0	0	0	0	0	497,934	(259,000)	17,075	256,009	256,009	13,647,053	13,391,044
2044	0	0	0	0	0	0	0	497,934	(259,000)	17,076	256,010	256,010	13,647,053	13,391,043
														EIRR
														15.42%

13.10.4 Economic Internal Rate of Return (EIRR)

As Table 13.10.1 shows the estimate of EIRR for the project is 15.42 percent. The EIRR of 15.4 % falls on the range of 13% - 15%, which are the levels commonly employed to assess an infrastructure project to be economically feasible.

Table 13.10.2 Overall Economic Benefit of New Chiriqui Port Project

Year	Land Transportation of Containers	Additional Cost (per mean size of container)	Benefit from Container Handling	Fertilizer from Costa Rica	Land Transportation Cost (per Ton)	Benefit of Sea Transportation	Fertilizer thru Pedregal	Wheat	Corn	Bananas	Total Volume of Four Goods	Saving of Shipping Cost per	Benefit from Four Goods
unit	TEU	USD	USD	Ton	USD	USD	ton	ton	ton	ton	ton	USD	USD
2005	0	450	0	0	0	0	0	0	0	0	0	10	0
2006	0	450	0	0	0	0	0	0	0	0	0	10	0
2007	0	450	0	0	0	0	0	0	0	0	0	10	0
2008	0	450	0	0	0	0	0	0	0	0	0	10	0
2009	0	450	0	0	43	0	0	0	0	0	0	10	0
2010	0	450	0	0	43	0	0	0	0	0	0	10	0
2011	14,000	450	3,780,000	35,100	43	1,521,000	35,100	35,500	95,700	20,000	166,300	10	1,663,000
2012	14,600	450	3,942,000	36,750	43	1,592,500	36,750	36,200	101,000	20,000	173,950	10	1,739,500
2013	15,400	450	4,158,000	38,500	43	1,668,333	38,500	37,000	106,400	20,000	181,900	10	1,819,000
2014	16,000	450	4,320,000	40,300	43	1,746,333	40,300	37,800	111,700	20,000	189,800	10	1,898,000
2015	17,000	450	4,860,000	42,200	43	2,491,667	42,200	38,500	118,500	20,000	223,500	10	2,235,000
2016	17,800	450	5,103,000	44,200	43	2,524,167	44,200	39,100	125,300	20,000	232,650	10	2,326,500
2017	18,800	450	5,346,000	46,250	43	2,556,667	46,250	39,700	132,200	20,000	240,800	10	2,408,000
2018	19,600	450	5,589,000	48,450	43	2,589,167	48,450	40,300	139,000	20,000	248,950	10	2,489,500
2019	20,600	450	5,832,000	50,700	43	2,621,667	50,700	40,900	145,800	20,000	257,100	10	2,571,000
2020	21,800	450	6,075,000	53,100	43	2,654,167	53,100	41,500	155,400	20,000	266,250	10	2,662,500
2021	23,000	450	6,318,000	56,060	43	2,686,667	56,060	41,800	164,900	20,000	274,500	10	2,745,000
2022	24,200	450	6,561,000	58,200	43	2,719,167	58,200	42,000	174,500	20,000	282,750	10	2,827,500
2023	25,200	450	6,804,000	60,950	43	2,751,667	60,950	42,200	184,000	20,000	291,000	10	2,910,000
2024	26,200	451	7,089,720	63,800	43	2,773,333	63,800	42,400	193,600	20,000	300,000	10	3,000,000

Year	Sugar	Saving of Shipping Cost per Ton	Benefit from Sugar	Tuna Boat	Crews per Boat	Average Consumption	Tuna Handling	Benefit from Tuna Boats	Overall Benefit
unit	ton	USD	USD	Calls	Person	USD	USD	USD	USD
2005	0	4	0	0				0	0
2006	0	4	0	0				0	0
2007	0	4	0	0				0	0
2008	0	4	0	0				0	0
2009	0	4	0	0	0	0	0	0	0
2010	0	4	0	0	0	0	0	0	0
2011	20,000	4	80,000	90	22	300	90,000	684,000	7,728,000
2012	20,000	4	80,000	90	22	300	90,000	684,000	8,038,000
2013	20,000	4	80,000	90	22	300	90,000	684,000	8,409,333
2014	20,000	4	80,000	90	22	300	90,000	684,000	8,728,333
2015	20,000	4	80,000	90	22	300	90,000	684,000	10,350,667
2016	20,000	4	80,000	90	22	300	90,000	684,000	10,717,667
2017	20,000	4	80,000	90	22	300	90,000	684,000	11,074,667
2018	20,000	4	80,000	90	22	300	90,000	684,000	11,431,667
2019	20,000	4	80,000	90	22	300	90,000	684,000	11,788,667
2020	20,000	4	80,000	90	22	300	90,000	684,000	12,155,667
2021	20,000	4	80,000	90	22	300	90,000	684,000	12,513,667
2022	20,000	4	80,000	90	22	300	90,000	684,000	12,871,667
2023	20,000	4	80,000	90	22	300	90,000	684,000	13,229,667
2024	20,000	5	100,000	90	22	300	90,000	684,000	13,647,053

13.11 Initial Environmental Examination (IEE)

The long-term environmental effects consequent to the implementation of the new port development master plan in Chiriqui (Puerto Armuelles) are evaluated on preliminary basis, delineated between social effects and other effects, so as to form the IEE (Initial Environmental Examination). The environmental effects are principally focused on potential adverse long-term effects and their significance and mitigation measures as appropriate. The completed provisional IEE format for screening and checklist for scoping established by JICA is shown in Table 13.11.1 and Table 13.11.2 respectively.

(1) Social Effects

This is the most elaborate port development master plan where an entire new port would be built to handle a variety of cargoes including containers. Accordingly, the required hinterland for the port facility would involve land acquisition and resettlement of population as well as housing compensation requirements. In this respect the affected people are willing to be cooperative provided they are awarded due compensation for their resettlement. Accordingly, it is concluded that potential adverse social effects consequent to the implementation of the overall master plan is manageable and all land and property acquisition works could be accomplished in an amicable manner with the adoption of a reasonable compensation and relocation system.

The beneficial social effects of the master plan include, in addition to the direct employment opportunity linked to an elaborate operational port, indirect employment opportunities related to the eventual economic development of the Chiriqui region as a whole having high agro industrial development potential.

(2) Other Effects

The construction works of the port facility involve a very significant dredging and subsequent dredged material management works. In this respect the dredged material is of clayey soil and it is evaluated as non-contaminated (ref. Section 13.4.1). Still as per its soil property, the dredged material has no significant engineering reuse potential for such use as a reclamation material. Still it has the potential for reuse in regeneration of mangrove vegetation, though such a suitable and economically viable site for its reuse for regeneration of mangrove vegetation at a nearby coastal wetland area is not available. Hence, it is planned to dispose this uncontaminated dredged material in deep seawaters of about 120m deep, located at a distance of about 1km offshore from the planned dredging area for port development. The dredged material disposal management issue, including the beneficial use of dredged material for the regeneration of mangrove vegetation, is dealt with in details under EIA (environmental impact assessment) in Section 17.7 of Chapter 17 (Volume 2).

This dredging and dredged material disposal works would adversely affect the aquatic life, in particular the benthic organisms inhabiting the seabed having very little mobility, in both these areas for a considerable period of time, at least spanning entire period of dredging and dredged material disposal works and also probably beyond this dredging work period. However, in the long-term the aquatic life in the areas, including benthic organisms is expected to recover naturally. Accordingly, any potential adverse effects consequent to this dredging and dredged material disposal works are assessed as only of medium term and have no significant long-term (permanent) adverse effects.

In fact the most significant potential long-term adverse effects consequent to the berthing of ships in calm port sea waters protected with breakwaters, is the potential accumulation of water pollutants in the port waters attributed to ship berthing as well as port terminal operation including cargo handling activities, in particular handling of dry-bulk cargo having high dispersion potential. In order to mitigate potential port water pollution, AMP as the project owner shall undertake a vigilant waste management program for the port. In this respect concerning mitigation of pollution due to ship and vessel berthing, implementation of MARPOL requirements including its Annexes by AMP is emphasized.

Moreover, fish processing work would result in inherent generation of predominantly putrescible organic solid wastes, which also requires due management measures by AMP to mitigate potential coastal water pollution. Still, since this solid waste of fish origin is amenable for processing as animal feed and hence has market potential for reuse, such a reuse program is recommended.

Table 13.11.1 Format for Screening-Chiriqui Master Plan

No.	Environnemental Item	Description	Evaluation*1	Remarks (reasons)
Social Environment				
1.	Resettlement	Resettlement due to an occupancy (transfer of rights of residence/land ownership)	[Y][N][?]	Resettlement would be involved
2.	Economic activities	Loss of bases of economic activities, such as land, and change of economic structure	[Y][N][?]	No significant loss is anticipated
3.	Traffic and public facilities	Impacts on schools, hospitals and present traffic conditions such as the increase of traffic congestion and accidents	[Y][N][?]	Potential iinterference to normal traffic due to construction traffic
4.	Split of community	Community split due to interruption of area traffic	[Y][N][?]	No effect (no split)
5.	Cultural property	Damage to or loss of value of churches, temples, shrines, archaeological remains or other cultural assets	[Y][N][?]	No known treasures, still be verified
6.	Water rights and rights of common	Obstruction of fishing rights, water rights, rights of common	[Y][N][?]	Potential infterfernce to fishing during construction
7.	Public health condition	Degeneration of public health and sanitary conditions due to generation of garbage and the increase of vermin	[Y][N][?]	An issue of construction site management
8.	Waste	Generation of construction wastes, surplus soil and general wastes	[Y][N][?]	From construction site works including dredging works
9.	Hazards (risk)	Increase in danger of landslides, cave-ins, etc.	[Y][N][?]	Construction safety management issue
Natural Environment				
10.	Topography and geology	Changes of valuable topography and geology due to excavation or filling work	[Y][N][?]	No such valuable items
11.	Soil erosion	Topsoil erosion by rainfall after reclamation and deforestation	[Y][N][?]	Surface erosion, a significant construction site management issue
12.	Groundwater	Contamination caused by damage and filtrate water in excavation work and lowering of groundwater table due to overdraft	[Y][N][?]	No effect (no interference to groundwater)
13.	Hydrological situation	Changes of river discharge and riverbed condition due to landfill and drainage inflow	[Y][N][?]	A small diversion work
14.	Coastal zone	Coastal erosion and change of vegetation due to coastal reclamation and coastal changes	[Y][N][?]	A significant constuction site management issue
15.	Fauna and flora	Obstruction of breeding and extinction of species due to changes of habitat conditions	[Y][N][?]	Dredging and dredged material disposal would have affect
16.	Meteorology	Changes of temperature, precipitation, wind, etc. due to large-scale land reclamation and building construction	[Y][N][?]	No effect (Plan is not that large scale)
17.	Landscape	Change of topography and vegetation due to reclamation. Deterioration of aesthetic harmony by structures	[Y][N][?]	Reclamation works is invoved
Pollution				
18.	Air pollution	Pollution cause by exhaust gas or toxic gas from vehicles	[Y][N][?]	Construction vehicles
19.	Water pollution	Pollution cause by inflow of silt, sand and effluent from factories, etc.	[Y][N][?]	Dredging and dredged material disposal works
20.	Soil contamination	Contamination caused by dust and asphalt emulsion	[Y][N][?]	During construction works
21.	Noise and vibration	Noise and vibration generated by vehicles	[Y][N][?]	During construction works
22.	Land subsidence	Deformation of land and land subsidence due to the lowering of groundwater table	[Y][N][?]	No interference to groundwater
23.	Offensive odor	Generation of exhaust gas and offensive odor by facility construction and operations	[Y][N][?]	Construction and fish processing operation works
Overall evaluation: Necessity for implementation of IEE and/or EIA			[Y][N]	Preliminary EIA study is required

*1 Y: Yes
N: No
?: Unknown (To be confirmed)

Table 13.11.2 Checklist for Scoping-Chiriqui Master Plan

No.	Environmental Item	Evaluation	Reasons
Social Environment			
1	Resettlement	C	Land acquisition and resettlement would be involved
2	Economic activities	D	The project will benefit port service industry (D in evaluation means no adverse effect).
3	Traffic and public facilities	C	Potential interference of construction work and traffic with regular traffic
4	Split of community	D	No community split is involved
5	Cultural property	C	Existence of treasures is not expected, but to be verified
6	Water rights and Rights of common	C	Dredging and dredged material disposal works may affect fishing rights
7	Public health condition	C	Construction site worker related public health management
8	Waste	B	Generation of construction including dredging and facility operational waste
9	Hazards (risk)	C	Construction site safety management
Natural Environment			
10	Topography and geology	C	No significant adverse effect is anticipated, still be verified
11	Soil erosion	B	A construction site management issue to be taken care of
12	Groundwater	D	No effect since project is not related to groundwater
13	Hydrological situation	C	Effect due to small river diversion be verified
14	Coastal zone	C	Potential effect to be monitored during facility operation
15	Fauna and flora	C	Medium–term adverse effect during dredging and dredged material disposal work is anticipated
16	Meteorology	C	Project has no effect though meteorology may effect construction works
17	Landscape	C	Plan alters landscape to some extent
Pollution			
18	Air pollution	B	Use of construction machinery, vehicles may cause air pollution
19	Water pollution	B	The construction, dredging and dredged material disposal works are sources of water pollution also proper facility management is required to mitigate operational water pollution
20	Soil contamination	D	No significant soil contamination is anticipated
21	Noise and vibration	B	Construction machinery and vehicles may produce noise and vibration
22	Land subsidence	D	No effect since project has no interference to groundwater
23	Offensive odor	C	Fish processing is a source of potential facility operational offensive odor

Note 1: Evaluation categories:
A: Serious impact is expected
B: Some impact is expected
C: Extent of impact is unknown (Examination is needed. Impacts may become clear as study progresses.).
D: No impact is expected. IEE/EIA is not necessary.
Note 2: The evaluation should be made with reference to the "explanation of item" (Table 4-5)

13.12 Recommendations on Regional Economic Development

During the implementing stage of the project, the participation of private sector should be duly considered. While the public sector is responsible for financing the construction of the basic facilities such as breakwaters, navigation channel with navigation aids, basin and access roads, the construction of wharves and equipment can be financed by private sector.

Above all, the access highway that is directly connecting the port with David City is really necessary. Once the port master plan is completed, AMP should coordinate with the Ministry of Public Works to interface the plan with the highway development plans. Relationship with other development projects like Baru Free Zone, PTP projects should be coordinated, Import/export to Costa Rica should be promoted, the road between Chiriqui Grande and David should be improved, etc. to be described.

With the scale of the project, the development plan of Chiriqui New Port should be approved as a national project. The dissemination of the project to the maritime community and local industries is also very important to invite private participation in the project.

Chiriqui Port is intended to provide more advantageous transport system for the future cargo traffic and to provide better service to current users of Puerto Armuelles and Pedregal Port. The bulk cargo handling service, i.e. fertilizer import and sugar export at Pedregal Port, and supply service for tuna boats are the existing demand, while import of maize and soy beans as well as import and export of containers are the potential demand that have not been realized container currently.

Therefore, the development of the port should be well interfaced with the growth of the traffic demands. The study team keeps working further elaborating the plan including the preparation of the staged development of the port and the feasibility study for a short-term plan.

The results shall be presented in the draft final report.

14. MASTER PLAN OF COQUIRA PORT

14.1 Development Scenario

14.1.1 Basic Development Needs

(1) Closing of Panama Port

Puerto de Panamá, known as the Fiscal Pier, is located on the Bay of Panama. The port consists of a jetty pier with two berthing sides. One of the berthing sides (east side) is 125 m long and the other (west side) is 110 m long.

Table 14.1.1 Port Facilities: Panama Port (Fiscal Pier)

Item	Description
Administrator	AMP
Category	General Cargo Port
Port Area	2,000 m^2
Berth Length	Jetty Pier: 125 m long x 14.5 m wide (East side 125 m, west side 110 m)
Design Depth	0 - 4 m
Cargo Handling Equipment	Ship gear and hoists on the pier
Service Rendered	Navigational aid (beacon and buoys), Radio communications, Fresh water supply and bunkering services
Shed	1,000 m^2 on the pier
Cargo Handling Capacity	17,000 tons/year (estimate by JICA Study Team)

Fiscal Pier is to be demolished by the re-development program of the waterfront area in Plan para el Saneamiento de la Bahía de Panamá, while the current sea transport connecting Darien and the remote islands with Panama City docks at Fiscal Pier. This function has to be secured by construction of a new pier at a proper location (i.e., Coquira) in the near future.

Study Team’s forecast indicates that the cargo volume on the route of Panama Port - Darien exceeds port capacity of the Panama Port (17,000 tons/year) in 2007 - 2008.

To cope with the demolition of the port function of Fiscal Pier and the increase of the handling volume of general cargo and dry bulk cargo at Panama Port, the port function is necessary to secure the transport linking Panama with the Darien province and the remote islands.

(2) Waterway Transportation for Coastal Villages

The coastal villages in the eastern region of Panama Province, which don’t have any paved highway to them, are connected with Coquira by waterway transport through Rio Hondo, Rio Pasiga, Rio Majé. Waterway traffic has the significant importance to this area and the convenience of the waterway traffic to link with the Panama region has to be maintained for the future.

In this chapter, construction of port facilities at Coquira is proposed, in conjunction with the above traffic development.

14.1.2 Development Targets

(1) Short-term Development

The task of the short-term development is to cover the shortfall of the port capacity of Panama Port.

Figure 14.1.1 gives the cargo volume forecast and the cargo handling capacity at Panama Port (Fiscal Pier). The cargo volume is anticipated to exceed the capacity of Fiscal Pier in the 2007 - 2008 period, and the complementary port function is required to cover the shortfall of the capacity of Fiscal Pier.

In order to secure the port function linking the Darien region and the remote islands with the Panama region, construction of a new cargo berth is proposed at Coquira.

After the extension of the Pan-American Highway up to La Palma and Yaviza, the cargo traffic by sea-borne route is expected to decline to the level lower than the current volume (refer to Figure 14.1.1). On a long-term basis, Panama Port (Fiscal Pier) is obliged to close its functions.

The new berth at Coquira will function as the substitute of Panama Port (Fiscal Pier).

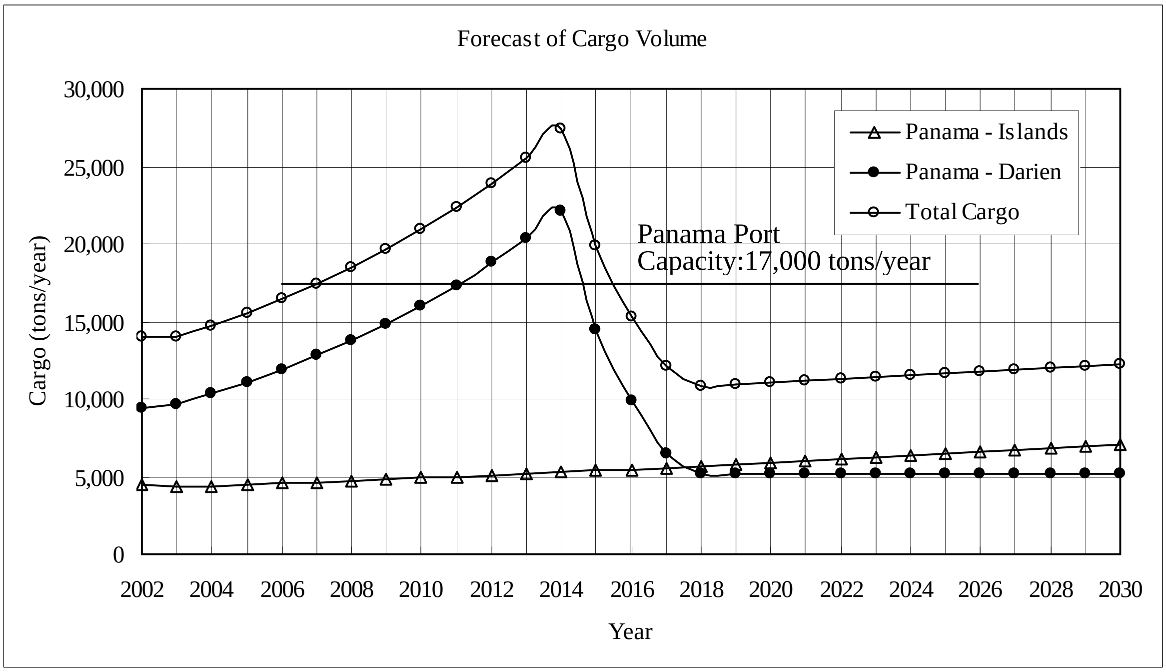


Figure 14.1.1 Forecast Cargo Volume at Panama Port

The function of Panama Port consists not only of cargo handling but also the administration functions of several governmental agencies: namely, CIQ (customs, immigration, quarantine), National Police, AMP and ANAM. Panama Port is an open port to foreign countries.

It is assumed that a part of these administration functions except for CIQ will be relocated to the proposed new site, Coquira Port. Table 14.1.2 gives the short-term development targets of Coquira Port.

Table 14.1.2 Short-term Targets of Coquira Port Development

	Facilities	Responsible Agencies
Port Facility	General Cargo Berth: 30 m x 15 m	AMP / Private
	Shed: 1,000 m^2	
	Yard Road: 2,675 m^2	
	Mooring Buoy x 3	
Building	Administration Building: 300 m^2 (150 m^2 x 2 stories; AMP, National Police, ANAM, SALUD)	AMP
	Workshop: 400 m^2	AMP / Private
Utility	Parking Space (Truck, bus): 800 m^2 Parking Space (equipment): 400 m^2	AMP
	Fuel Tank, water reservoir, power substation	AMP / Private
Equipment	Mobile crane (25-ton) x 1	AMP / Private
	Forklift (3.5-ton, Diesel) x 3	
Land Acquisition	Port area: 8,100 m^2 (90 m x 90 m) Road: 900 m^2 (10 m x 90 m)	AMP
Approach Road	900 m^2 (90 m x 10 m)	AMP

(2) Long-term Development (2024)

In the long-term, the cargo volume handled at Coquira is expected to decline: i.e., most of the cargo transport, especially on the sea-borne route between Panama and Darien, is forecast to shift to the road.

Although further investment to the port facility is not expected based on present trends, there is some possibility that Chepo and Coquira would be developed as the logistics center of the eastern region of Panama Province in line with the development in Darien Province. Hence, the development plan of Coquira Port is designed to secure room for future expansion.

The access road from Chepo, on the Pan-American Highway, to Coquira (about 6 km) is paved, but is presently a narrow and long and winding road. Improvement of the road condition is required in the future.

14.1.3 Benefits by Development

(1) The primary purpose of the port development at Coquira is to complement the capacity of Fiscal Pier (Panama Port) that will become insufficeint in a few years. Congestion and confusion in berth occupancy at Fiscal Pier will be resolved by the development.

(2) It is reasonable to assume that the passenger traffic between the regions of Darien and Panama City will shift to road traffic after the Pan-American Highway is constructed and opened.

(3) The seaborne traffic will continue to provide passenger traffic and logistics among the coastal region of the eastern Panama Province, the archipelago de Las Perlas and the Panama City region. Savings of travel time is anticipated, particularly, in the passenger traffic between Las Perlas and Panama City via Coquira and Chepo.

(4) The present Panama Port is located on the shallow mud flat wetland in Panama Bay and the bed of the harbor basin is about LWS+0 m. When the basin dries up, ship entrance and departure become impossible at low tide. The ships at moorage will ground.

While Rio Bayano on which Coquira Port is located has a riverbed with more than LWS-3 - 5 m depth (refer to Figure 14.1.2), there would be less disadvantages for the relatively small ships of the dimensions of those calling Panama Port (with 1.2 - 1.5 m draught).

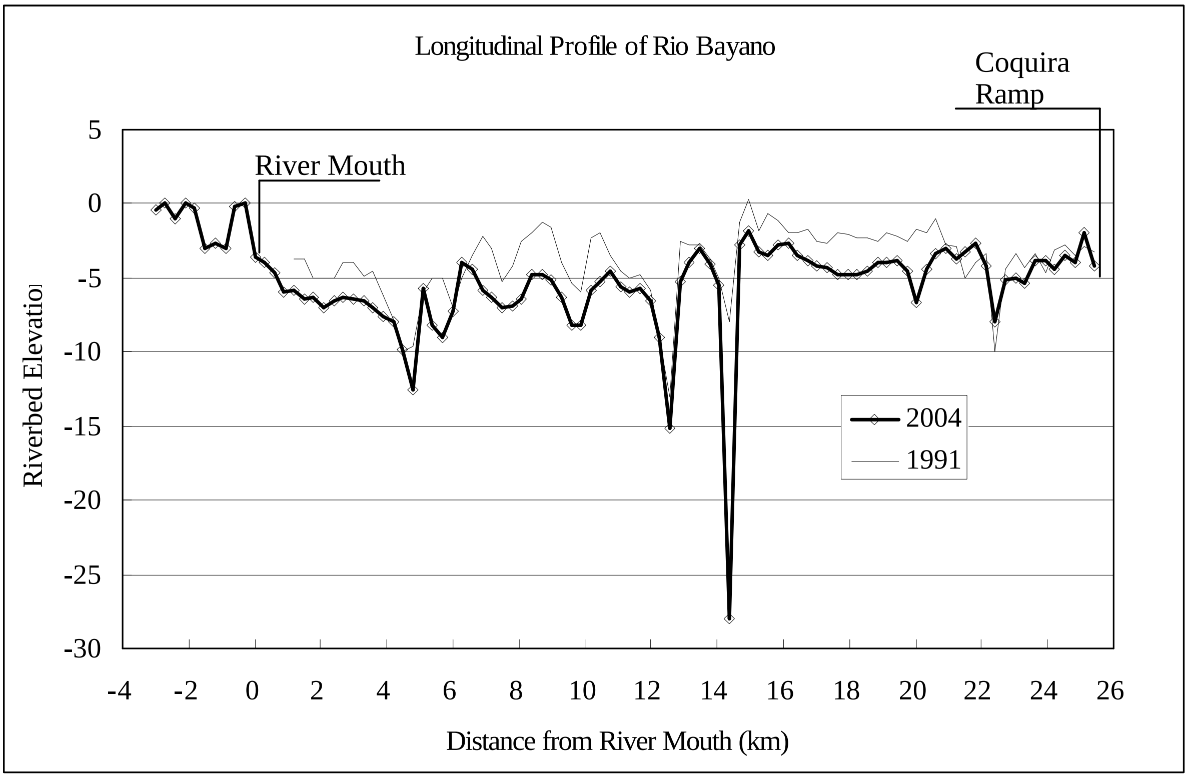


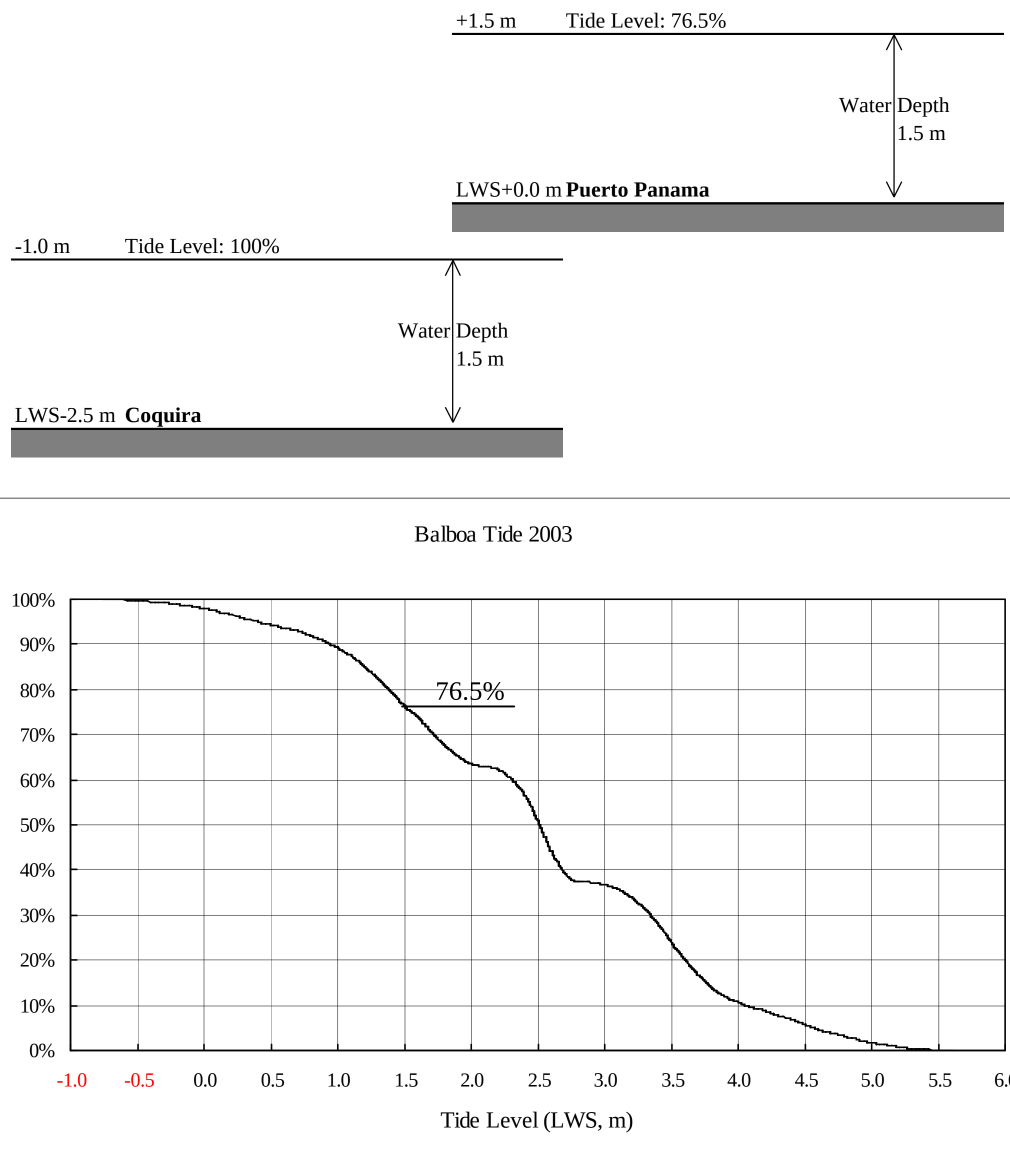
Figure 14.1.2 Longitudinal Profile of Rio Bayano (from River Mouth to Coquira)

(5) The probable relationship between tide level and water depth was studied as follows assuming that the harbor basin at Puerto de Panama is LWS+0 m, at Coquira LWS-2.5 m, and the design water depth to be secured at those harbors is 1.5 m.

The tide level to secure design water depth 1.5 m at Panama Port is LWS+1.5 m, while it is LWS-1.0 m at Coquira Port. The probability of occurrences of those tide levels is evaluated as 76.5 % at Panama and 100 % at Coquira based on the Exceeding Probability of the Balboa

Tide (the probability of occurrence of tide level that exceeds a certain tide level; refer to Figure 14.1.3, prepared from the Balboa Tide Table 2003).

That is to say, at Panama Port, ships will become aground with 23.5 % probability, while at Coquira, ship entrance and departure are 100 % possible even at low tide. The benefits of the seaborne transport on schedule and shipping operation not depending on the tide level are secured by the port development at Coquira to substitute the functions of Fiscal Pier.



Source: JICA Study Team

Figure 14.1.3 Exceedence Probability of Balboa Tide

14.2 Traffic Demand

14.2.1 Cargo Traffic

Cargo traffic volume at Panama Port is summarized in Table 14.2.1 based on the port statistics in the recent years and according to the origins and destinations of the remote islands in Panama Province or the villages in Darien Province.

Table 14.2.1 Cargo Traffic Record at Panama Port by Origin/Destination

(1) Remote Islands in Panama Bay (Unit in ton/year)

	Loading at Panama Port				Unloading at Panama Port			
Year	**1998**	**2000**	**2001**	**2002**	**1998**	**2000**	**2001**	**2002**
Contadora	2,367	2,309	1,718	1,858	161	254	235	438
San Miguel	679	584	744	562	173	93	142	271
La Esmeralda	-	-	108	314	-	-	13	94
La Guinea	-	-	138	117	-	-	14	28
Pedro Gonzalez	-	-	165	222	-	-	14	7
Saboga	-	18	34	-	-	1	21	-
Taboga	24	145	324	616	6	74	25	1
Taboguilla	-	46	-	-	-	-	-	-
Total	**3,070**	**3,102**	**3,231**	**3,689**	**340**	**422**	**464**	**839**

(2) Darien Province and Panama Province (Unit in ton/year)

	Loading at Panama Port				Unloading at Panama Port			
Year	**1998**	**2000**	**2001**	**2002**	**1998**	**2000**	**2001**	**2002**
La Palma	1,134	432	107	1,334	604	284	88	581
El Real	-	-	-	76	199	-	77	46
Yaviza	271	1,181	632	667	112	767	303	536
Camoganti	116	79	10	-	38	15	4	-
Sub-total	**1,521**	**1,692**	**749**	**2,077**	**953**	**1,066**	**472**	**1,163**
Garachine	44	-	779	1,634	38	-	162	1,059
Sambu	1,280	2,270	1,091	183	764	1,155	449	54
Jaque	1,034	1,489	1,484	2,151	634	904	564	1,041
Puerto Piña	-	65	15	14	-	80	21	17
Chiman	24	43	-	26	36	54	-	11
Sub-total	**2,338**	**3,867**	**3,369**	**4,008**	**1,472**	**2,193**	**1,196**	**2,182**
Total	**3,859**	**5,559**	**4,118**	**6,085**	**2,425**	**3,259**	**1,668**	**3,345**

Source: Port Statistics, AMP

The following assumptions are given to forecast the cargo traffic to be handled at Panama Port (and Coquira Port in the future).

(1) Volume of the loading cargo from Panama Port to the remote islands in Panama Province is to increase in proportion to the population of the objective region. The annual growth rate is given as 1.83 %, the population growth rate of Panama Province (2003 - 2025; Source: Direccion de Estadistica y Censo, Contraloria General de la Republica)

(2) The items of the unloading cargo from the remote islands to Panama Port are mainly empty bottles, empty cylinders of fuel gas and empty containers of some consumer goods. The volume is estimated giving the uniform rate (15 %; average in 1998 - 2002) of the volume of the loading cargo.

(3) Volume of the loading cargo from Panama Port to the villages in Darien Province is to increase in proportion to the population growth and the economic development of the objective region. The annual growth rate is given as 10 % here, the average growth rate of the unloading cargo in 1998 - 2002 (refer to Table 14.2.1 (2) Total).

(4) The items of the unloading cargo from the Darien villages to Panama Port are the local agro-products, marine products and empty bottles of the consumer goods, and their yearly changes seem erratic. The volume is estimated giving the uniform volume as 3,000 ton/year (average in 1998 - 2002) from the above table.

(5) It is expected that the cargo and passenger traffic will shift to the road transportation following the pavement extension of Pan-American Highway to Darien Province, and the cargo volume from/to Panama Port to/from Darien will decline gradually. The year when the growing trend shift to the declining trend is assumed as 2014, 10 years from now.

(6) However, the regions such as Garachine, Sambu, Jaque, Puerto Pina in Darien Province and Chiman in Panama Province (refer to the location map; Figure 14.2.1) will not receive the direct benefit of the extension of Pan-American Highway immediately. Hence, the sea-borne traffic between Panama Port and those regions will survive. The cargo volume is estimated giving the uniform volume as loading: 3,400 ton/year, and unloading: 1,800 ton/year on the average in 1998 - 2002 (refer to Table 14.2.1 (2) Sub-total).

The cargo traffic forecast at Panama Port based on the above-mentioned development scenario and the assumptions is given in Table 14.2.2 (refer to Figure 14.1.1 also).

Figure 14.2.1 Location Map of Darien Villages

Table 14.2.2 Cargo Traffic Forecast at Panama Port by Origin/Destination

Year	**Panama** Port from/to **Islands**				**Panama** Port from/to **Darien**				Total
	Loading	Unloading	Sub-Total		Loading	Unloading	Sub-Total		
2002	3,689	839	4,528		6,085	3,345	9,430		13,958
2003	3,757	563	4,320		6,694	3,000	9,694		14,013
2004	3,825	574	4,399		7,363	3,000	10,363		14,762
2005	3,895	584	4,480		8,099	3,000	11,099		15,579
2006	3,967	595	4,562		8,909	3,000	11,909		16,471
2007	4,039	606	4,645		9,800	3,000	12,800		17,445
2008	4,113	617	4,730		10,780	3,000	13,780		18,510
2009	4,188	628	4,817		11,858	3,000	14,858		19,675
2010	4,265	640	4,905		13,044	3,000	16,044		20,948
2011	4,343	651	4,994		14,348	3,000	17,348		22,343
2012	4,422	663	5,086		15,783	3,000	18,783		23,869
2013	4,503	676	5,179		17,361	3,000	20,361		25,540
2014	4,586	688	5,274		19,097	3,000	22,097		27,371
2015	4,670	700	5,370		11,458	3,000	14,458		19,829
2016	4,755	713	5,468		6,875	3,000	9,875		15,344
2017	4,842	726	5,569		4,125	2,400	6,525		12,094
2018	4,931	740	5,670		3,400	1,800	5,200		10,870
2019	5,021	753	5,774		3,400	1,800	5,200		10,974
2020	5,113	767	5,880		3,400	1,800	5,200		11,080
2021	5,207	781	5,988		3,400	1,800	5,200		11,188
2022	5,302	795	6,097		3,400	1,800	5,200		11,297
2023	5,399	810	6,209		3,400	1,800	5,200		11,409
2024	5,498	825	6,322		3,400	1,800	5,200		11,522
2025	5,598	840	6,438		3,400	1,800	5,200		11,638
2026	5,701	855	6,556		3,400	1,800	5,200		11,756
2027	5,805	871	6,676		3,400	1,800	5,200		11,876
2028	5,911	887	6,798		3,400	1,800	5,200		11,998
2029	6,019	903	6,922		3,400	1,800	5,200		12,122
2030	6,130	919	7,049		3,400	1,800	5,200		12,249

14.2.2 Analysis of Ship Calls

According to the actual records of port calls at Puerto Panama, most of the cargos between Panama and the Darien ports and between Panama and the islands can be considered carried by the following 10 ships (refer to Table 14.2.3).

The average port calls effective in the cargo transportation between Panama Port - Darien and Islands are estimated as follows.

Average Net Tons of the ships: 55 tons; where the average carrying volume per ship is assumed 35 tons/ship (about 60 % of their net ton)
Total cargo volume per year: 12,595 tons/year
Average port calls per ship: (209 + 186)/10 = 39.5 calls/ship/year
Average frequency of calls: 310 days/(39.5 calls/ship) = 7.8 days/ship
10 (ships) x 39.5 (calls/ship/year)/310 (days/year) = 1.2 calls/day

Actually, the ships are plying between Puerto Panama - Darien and the islands at about 8 - 10 days intervals and above analysis correspond to the actual ship operations.

Table 14.2.3 Cargo Ships plying between Panama Port - Darien and Islands

	Ship Name	Destination	GRT	Net Ton	LOA (m)	Calls at Panama	Cargo (tons) year 2000
	to **Darien**						
1	Don Jaime III	Yavisa	52.30	27.04		28	805.3
2	Doña Flor	Jaque, La Palma	73.91	59.12	19.78	20	1,039.3
3	El Amparo	Jaque, Yavisa	110.75	47.05		47	2,219.3
4	Elizabeth Herminia	Sambu, La Palma	90.67	72.53	19.65	38	2,907.3
5	En Voz Confio	Jaque, Yaviza	64.80	51.84		29	652.7
6	Gran Abel	Sambu, Yaviza	93.33	-		33	1,868.5
7	Mi Juanita	Yaviza, Jaque	73.91	-		14	522.9
			Average 80.0	51.6		Subtotal 209	Sub-total **8,954**
	to **Islands**						
8	Albatros	San Miguel				34	518.0
9	Covadonga	Contadora	46.80	-	24.4	81	2,337.0
2	Doña Flor	Contadora	73.91	-	19.78	1	93.9
3	El Amparo	San Miguel	110.75	47.05		3	27.6
4	Elizabeth Herminia	Taboga, Ensenada	90.67	72.53	19.65	2	106.5
10	El Manguito	San Miguel	14.91	-		49	23.7
	Gran Abel	Taboga	93.33	-		2	128.3
7	Mi Juanita	San Miguel, Contadora, Taboga	73.91	-		10	335.3
	Punta Cocos	Taboguilla	15.05			1	45.8
	Ritin	Contadora	61.53			3	25.0
			Average 29.8	59.8		Subtotal 186	Sub-total **3,641**
	General Cargo					**Total**	**12,595**
	Diesel Oil	Loading at Panama					1,028
	Marine Products	Unloading at Panama					1,962
	Total Cargo Traffic (2000) at Puerto Panama						**15,585**

Source: JICA Study Team based on Port Statistics by AMP

It should be noted that these cargo ships also provide services as cargo-passenger type of on the sea-routes between Puerto Panama - Darien and the remote islands. Passengers of these cargo-passenger ships come onboard with their over handful of cabin baggage and carry back the packages of goods. Those cargo traffic records do not emerge in the port statistics. These understanding are taken into account to the facility planning at Coquira.

14.3 Natural Conditions

This section describes natural conditions about Coquira Port, focusing topographic and bathymetric conditions, oceanographic conditions and subsoil conditions for the master plan study.

14.3.1 Topographic and Bathymetric Conditions

Topographic and bathymetric surveys were conducted in order to get detail current information, more than existing maps and/or charts around existing ports on the following conditions: that Datum elevation was referenced to the MLWS based on tide observation related to the Port of Balboa, the geographic coordinates used Mercator's Universal System (UTM), grid zone No.17 and the spheroid was based on Clark 1866 on the survey maps.

Coquira Port : The results of topographic and bathymetric surveys are shown in Figures 14.3.1 (1) to 14.3.1 (5). Two benchmarks indicated in the figures were established as shown below.

BM Description	Coordinates		Elevation	
	E	N	Datum	(m)
1	713,036.32	1,009,220.51	MLWS	8.31
2	712,999.57	1,009,204.55		7.41

The landside around existing Coquira Port is flat without woods close by and there are some concession areas operated by private companies.

The public dock is used in common for passenger service, small fishing boats and the loading/unloading of the necessities for the locals. Therefore, there is a passenger terminal, small stores, gas station and restaurants on the paved area. The land area is possible to expand or develop on the downstream side of the Chepo river, although there are some issue in connection with ownership of privatization or of public management.

14.3.2 Hydraulic Conditions

Generally hydraulic conditions on Coquira Port are summarized in Table 14.3.1. The information is referenced from the existing publication[6], design and survey reports or drawings conducted by AMP.

At this river port, there are no permanent tide observation spots and authorized tide relation, although predicted tide data on Reo Chepo, Isla Chepillo by harmonic analysis only refer to the port. The port is located in the area 25 km from the river mouth, so the actual water level fluctuation may affect not only tidal range but also river flux.

[6] International Marine, Tide Tables 2003 West Coast of North and South America, McGraw Hill Press, 2002
US Defence Mapping Agency & Admiralty, UK, Chart

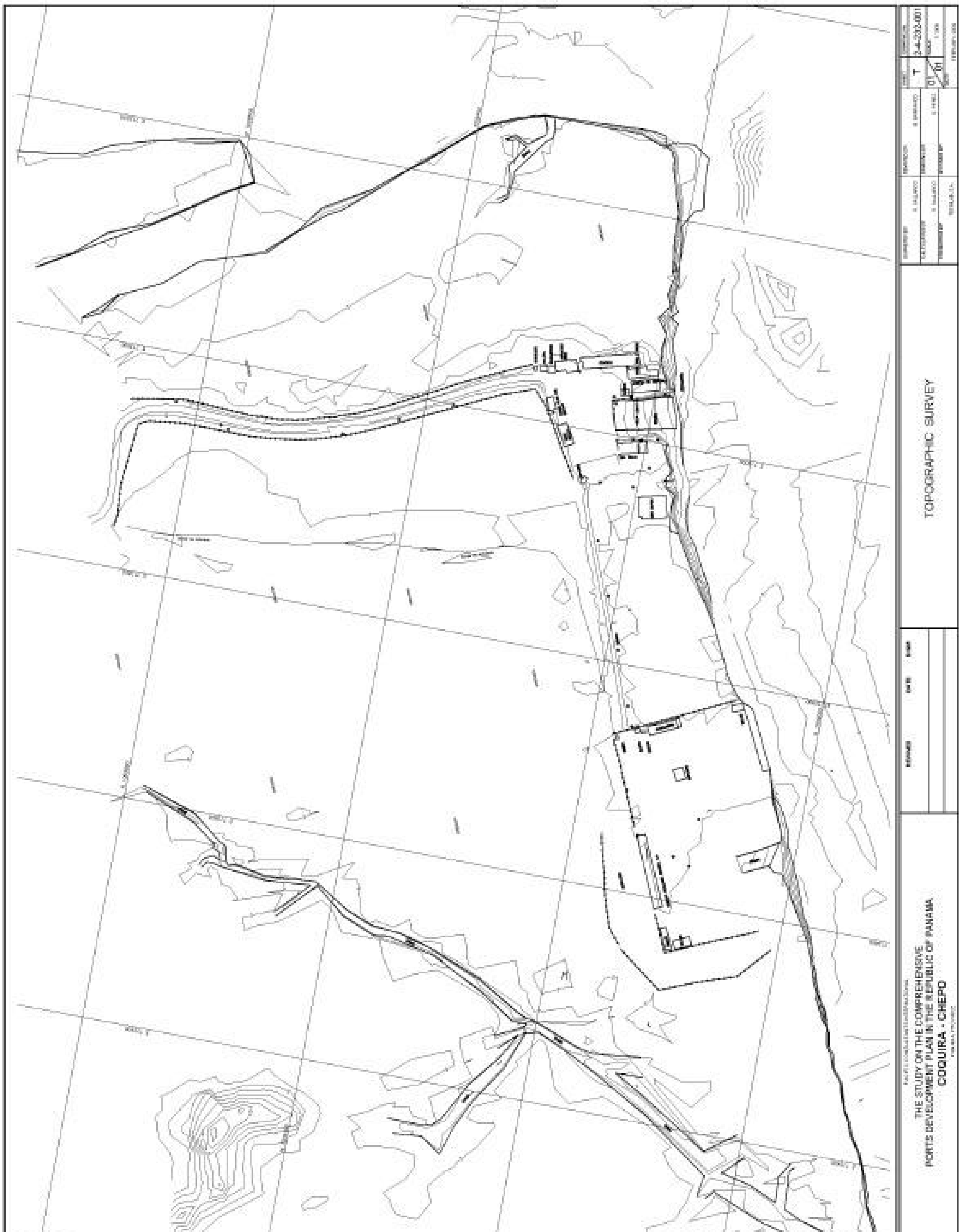


Figure 14.3.1 (1) Survey Map at Coquira Port

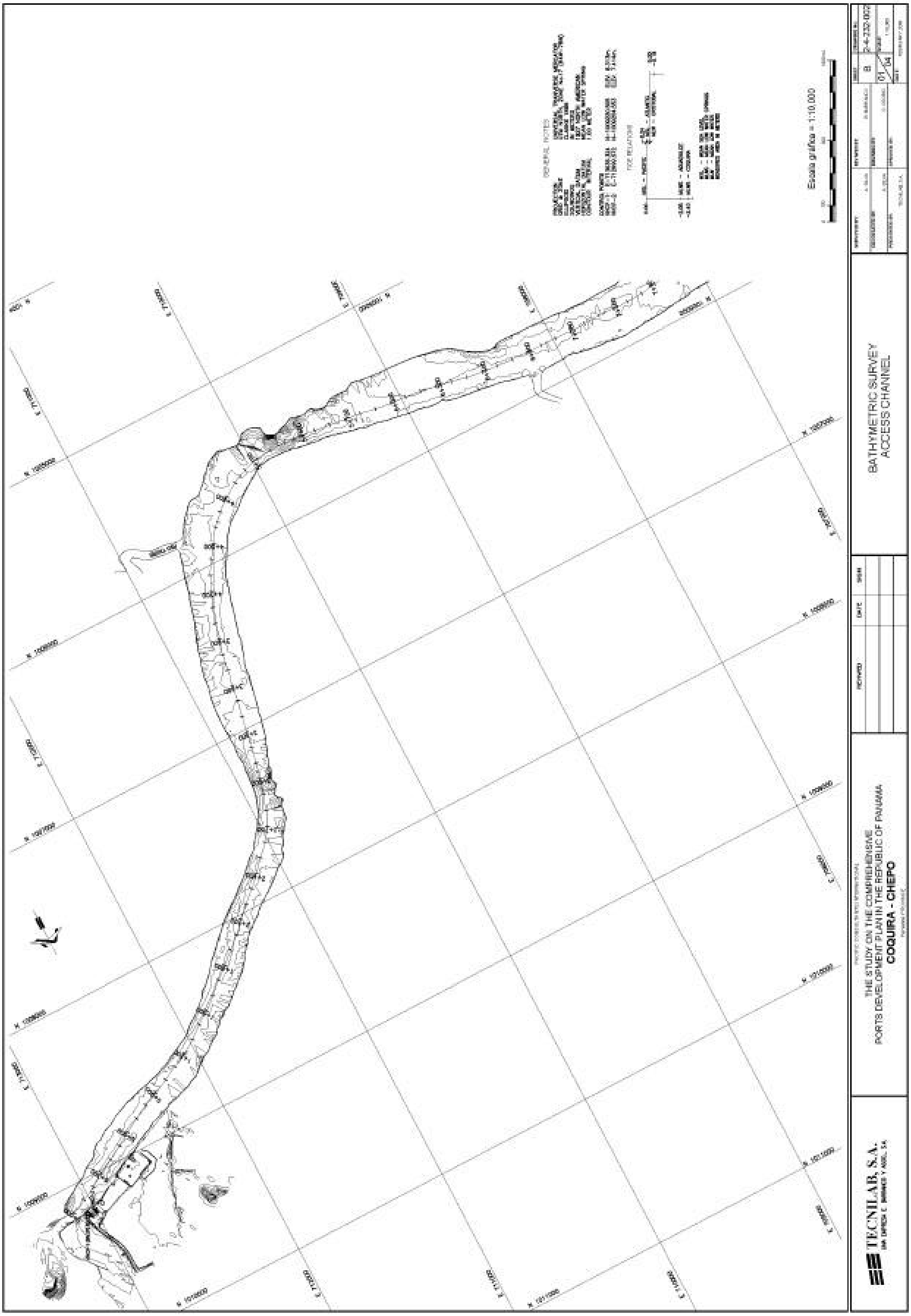


Figure 14.3.1 (2) Survey Map at Coquira Port

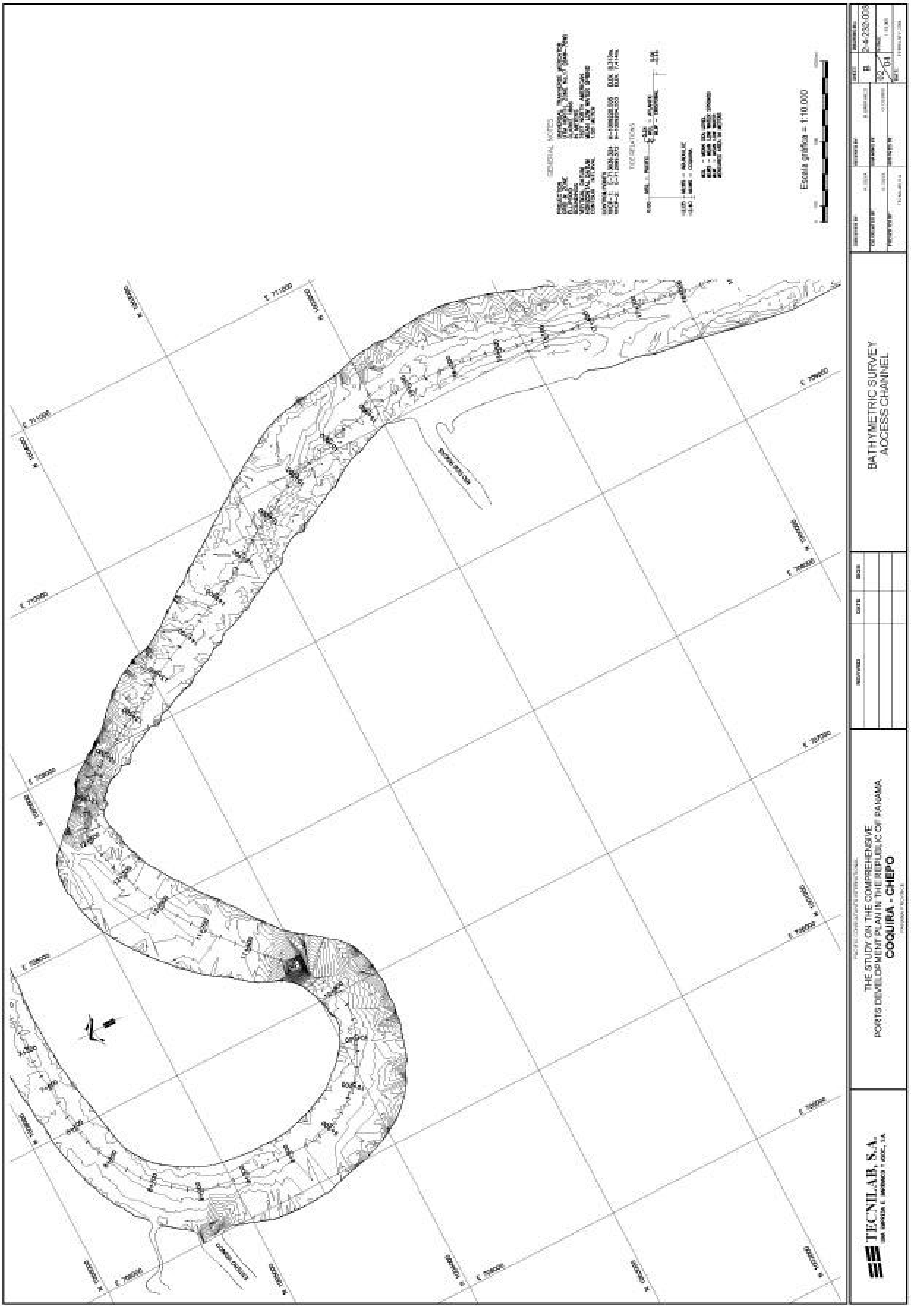


Figure 14.3.1 (3) Survey Map at Coquira Port

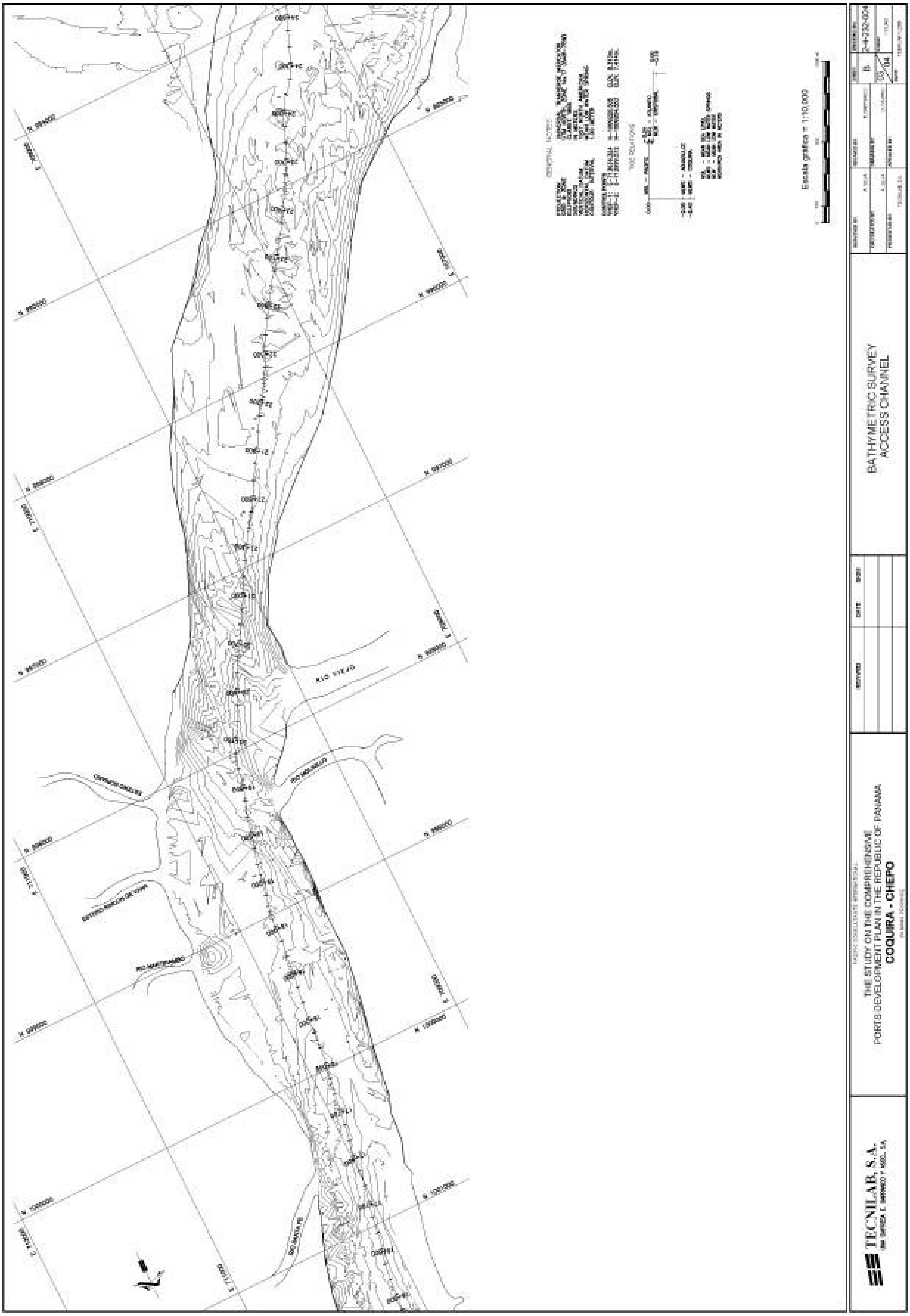


Figure 14.3.1 (4) Survey Map at Coquira Port

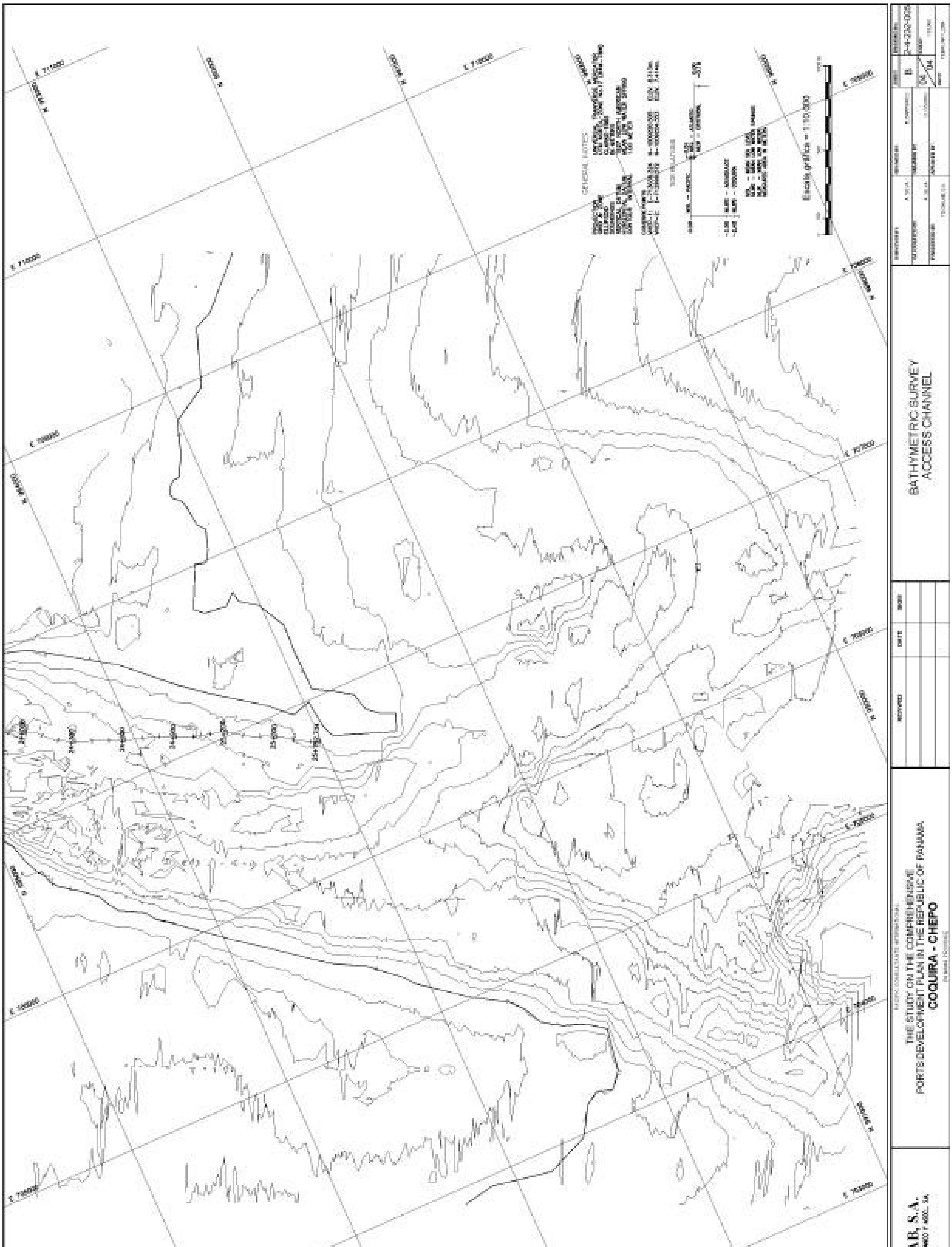


Figure 14.3.1 (5) Survey Map at Coquira Port

Table 14.3.1 Summary of Hydraulic Conditions

Name of Port	Tide							Current (m/sec)	Waves (Annual Max.)		Referred Nearest TidePoint
	Ref. Port	Difference from Reference Port				Tidal Range (m)	MLWS		Height	Period	
		Time (HH:MM)		Height (m)			from MSL (Pacific)		$H_{1/3}$ (m)	T (sec)	
		HWL	LWL	HWL	LWL						
Coquira Port	Balboa	-0:01	-0:02	-0.03	0.00	< 6.4*	-2.40	< 0.5*	-	-	Reo Chepo

Note
1) Tide information to each port in the list is referred from nearest reference place authorized in official publication.
2) Difference such as time and height for HWL and LWLshould be added or multiplied with correspnded level of referred nearest point.
3) Asterisked values of current and waves mean figure by interview and chart.

However, the following correction coefficients with the tide of Balboa Port shown in the table are extracted as reference information. Tidal Range is less than 6.4 m, and bigger than Chriqui Port even same Pacific Ocean. Experimentally the MLWS on these ports seems to define -2.40 m from the MSL on the Pacific Ocean officially established in using the tide data observed on Balboa Port, based on temporary tide observation or tide study.

Around the port area, it is observed that erosion along bank may be advanced by ship generated waves. Protected by Isla del Rey, the waves on the entrance of the river mouth is probably calm and small.

River current of the area around port seems to be maximum 0.5 m/sec at best.

14.3.3 Subsoil Conditions

Soil investigations were conducted in order to get detail information for the target points around existing port.

Coquira Port : Figure 14.3.2 shows borehole locations. Subsoil profiles along representative section were assumed based on the boring logs and SPT-N values as presented in Figure 14.3.3.

This site is located on Las Lajas Formation, composed of alluvions, consolidated sediments, sandstone, corals, conglomerates, carbonaceous shale, and delta depositions.

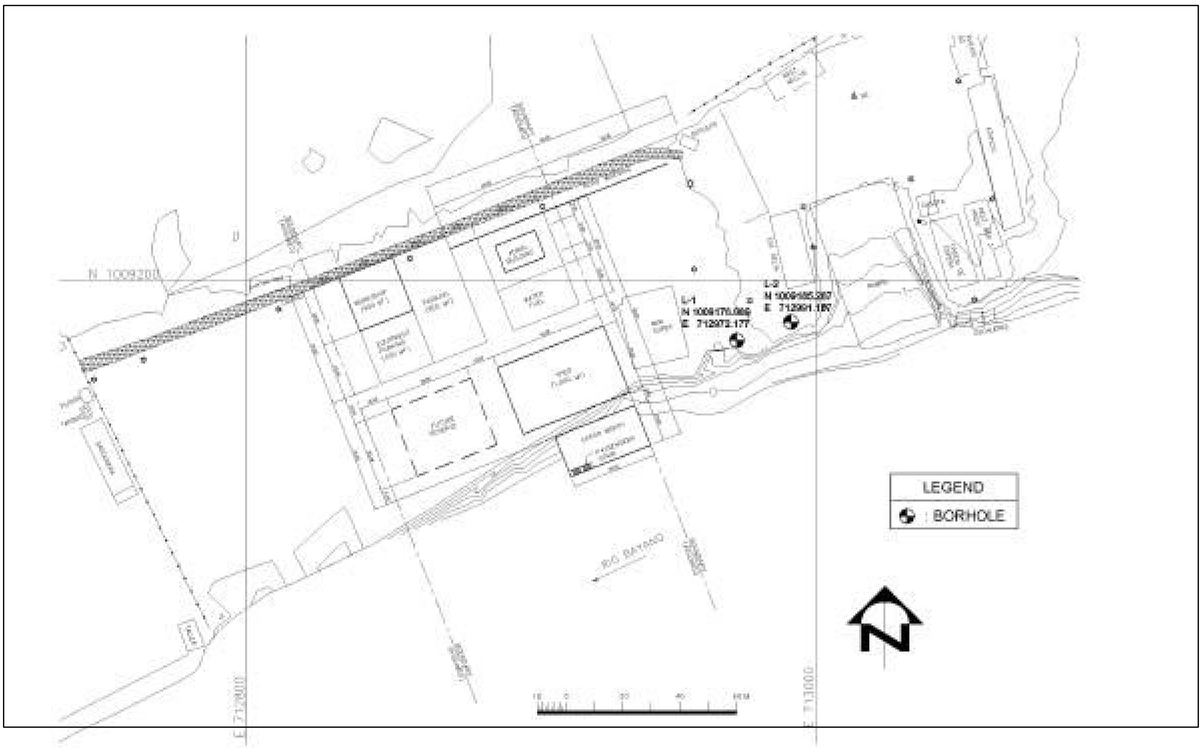


Figure 14.3.2 Location Map of Soil Investigations

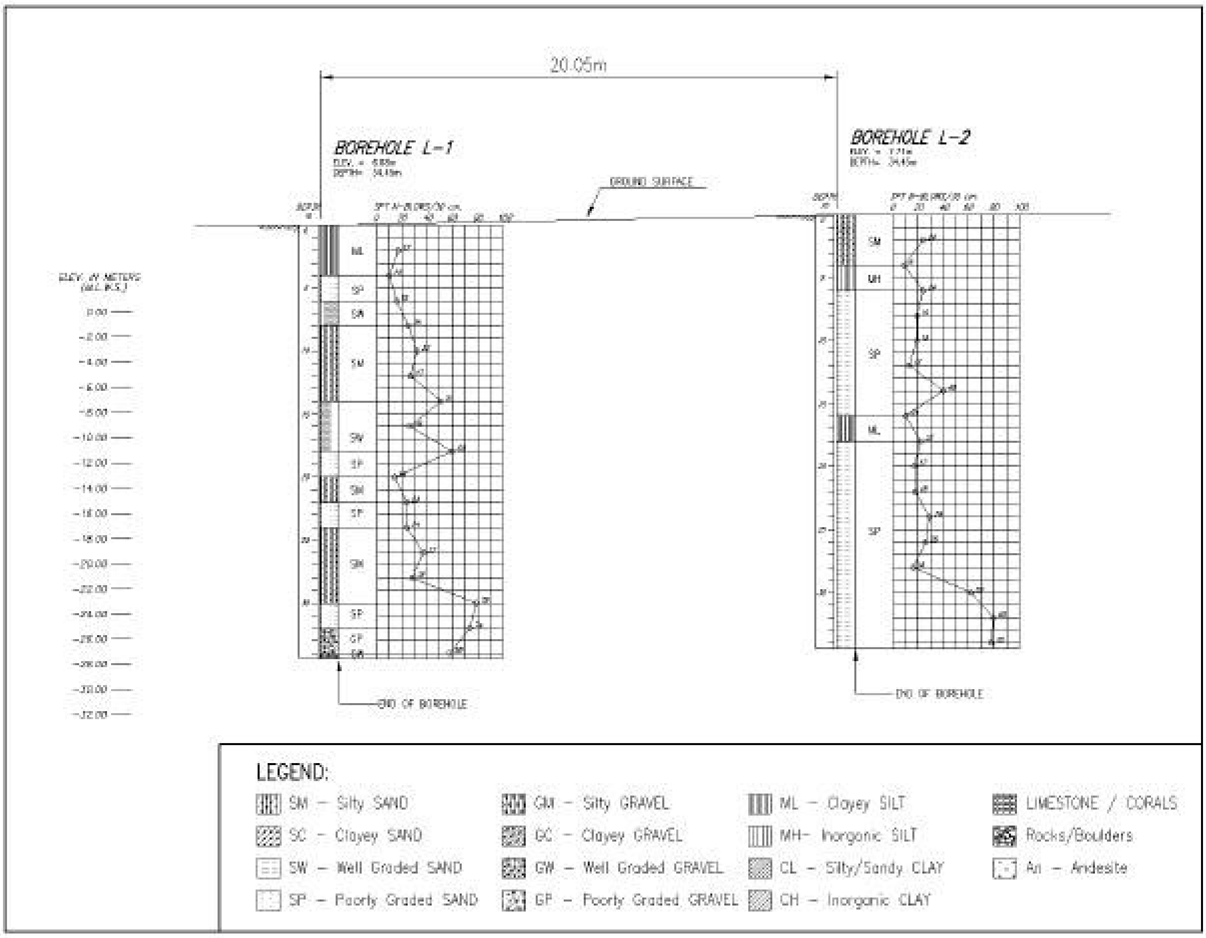
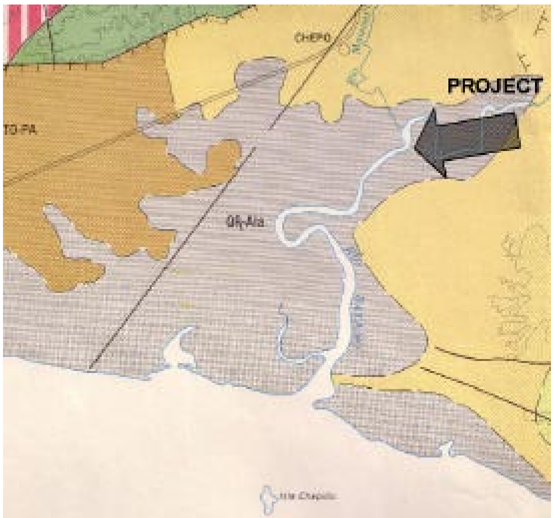


Figure 14.3.3 Boring Logs at Coquira Port

Boreholes L-1 and L-2: The first strata is a fill, consisting of Inorganic Silt (MH) yellow color (L-1), and Silty Sand (SM) brown color (L-2), with sandstone fragments, very consistent consistency, low plasticity, medium natural water content, the depth in both is 4.0 meters. The next stratas consist of Inorganic Silt (MH), consistent consistency and medium plasticity. Poorly Graded Sand (SP) with some igneous rock fragment in L-1 and feldspar, quartz and basalt fragments in L-2,



Poorly Graded Sand (SP) with some igneous rock fragment in L-1 and feldspar, quartz and basalt fragments in L-2, loose to very dense compactness varies with the depth. Poorly Graded Silty Sand (SM) in L-1, firm to very dense compactness, non plastic. Well Graded Sand (SW), very firm to dense compactness, non plastic in L-1. Well Graded Gravel (GW) with igneous rock fragments, very dense compactness. Poorly Graded Gravel (GP) with igneous rock fragments, is very dense compactness; both in L-1.

14.4 Environmental Condition

14.4.1 Water Environment

The water environmental condition at the Coquira port area was studied, contrary to all the other ports of the master plan, only on a preliminary basis. This is in consideration to the fact that Coquira is essentially a small river port located in the fresh water reaches of the Chepo (Bayano) River, even though the port area is subjected to tidal influence. Accordingly the port water area in effect does not belong to coastal water environment but to riverine fresh water environment.

Water quality sampling and analysis was conducted only at field using potable water quality measurement instrument. No laboratory analysis either for water or sediment (riverbed material) quality was performed. The most significant water quality parameters determined as the representative indicator of organic pollution is DO (dissolved oxygen). The other significant parameters determined included turbidity, pH, TDS (total dissolved solids) and salinity. The water quality measurement was conducted from the port water area to all the way downstream of the river up to the river mouth to the sea (Pacific Ocean).

Consistently high DO levels of 6 mg/l or more were measured throughout the sampling that clearly demonstrated no significant organic pollution in the river waters of Coquira port including its downstream reaches. This was further confirmed with visual site inspection. Still, oil pollution was visibly evident in the port waters and its immediate vicinity implying the requirement for strict oil pollution control measures by AMP concerned to vessel movements.

14.4.2 Riverine Ecology

The freshwater wetland vegetation basically inhabits the banks of Coquira port and its immediate vicinity. Such freshwater wetland vegetation includes pistia, herbaceous plants and chestnut trees.

The species of mangrove that inhabits the downstream riverbank areas from the Coquira port toward the sea in its estuarine saline river water reaches include red mangrove (*Rhizophora)* and also black mangrove (*Avecenia germinas*) and salty mangrove (*Avecenia bicolor*) both with a canopy of about 15 m high, which are dominant in the interior areas from the riverbanks.

The fauna species present in the Coqira port (fresh) water area include crocodiles (*Crocodylus acutus*) and freshwater fishes, mainly tilapias (*Tilapia nilotica*). There are also species of saline water fishes like snapers (Lutjanidae), white and yellow weakfish (Scianidae), robalos (Centropomidae), mojarras (Guerridae), jureles (Carangidae) and sporadical presence of tarpoons (*Megalops atlanticus*). All of these fish species are commercially important. Also there are two species of ecological importance in this fresh water area, namely swordfish (*Pristis pristis*) and bull shark (*Carcharinus leucas*).

In the estuarine saline river waters at further downstream of the Coquira port where mangrove vegetation is dominant, there should exist at least 30 species of fish and 7 species of palaemonids shrimps like *Macrobrachium* spp and *Palaemon* spp. Moreover this estuarine saline water zone is very important since it contributes to the development and protection of important species of marine shrimps like *Trachipenaeus* spp., *Litopenaeus* spp., and anchovees (*Cetengraulis misticetus*).

14.4.3 Social Environmental Aspects

The social environmental aspects principally targeting the population living around the Coquira port area was studied using available data as well as focused interview surveys. The basic social environmental condition of the population along with perception of the population concerning the port development is delineated below.

Coquira, also known as La Capitana, is basically a transit zone facilitating movement of people and goods via Coquira port principally between Chepo area and other communities located in the Bayano (Chepo) river shores and margins. According to the census of the year 2000, the population of Coquira community is very low with only of 55 inhabitants composed of 22 women and 33 men having a very high masculinity index. It is noted that the the intra district of Chepo has a population of 12 734 people. The average age of this small population of Coquira is young and only of 28 years with a potentially economically active population between 15 and 64 years of age constituing 73%.

Employed population in Coquira is of 33 people, of which about 20 are engaged in agricultural activities. Only 2 people declared themselves as unemployed in the last census of year 2000. The median income of the people employed is only USD (Balboa) 161.5, still the median family income is much higher amounting to USD 310, indicating widespread tendency of working couple in most families.

Fishing is a very significant economic activity in the Bayano river that icludes the Coquira port water zone as well. In this respect there exists a privately owned shrimp processing company for exporting shrimps, which also has its own fish and shrimp berthing facilities located along the Bayano river. This privately owned facility is located nearby the existing public port of Coquira dedicated for the transport of people and goods and hence it is an integral part of the Coquira port. Also there are around 300 artisan fishermen in Coquira and their major fish catches from the Bayano river include weakfish, snook and shrimps.

In the inland agricultural zones of Coquira rice and other nonpermanent and permanent crop cultivation as well as animal husbandary are the major economic activities. The most important permanent crops cultivated are mangoes, cashews, coconuts, plantains and oranges.

An important basic problem identified by the population concerned to the Coquira port is the lack of secure overnight shelter either in or around the port for the people who are unable to proceed with their trip, either due to late arrival in Coquira or delays attributed to inclement weather.

Concerning the development of the port as per the master plan, perception of the population is positive among all stake holders. In fact they all agree on the need for the development of Coquira port and it would be beneficial for the whole community. Still, they feel it is important to control oil spills in the port waters inorder to protect the port water environment of Bayano (Chepo) river.

14.5 Facility Planning and Layout

14.5.1 Berth

(1) Unit Quay Length

The existing facility of Puerto Panama has a jetty-shaped pier with 125 m in length and the both sides of the pier are utilized for cargo handling. The new berth at Coquira is planned to have the equal productivity of the original function of Fiscal Pier. And modernized cargo handling at the new berth will maintain the same productivity with Fiscal Pier.

Average length of the calling ships is as follows; LOA = 20 m, breadth = 5.5 m, draft = 1.2 m. Maximum length is LOA = 24.4 m of Covadonga.

Considering the maximum length (LOA) of the calling ships at Puerto Panama (25 m), the unit quay length of the berth is given as **30 m** (1.15 x LOA = 28.75 m).

Considering the operation of cargo handling equipment, 15 - 20 m width apron space needs to be secured between berth and shed.

(2) Berth Capacity for Cargo Volume

In order to secure the port function linking the Darien region and the remote islands with the Panama region, construction of the new cargo berth is proposed at Coquira. The berth length to cover the immediate demand is planned as 30 m (1-berth) and its capacity is evaluated as follows.

Berth occupancy ratio:	0.4 (recommended spatial ratio for occupancy of 1-berth; UNCTAD)
Operation hours:	8 hours/day (1 ship calls/day)
Work time ratio:	0.7 (time safety ratio for occupancy of the berth)

Taking into account the big tidal range of 5 - 6 m, cargo handling is assumed to use quayside mobile crane (or hoists on deck) with assistance of forklifts on the wharf and ship-gear cranes. The performance is given as 20 tons/hour/gang.

Capacity = 1 (berths) x 0.4 x 310 (days/year) x 8 (hours/day) x 0.7 x 20 (tons/hour/gang) x 1 (gang/berth) = 14,000 tons/year.

Staged development of the port capacity is assumed as shown in Figure 14.5.1.

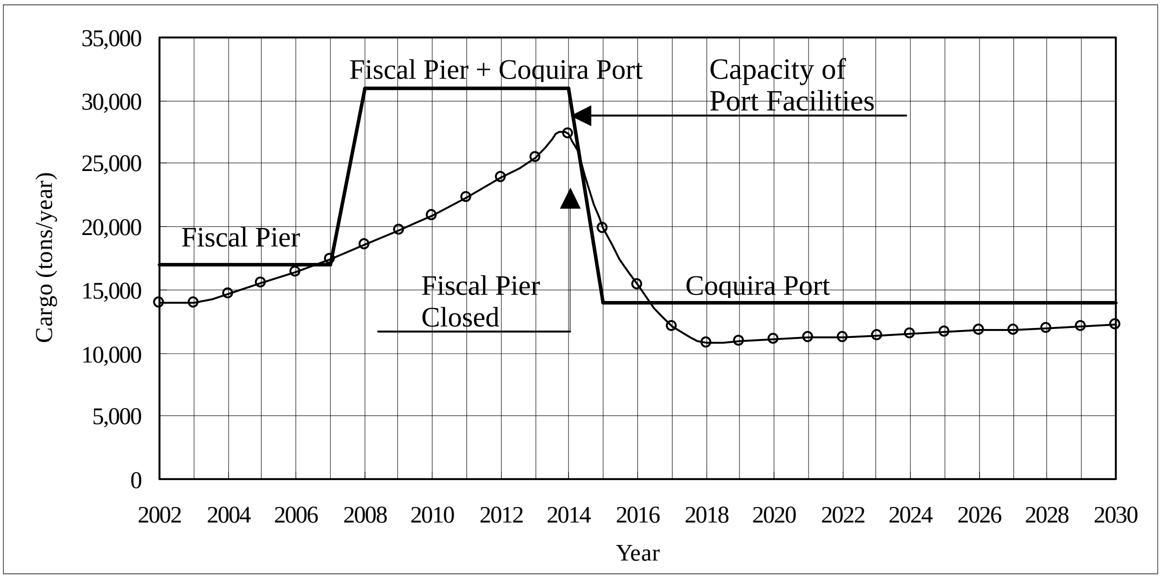


Figure 14.5.1 Staged Development of Coquira Port

(3) Structure Type of Berth

There exists a ramp in Coquira and it is understood that the ramp is a convenient facility for small fishing boats to land their fish-catches and transact with fish-brokers directly on the ramp.

For convenience of the cargo vessels and cargo-passenger boats to berth, a wharf crane is necessary to handle their cargo and RC deck structure supported by piles is appropriate. Installation of a staircase is taken into consideration for convenience of boarding passengers.

Floating pier may be reasonable for ferryboat or Ro-Ro vessel to berth where water-level fluctuation is large, but it is impossible to install cargo crane on a pontoon. It is not advisable to choose floating pier to secure the function of Fiscal Pier.

14.5.2 Storage Space

In most cases, general cargo will be stored in warehouse at the port for 1 -2 weeks waiting for the port calls of the ships to the proper destination.

Assuming that a third of the cargo will go through the shed and another third will use open storage area, required space for storage facilities is needed in the long-term. Utilization of the Open Storage is assumed for the stock of bulk cargos such as agriculture machineries, construction equipment and construction materials from Panama.

Cargo ratio to be stored:	1/3 (shed, yard)
Dwelling time:	14 days (shed); 28 days (yard)
Shed throughput:	2.0 ton/m^2 (cargo volume per unit area of shed)
Yard throughput:	1.0 ton/m^2 (cargo volume per unit area of yard)
Area occupancy ratio:	60 % (shed); 70 % (yard)

<u>Shed area</u> = (cargo volume) x (stored cargo ratio) x (dwelling time)/365 days/(cargo volume per unit area)/(shed occupancy ratio)/(net area ratio) = 16,000 x (1/3) x 14/ 365 / 2.0 / 0.6 / 0.5 = 340 m^2 (400 m^2)

<u>Open Storage area</u> = (cargo volume) x (stored cargo ratio) x (dwelling time)/365 days/(cargo volume per unit area)/(yard occupancy ratio) = 16,000 x (1/3) x 28/ 365 / 1.0 / 0.7 = 585 m^2 (600 m^2)

Too small a shed is not convenient for the operation of cargo handling equipment. The above two storage spaces should be incorporated to one shed area with the dimension 1,000 m^2.

14.5.3 Cargo Handling Equipment

In order to modernize the cargo handling at the port coping with the big tidal range, installation of **1 mobile crane** and **3 forklifts** are planned.

(1) Crane

Calling ships at Panama Port have their own ship gears, but the reach becomes shorter during the low tide. So most of the ships have to load and unload their cargoes and supplies by their ship gear under the risk that the handling time would overrun unexpectedly. It is considered appropriate to provide a mobile crane to cover the extension of the berth for equipment.

A nominal 25-ton capacity crane is planned so that a 3.5 tons cargo can be lifted at 10 meters ahead of outreach.

(2) Forklift trucks

Three diesel forklift trucks (3.5-ton capacity) are planned to provide efficient and modernized port operation in conjunction with the installation of mobile crane.

14.5.4 Administration Functions

Governmental administration functions to be relocated to Coquira Port and the numbers of personnel of each office are assumed shown below. Design working spaces are given in the table.

Table 14.5.1 Configuration of Administration Building

	Government Agencies	Persons	Design Space
1	AMP	14 4 (Security)	150 m^2 (Ground Floor)
2	National Police	6	150 m^2 (Upper Floor)
3	ANAM	2	
4	SALUD	3	

Source: Departmento de Puertos (Arquitecto), AMP

Above-mentioned functions are to be accommodated in one administration office building.

General layout plan of the Coquira Port development is shown in Figure 14.6.2.

14.6 Preliminary Design of Facilities

14.6.1 Design Concept

The new port facilities planned at Coquira Port are mainly a general cargo berth and warehouse.

The design concepts for the marine facilities are as follows:

- To relocate Fiscal Pier of Panama Port
- To maintain smooth river flow
- To enable tide-free cargo handling
- To ensure safe and easy use for passengers.

The general layout plan at Coquira Port is shown in Figure 14.6.2. The planned general berth is located about 100 m downstream from the existing AMP ramp and parallel to the river stream. The structural type of berth is planned with an open wharf type supported by vertical piles to maintain smooth river current and suit to the subsoil conditions at the site.

14.6.2 Design Conditions

(1) Natural Conditions

1) Tide

Tide levels at Coquira Port are shown in Table 14.6.1.

Table 14.6.1 Tide Levels at Coquira Port

MHHW (Mean Higher High Water Level)	+ 4.94 m
MSL (Mean Sea Water)	+ 2.30 m
MLWS (Mean Low Water Spring)	± 0.00 m

Source: JICA Study Team

2) Wave

Ship Waves Height: H = 0.2 m, assuming that waves are generated by moving vessels.

3) Subsoil Conditions

According to the result of subsoil investigations, the typical subsoil conditions at site are as shown in Figure 14.6.1.

▽Existing Ground

Clayey Silt N=10, c=10tf/m^2, γ =1.7tf/m^3

▽+3.00 m (below MLWS)

Graded Sand N=15, ϕ=30°, γ =1.8tf/m^3

▽-2.00 m

Silty Sand N=30, ϕ=35°, γ'=1.0tf/m^3

▽-20.00 m

Graded Sand/Gravel N>50, ϕ=40°, γ'=1.0tf/m^3

Source: JICA Study Team

Figure 14.6.1 Typical Subsoil Conditions

4) Seismic Coefficient

Seismic coefficient of effective peak acceleration at Coquira Port is 0.13 according to the Regulation of Structural Design for the Republic of Panama 1994.

(2) Usage Conditions

1) Target Vessels

The proposed maximum dimensions of the target vessels are shown in the following table:

Table 14.6.2 Dimensions of Target Vessels

	General Cargo Ship	Passenger Speed Boat
Tonnage (GRT)	110	-
Length overall (m)	24.4	9.0
Breadth (m)	5.5	2.0
Draught (m)	1.2	0.5

Source: Estimate by JICA Study Team

2) Surcharge

Surcharge for normal condition: W=1.0 tf/m^2

Surcharge for seismic condition: W=0.5 tf/m^2

3) Live Load

Total weight of truck: 20 tf/truck

Mobile crane truck: 25-ton capacity

Forklift truck: 3.5-ton capacity

4) Width of Berth: 15 m

Length of Berth: 30 m

Land Acquisition: 8,100 m^2 (90 m * 90 m)

Road: 900 m^2 (10 m * 90 m)

5) Lifetime: 50 years

14.6.3 Design of Berthing Facilities

(1) Crown Heights of Berth

The crown heights of berth are determined by the following formula and in consideration of existing ground level and facilities.

Crown Height of Berth = MHHW (+4.94 m) + 0.6*H(0.2 m) = +5.06 m , say +5.0 m

(2) Required Depth of Berth

The required depth of berth is determined by the following formula and in consideration of existing seabed level and facilities.

Required Depth of Berth = MLWS (±0.00 m) – Draught (1.2 m) – 0.5*H (0.2 m) = -1.30 m,
say -2.0 m

(3) Selected Structural Type

The general cargo berth is planned with open pile type RC deck structure supported by the PC concrete piles. Based on the subsoil investigation for the site, a silty sand layer (N value 30) uniformly exists until –20 m below MLWS. Thus, PC concrete piles are to be driven into this layer to secure the bearing force.

For the horizontal force of the berth such as vessel berthing, mooring force and seismic force of the berth, the whole vertical piles are to be sustained. Based on the alignment of the piles and loads on the berth, the adopted size of the square piles is 500 x 500 mm for the general cargo berth.

The RC deck for the berth is consist of RC pile caps, RC beams on the piles and RC slab on the beams. The concrete stairs for passengers are planned at the front side of the berth in order to get on and off the speedboat in safety.

Based on the design vessel size, berth accessories such as mooring bollards and fenders are determined. The capacities of accessories are planned 15-ton bollard and wooden fenders. The mooring bollards are installed at 9 m intervals and the curbing are installed between the bollards. The sheet pile quay walls are planned to retain the existing ground and to prevent the scouring. The adopted size of the sheet piles are type-III, the vertical pile anchorages are 300 mm of H-section steel piles and the diameter of tie rod is 38 mm of HT690. The cargo berth will be equipped with mechanical hoists for loading and unloading of rather heavy cargoes like gas and fuel containers. A transit shed will be provided in consideration of heavy rain.

The typical structural drawing is shown in Figure 14.6.3.

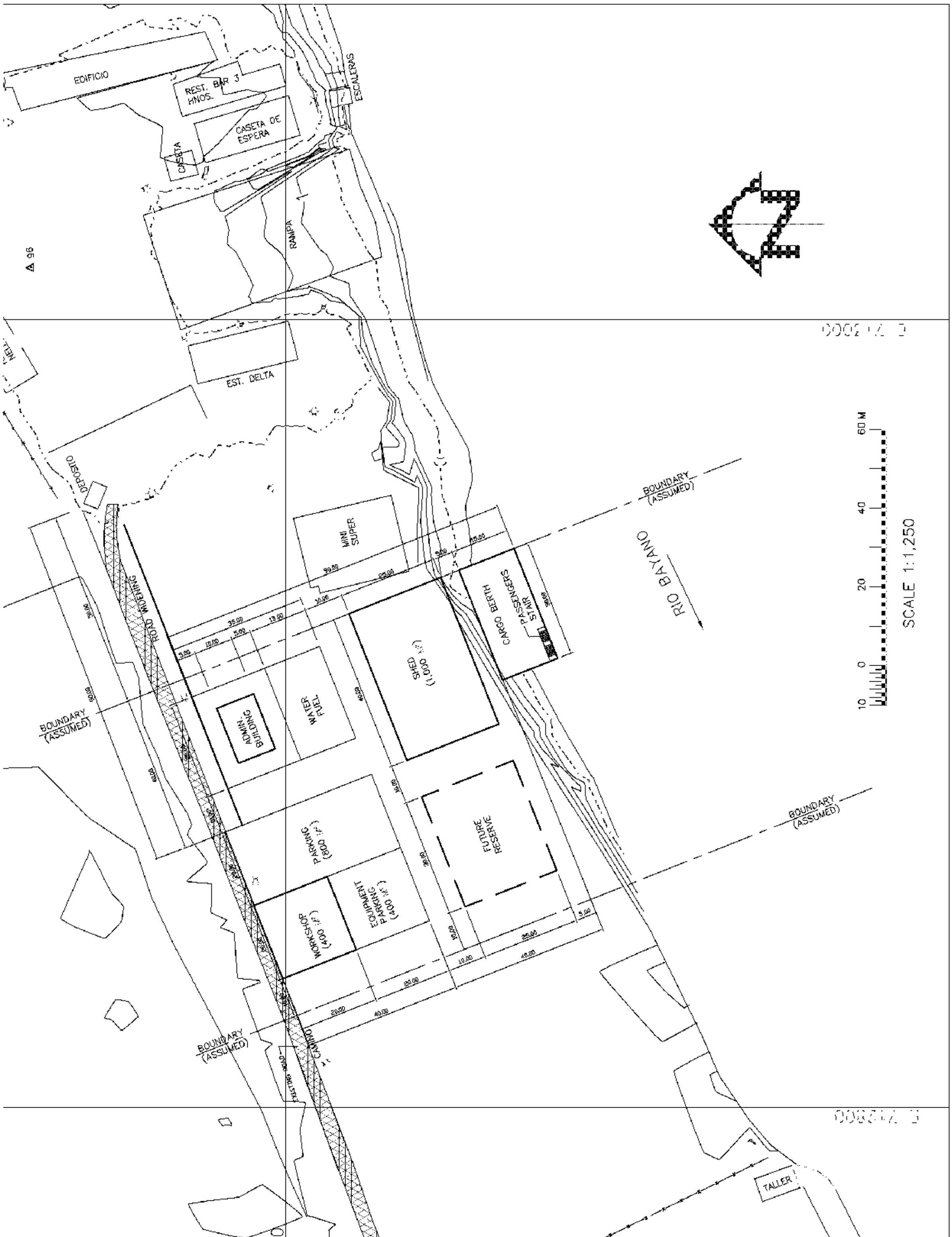
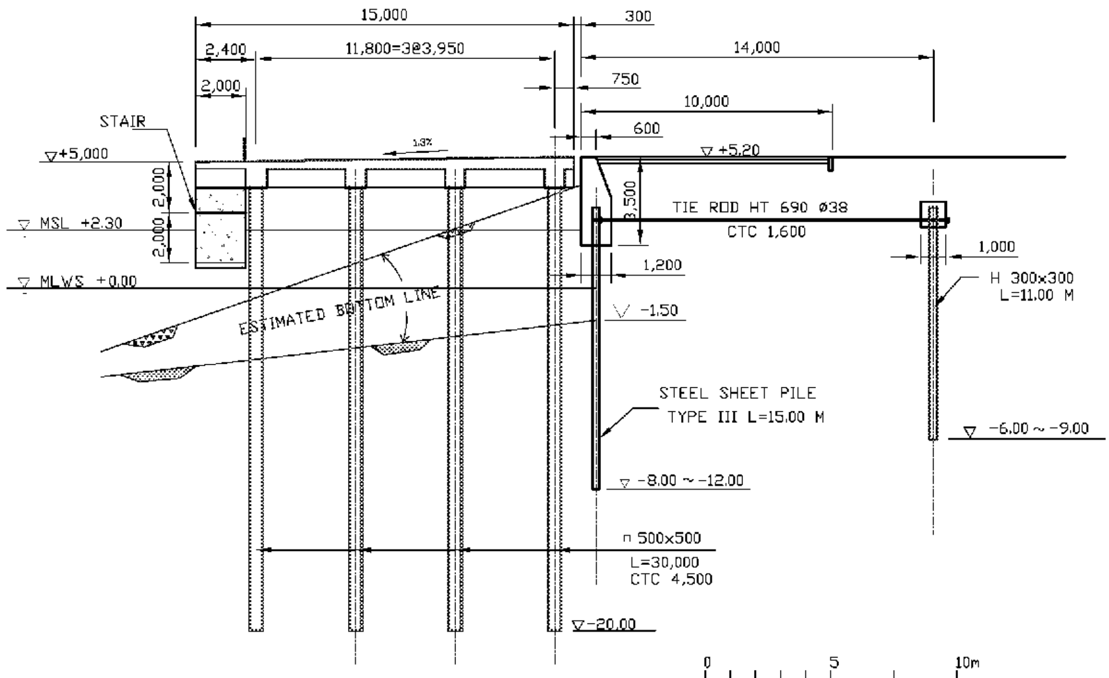
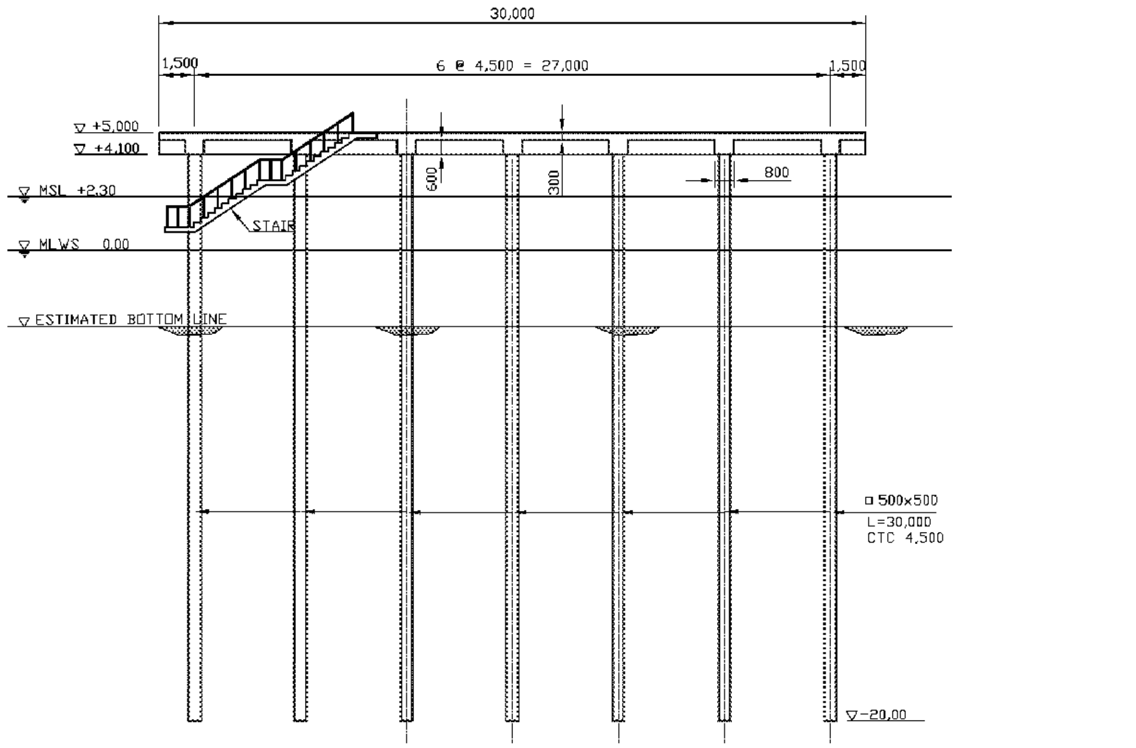


Figure 14.6.2 General Plan of Coquira Port



SIDE VIEW



FRONT VIEW

Figure 14.6.3 Typical Section of Coquira Port

14.7 Project Implementation

In this section, major construction methods, procurement of construction materials and construction equipment are discussed. The information on the procurement condition below is based on the market investigations and interviews from the construction companies and suppliers, etc.

14.7.1 Project Site

Coquira Port is a local river port, located approx. 10 km upstream from the river mouth of Chepo River. River passageway has enough depth for the navigation of cargo ships, connecting to Darien and islands in Panama Gulf.

14.7.2 Construction Method for the Major Facilities

(1) Berthing Facilities: PC-Pile supported Shore Bridge (-3m), with SSP type Retaining Wall

1) Piling

The estimated pile length is approx. 28 m. Pre-stressed concrete piles divided in three pieces will be mobilized by land and connected in the piling leader. It will be driven by D-40 hammer from land side.

2) Concreting

Total concrete volume is estimated at 1,400 cu.m excluding buildings. Ready mixed concrete is available in the vicinity of Coquira.

(2) Civil Works

1) Retaining Wall

Steel Sheet Pile (SSP) type retaining wall is constructed behind the -3 m berth. Construction will be carried out mainly from land side, by use of a crane with vibro-hammer.

2) Pavement

The internal road is to be paved with 10 m width by asphalt. Approx. 750 cu.m of hot mixed asphalt is to be supplied from the mixing plant along Pan-American Highway.

(3) Yard / Building

1) Building

An RC-concrete made, two-story, 450 sq.m of management office, and a concrete block made, one-story custom office are constructed in the port area.

2) Shed

A steel framed, one-story workshop and a warehouse are constructed in the port area. The planned floor area is 400 sq.m and 1,000 sq.m respectively.

3) Fence / Gate

Steel made fence is to be constructed around the port, and two entrance gates are to be constructed.

(4) Utilities

1) Electricity

Required electricity will be supplied through city line operated by the private company.

2) Water

Required water will be supplied by IDAAN.

(5) Navigation Aids

3 units of a steel made mooring buoy with a concrete made anchor are to be installed by use of a work boat.

14.7.3 Purchase of the Materials

(1) Fine Aggregates

River sand is to be supplied from Pacora River (25 km from the site) by land.

(2) Stone

1) Coarse Aggregates

Sieved coarse aggregates can be supplied from the quarries near Pacora River.

2) Armor Stone

Armor stone, 1 ton/pc, is available in the upstream of Pacora River (35 km from the site).

(3) Reclamation Material

Reclamation material is available at neighboring towns of Coquira.

(4) Others

1) Mooring Buoys

3 units of a steel made mooring buoy are to be fabricated in Panama City or a neighboring town, and mobilized by land.

2) Forklift and Crane

3 units of a 3.5 ton capacity forklift and 2 units of a deck crane are to be purchased through trade agents in Panama City.

14.7.4 Mobilization of the Construction Equipment

(1) Heavy Equipment

All of heavy equipment is to be mobilized from Panama City by land.

(2) Anchoring Boat

An anchoring boat is necessary to install mooring buoys and support quay construction from sea side. It can be mobilized from Panama City.

(3) Concrete Plant

Ready mixed concrete is available at neighboring towns of Coquira.

14.8 Project Costs and Capital Expenditure

14.8.1 Project Costs

(1) Introduction

In this section, the preliminary cost for the master plan was estimated based on the following method.

- For the purpose of estimation of the preliminary cost, unit prices of each element such as major construction materials, equipment and manpower cost are determined on the basis of the regional unit prices collected from contractors and suppliers on December 2003, in the field survey in the study area.
- The basic costs of imported products are estimated using the exchange rate on December 2003.
- The capacity and capability of the local contractors are checked with respect to their experience of marine construction works considering the size of each experience.

(2) Preliminary Cost

Based on the above conditions, preliminary cost for the master plan is estimated as shown in the following table.

Table 14.8.1 Preliminary Cost for Master Plan of Coquira Port

Coquira						Unit : USD
Item		**Dimensions**	**Unit**	**Quantity**	**Unit Rate**	**Amount**
1	Land Preparation	including Hinterland	sq.m	7,200	4.3	30,660
2	-3.0m Berth	450 sq.m	sq.m	450	2,301.7	1,035,776
3	Revetment	SSP type	lin.m	40	6,822.9	272,914
4	Building	Office, Workshop, Shed, Gate & Fenc	sq.m	1,700	245.6	417,500
5	Fuel Supply	Oil Tank and Piping	l.sum	1	115,120.0	115,120
6	Pavement	Hinterland	sq.m	2,675	106.0	283,550
7	Outdoor Lighting		unit	30	1,250.0	37,500
8	Landscaping		sq.m	1,440	3.0	4,320
9	Utilities	Suppline Line, Connection to city line	l.sum	1	65,920.0	65,920
10	Equipment	Crane and Forklift	l.sum	1	83,500.0	83,500
Total						**2,346,760**

14.8.2 Capital Expenditure

The capital expenditure schedule assumptions are as follows for economic analysis purpose.

- Start detailed design and select the contractor in 2005.
- Construction in 2006.
- Life expiring facilities such as utilities, mooring devices and plant are to be renewed in 10th year.

Table 14.8.2 Capital Expenditure Schedule for Master Plan of Coquira Port

Coquira	**USD**	**2,346,760**

YR	**Construction** 0.84			**Plant / Equipment** 0.16			**Engineering**	**Maintenance**
	Foreign	**Local**	**Sub Total**	**Foreign**	**Local**	**Sub Total**	10%	1%
F : L	0.61	0.39	1.00	0.61	0.39	1.00		
2005							140,806	
2006	1,206,251	772,519	1,978,770	224,325	143,665	367,990	93,870	
2007								23,468
2008								23,468
2009								23,468
2010								23,468
2011								23,468
2012								23,468
2013								23,468
2014								23,468
2015				Renewal of Plant/Equipment				23,468
2016				224,325	143,665	367,990		23,468
2017								23,468
2018								23,468
2019								23,468
2020								23,468
2021								23,468
2021								23,468
2023								23,468
2024								23,468
ST	1,206,251	772,519	1,978,770	448,651	287,329	735,980		
T	2,714,750						234,676	
GT	2,949,426							

14.9 Administration and Management

The objective of the development of Coquira Port is different from other three ports. The principal aim of the project is to provide an alternative port to Panama Port. Panama Port is presently serves for domestic shipping to and from the islands in Panama Bay, i.e., Isla Taboguilla, Isla de Rey and other islands. The Port will be soon closed for cargo handling due to the Panama City Development Plan.

There are several possible countermeasures to provide alternative port facilities for the domestic shipping service. One of the possible concepts is to use a private port in Amador. Another concept is to construct a new port to overtake the cargo handling function of Panama Port. The former concept requires no new facilities. However, AMP should negotiate with the operators of the private ports to ensure the tariff of the ports will not be too high for the ship operators. AMP should also request and negotiate with Panama City and other agencies so that domestic cargo ships are allowed to dock at the tourism ports in Amador.

The idea of closing Panama Port is to limit the entrance of cargo trucks into the tourism area in Panama City. It is unlikely that those agencies concerned with Panama City Development accept the ides of allowing cargo ships to use any of the private ports in Amador.

Therefore, the Study Team has been trying to propose an alternative plan on the basis of the second concept: the development of alternative port facilities. In this section, those issues related to administration and management of the new port facilities in Coquira Port.

14.9.1 Items to be taken into consideration in the planning

(1) Nature of the project

The development of Coquira Port is just the replacement of the current function of Panama Port by the new facilities. Basically, no substantial economic benefit is generated by the project. The project is providing a minimum access to the people in the remote islands and the compensation for the closure Panama Port, i.e. the gateway to the remote islands.

It is the responsibility of AMP to have the port operational when Panama Port is closed.

(2) Right of way acquisition for the project

The existing Coquira Port does not have enough space for new facilities: the existing facilities are situated on a private land. The acquisition of a right-of-way is one of the outstanding issues.

The current exercise of the project approval procedure of MEF, the public investment is allowed only on state owned lands. Thus, if the project will be implemented by the government fund, AMP should procure the landownership of the land area needed for the new port facilities.

(3) Existing ancillary industries at Coquira Port

Just few hundred meters away from the existing Coquira Port, there is a fishing port and a shipyard that are owned and operated by a private company. The company is planning to start a logistic service such as petroleum distribution.

14.9.2 Administration and management Plan

(1) Steps to be taken by AMP Head quarters

1) Acquisition of right of way

For the realization of the project, AMP should confirm the right-of-way, if it implements the project itself. Another alternative approach is to let a private firm to construct and operate a new wharf under a concession contract. For the latter approach, some incentives including financial assistance are needed to encourage private companies in the port operation business. In addition, AMP should take all the possible measures to maintain the tariff at a reasonable level.

2) Public and Private Partnership

Another possible way to clear the right-of-way issue is to seek a PPP (Public-Private Partnership) scheme. Since water areas are public property while land areas consist of both public and private properties. Thus, the port facilities constructed in the water area can be financed by public, while those facilities on land are financed by private firms who have the right-of-way.

There are various schemes of PPP that can be employed for this project. A concession of the port facilities on the water area is one of the examples. To establish a joint venture between AMP and private firm is another example. AMP should examine which scheme is more practical and should make necessary legal and administrative arrangements to implement the scheme.

3) Redeployment of labor among the port offices

When the new facilities of Coquira Port are operational, the port may need additional labor force, while Office of Panama Port requires only limited number of staff members, because of the closure for cargo handling. Thus, the redeployment of labor force is necessary. In addition, AMP should also take into consideration of the port workers presently employed for the cargo handling at Panama Port who are losing their job due to the port closure.

4) Assurance of shipping and logistic services

In the course of authorization of the project, AMP should first propagate the project to all the shipping companies and logistics firms, in particular those that are currently providing services at Panama Port. It is the responsibility of AMP Headquarter to ensure that the shipping services will continue between Coquira Port and the islands and that the logistics service will start operation at Coquira Port.

Once again, if necessary, AMP should examine the possible incentives to those private firms that will start business at the port.

(2) Steps taken by the Local Port Offices of Coquira Port

The port office of Coquira Port should play a role as the liaison between AMP Headquarters and the local institutions and communities.

14.10 Economic Analysis

14.10.1 The Scope of the Economic Analysis

The Panama Fiscal Port is now handling the cargo to the islands in the Bay of Panama and to the Darien Province. Due to the city planning of the Panama City, the Panama Fiscal Port is to be closed in near future. The Study Team proposes the Coquira Port to succeed the cargo handling for Darien Province and islands. A new berth construction project is planned at the neighborhood of the current Coquira port. The Study Team assumes that the Panama Fiscal Port will close at the end of 2014. The new berth will start handling the cargo that exceeds the capacity of Panama Fiscal Pier in 2007.

14.10.2 The Identification of the "Without Case"

The Amador Port in the Panama City has the best accessibility to the central business district of the city among the conceivable alternative ports for the current Panama Fiscal Port. But the Amador area has been demarcated as the tourism resources district and the activities that are incompatible with the principal land use of the district will not be feasible. Therefore, as the cargo terminal to the islands and Darien, the Amador Port is not recommended.

The Vacamonte Fishery Port has good accessibility to the Panama City also. But the port has been originally designed as the fishery port and the additional works is necessary to function as the substitute port of the Panama Fiscal Port. In addition, as the Vacamonte Port accommodates foreign tuna boats frequently, there is the bond area and the higher attention should be given on the security issues in the port. Therefore, the Vacamonte Port is excluded from the candidate for the "Without Case".

Thus, the Aguadulce Port is selected as the " Without Case" for the Coquira Port Project. The cargo from / to both the islands and the Darien Province will be handled through Aguadulce Port. The Aguadulce Port accommodates the cargo that exceeds the capacity of the Panama Fiscal Port until the end of 2014. The final destination of the cargo from the islands and the Darien Province will be assumed to be the Panama City and vice versa.

14.10.3 The Estimation of the Economic Cost

Table 14.10.1 summarizes the economic cost of the Coquira Port Project.

The domestic portion of the construction cost is multiplied by SCF (Standard Conversion Factor) in order to estimate the economic cost (i.e., true cost to the society).

Contingencies for the construction cost are estimated at 10 percent level.

Table 14.10.1 The Overall Cost and EIRR of the Coquira Port Project

USD

Year	Foreign Currency Total (Market Price)	Domestic Currency Total (Market Price)	Domestic Currency Total (Economic Price)	Total Construction Cost	Contingencies	Engineering Fee	Total Capial Investment	Operations & Maintenance (except Personnel)	The Saving of Fiscal Panama Maintenance	Total O&M Cost	Overall Cost	Overall Benefit	Net Benefit
2005	0	0	0	0	0	140,806	140,806	0		0	140,806	0	(140,806)
2006	1,430,576	916,184	806,242	2,236,818	188,607	93,870	2,519,295	0		0	2,519,295	0	(2,519,295)
2007	0	0	0	0	0	0	0	23,468		23,468	23,468	26,638	3,170
2008	0	0	0	0	0	0	0	23,468		23,468	23,468	90,833	67,365
2009	0	0	0	0	0	0	0	23,468		23,468	23,468	161,696	138,228
2010	0	0	0	0	0	0	0	23,468		23,468	23,468	239,861	216,393
2011	0	0	0	0	0	0	0	23,468		23,468	23,468	326,022	302,554
2012	0	0	0	0	0	0	0	23,468		23,468	23,468	421,178	397,710
2013	0	0	0	0	0	0	0	23,468		23,468	23,468	526,043	502,575
2014	0	0	0	0	0	0	0	23,468		23,468	23,468	641,692	618,224
2015	0	0	0	0	0	0	0	23,468	(31,200)	(7,732)	(7,732)	1,184,443	1,192,175
2016	224,325	143,665	126,425	350,750	0	0	350,750	23,468	(31,200)	(7,732)	343,018	880,616	537,598
2017	0	0	0	0	0	0	0	23,468	(31,200)	(7,732)	(7,732)	659,699	667,431
2018	0	0	0	0	0	0	0	23,468	(31,200)	(7,732)	(7,732)	574,751	582,483
2019	0	0	0	0	0	0	0	23,468	(31,200)	(7,732)	(7,732)	578,889	586,621
2020	0	0	0	0	0	0	0	23,468	(31,200)	(7,732)	(7,732)	583,106	590,838
2021	0	0	0	0	0	0	0	23,468	(31,200)	(7,732)	(7,732)	587,085	594,817
2022	0	0	0	0	0	0	0	23,468	(31,200)	(7,732)	(7,732)	591,740	599,472
2023	0	0	0	0	0	0	0	23,468	(31,200)	(7,732)	(7,732)	596,197	603,929
2024	0	0	0	0	0	0	0	23,468	(31,200)	(7,732)	(7,732)	600,693	608,425
2025	0	0	0	0	0	0	0	23,468	(31,200)	(7,732)	(7,732)	600,693	608,425
2026	224,325	143,665	126,425	350,750	0	0	350,750	23,468	(31,200)	(7,732)	343,018	600,693	257,675
2027	0	0	0	0	0	0	0	23,468	(31,200)	(7,732)	(7,732)	600,693	608,425
2028	0	0	0	0	0	0	0	23,468	(31,200)	(7,732)	(7,732)	600,693	608,425
2029	0	0	0	0	0	0	0	23,468	(31,200)	(7,732)	(7,732)	600,693	608,425
2030	0	0	0	0	0	0	0	23,468	(31,200)	(7,732)	(7,732)	600,693	608,425
2031	0	0	0	0	0	0	0	23,468	(31,200)	(7,732)	(7,732)	600,693	608,425
2032	0	0	0	0	0	0	0	23,468	(31,200)	(7,732)	(7,732)	600,693	608,425
2033	0	0	0	0	0	0	0	23,468	(31,200)	(7,732)	(7,732)	600,693	608,425
2034	0	0	0	0	0	0	0	23,468	(31,200)	(7,732)	(7,732)	600,693	608,425
2035	0	0	0	0	0	0	0	23,468	(31,200)	(7,732)	(7,732)	600,693	608,425
2036	224,325	143,665	126,425	350,750	0	0	350,750	23,468	(31,200)	(7,732)	343,018	600,693	257,675
2037	0	0	0	0	0	0	0	23,468	(31,200)	(7,732)	(7,732)	600,693	608,425
2038	0	0	0	0	0	0	0	23,468	(31,200)	(7,732)	(7,732)	600,693	608,425
2039	0	0	0	0	0	0	0	23,468	(31,200)	(7,732)	(7,732)	600,693	608,425
2040	0	0	0	0	0	0	0	23,468	(31,200)	(7,732)	(7,732)	600,693	608,425
2041	0	0	0	0	0	0	0	23,468	(31,200)	(7,732)	(7,732)	600,693	608,425
2042	0	0	0	0	0	0	0	23,468	(31,200)	(7,732)	(7,732)	600,693	608,425
2043	0	0	0	0	0	0	0	23,468	(31,200)	(7,732)	(7,732)	600,693	608,425
2044	0	0	0	0	0	0	0	23,468	(31,200)	(7,732)	(7,732)	600,693	608,425
													EIRR
													13.89%

Engineering fee is expected at ten percent for the construction cost except machine and electric equipment.

The cost of the operation and the maintenance has been estimated to be 1% of total construction cost

As for the Coquira port project, the number of the staff is expected to remain unchanged because the port is probably operated by private operator, and no additional staff for the administration would be needed.

14.10.4 The Estimation of the Benefit

Economic benefits have been estimated in the following manner: It is assumed that, without a new wharf is constructed in Coquira Port, Aguadulce Port should be used after the closure of Fiscal Port of Panama and that the cargoes to be handled there should be transported from Panama City to Aguadulce Port. Thus, the land transportation costs would be higher for the case without Coquira Port than "With" Coquira Port. The distances of sea transportation to and from the island in the Gulf of Panama and Darien are also shorter for the case of "With" Coquira port. The cost saving is Therefore, the transportation cost will be saved by the construction of Port of Coquira: the reduction of the transportation costs are USD 39.8 per ton for the cargoes to and from the island while USD 67.1 per ton is saved for those cargoes to and from Darien.

The economic benefits are summarized in **Table 14.10.2**

The land transportation cost per ton – km and the sea transportation cost per ton – km are estimated from the result of the direct interviews with the ship operator and the land transportation company at the Panama City

14.10.5 Economic Internal Rate of Return (EIRR)

As **Table 14.10.1** shows the estimate of EIRR for the project is 13.89 percent. The EIRR of 13.9% is falls on the range of 13% - 15%, which are the levels commonly employed to assess an infrastructure project to be economically feasible.

Table 14.10.2 The Economic Benefit of the Coquira Port Project

							Exess Cargo over Panama Port Capasity			Cost Through Aguadulce					Cost Through Coquira					
										Island-Panama		Darien - Panama			Island-Panama		Darien - Panama			
Year	From/To Islands	From/To Darien	Total	Panama Port Capacity	Coquira Port Capacity	Total Port Capacity	From/To Islands	From/To Darien	Total	Land Tranportation Cost	Sea Transportation Cost	Land Tranportation Cost	Sea Transportation Cost	Total Cost	Land Tranportation Cost	Sea Transportation Cost	Land Tranportation Cost	Sea Transportation Cost	Total Cost	Economic Benefit
Unit	Ton	Ton	Ton	Ton	Ton	Ton	Ton	Ton	Ton	USD	USD	USD	USD	USD	USD	USD	USD	USD	USD	USD
2005	4,480	11,099	15,579	17,000	0	17,000	0	0	(1,421)	0	0	0	0	0	0	0	0	0	0	0
2006	4,562	11,909	16,471	17,000	0	17,000	0	0	(529)	0	0	0	0	0	0	0	0	0	0	0
2007	4,645	12,800	17,445	17,000	14,000	31,000	118	327	445	4,266	3,722	11,754	23,509	43,251	1,706	1,567	4,702	8,638	16,613	26,638
2008	4,730	13,780	18,510	17,000	14,000	31,000	386	1,124	1,510	13,891	12,122	40,469	80,938	147,420	5,556	5,104	16,188	29,739	56,587	90,833
2009	4,817	14,858	19,675	17,000	14,000	31,000	655	2,020	2,675	23,577	20,574	72,723	145,446	262,320	9,431	8,663	29,089	53,441	100,624	161,696
2010	4,905	16,044	20,949	17,000	14,000	31,000	925	3,024	3,949	33,286	29,047	108,878	217,755	388,967	13,315	12,230	43,551	80,010	149,106	239,861
2011	4,994	17,348	22,342	17,000	14,000	31,000	1,194	4,148	5,342	42,987	37,512	149,325	298,651	528,475	17,195	15,795	59,730	109,734	202,453	326,022
2012	5,086	18,783	23,869	17,000	14,000	31,000	1,464	5,405	6,869	52,691	45,981	194,593	389,186	682,450	21,076	19,360	77,837	142,999	261,273	421,178
2013	5,179	20,361	25,540	17,000	14,000	31,000	1,732	6,808	8,540	62,343	54,403	245,097	490,195	852,038	24,937	22,907	98,039	180,113	325,995	526,043
2014	5,274	22,097	27,371	17,000	14,000	31,000	1,998	8,373	10,371	71,940	62,779	301,416	602,831	1,038,966	28,776	26,433	120,566	221,499	397,274	641,692
2015	5,370	14,458	19,828	0	14,000	14,000	5,370	14,458	19,828	193,320	168,700	520,488	1,040,976	1,923,484	77,328	71,032	208,195	382,487	739,042	1,184,443
2016	5,468	9,875	15,343	0	14,000	14,000	5,468	9,875	15,343	196,848	171,779	355,500	711,000	1,435,127	78,739	72,328	142,200	261,243	554,511	880,616
2017	5,569	6,525	12,094	0	14,000	14,000	5,569	6,525	12,094	200,484	174,952	234,900	469,800	1,080,136	80,194	73,664	93,960	172,619	420,437	659,699
2018	5,670	5,200	10,870	0	14,000	14,000	5,670	5,200	10,870	204,120	178,125	187,200	374,400	943,845	81,648	75,000	74,880	137,566	369,094	574,751
2019	5,774	5,200	10,974	0	14,000	14,000	5,774	5,200	10,974	207,864	181,392	187,200	374,400	950,856	83,146	76,376	74,880	137,566	371,967	578,889
2020	5,880	5,200	11,080	0	14,000	14,000	5,880	5,200	11,080	211,680	184,722	187,200	374,400	958,002	84,672	77,778	74,880	137,566	374,896	583,106
2021	5,980	5,200	11,180	0	14,000	14,000	5,980	5,200	11,180	215,280	187,864	187,200	374,400	964,744	86,112	79,101	74,880	137,566	377,659	587,085
2022	6,097	5,200	11,297	0	14,000	14,000	6,097	5,200	11,297	219,492	191,539	187,200	374,400	972,631	87,797	80,648	74,880	137,566	380,891	591,740
2023	6,209	5,200	11,409	0	14,000	14,000	6,209	5,200	11,409	223,524	195,058	187,200	374,400	980,182	89,410	82,130	74,880	137,566	383,985	596,197
2024	6,322	5,200	11,522	0	14,000	14,000	6,322	5,200	11,522	227,592	198,608	187,200	374,400	987,800	91,037	83,624	74,880	137,566	387,107	600,693
										150	190	150	300		60	80	60	160		
										Km	Km	Km	Km		Km	Km	Km	Km		

Land Transportation Cost (per Ton-Km): 0.2400 USD
Sea Transportation Cost (per Ton-Km): 0.1653 USD

14.11 Initial Environmental Examination (IEE)

The long-term environmental effects consequent to the implementation of the master plan in Coquira port are evaluated on preliminary basis so as to form the IEE (Initial Environmental Examination). The environmental effects are separated between social effects and other effects, principally focusing on potential adverse long-term effects and their significance and mitigation measures as appropriate. The completed provisional IEE format for screening and checklist for scoping established by JICA is shown in Table 14.11.1 and Table 14.11.2 respectively.

(1) Social Effects

Basically the planned facilities are to be constructed above the water of Chepo (Bayano) River along its riverbank in the form of rehabilitation and expansion of the existing port facilities. The expansion works of the port facility involves land acquisition since the port land area is privately owned. Still no resettlement of population including any housing compensation is involved. Considering the fact that the area involved is essentially an existing port, AMP could secure the required land for the expansion of port with the provision of reasonable compensation.

The beneficial social effects of expanded port to handle both passengers and cargo include increased employment opportunities.

(2) Other Effects

The port location for expansion is still in the fresh water reaches of Chepo River and hence there is no precious ecological resource like mangrove woods. Accordingly it is assessed that the expansion of the port facility in itself has no long-term significant adverse effects on ecological resources.

Still, berthing of vessels would result in inherent waste generation. AMP as the project owner, so as not pollute the waters of Chepo River, shall properly manage these wastes. The potential wastes generated due to vessel berthing include oily (bilge) wastes and also garbage. Proper management of these wastes so as to mitigate illegal dumping of such wastes into the rive waters is the only available means to mitigate water pollution attributed to vessel berthing.

Table 14.11.1 Format for Screening-Coquira Master Plan

No.	Environnemental Item	Description	Evaluation*1	Remarks (reasons)
Social Environment				
1.	Resettlement	Resettlement due to an occupancy (transfer of rights of residence/land ownership)	[Y][N][?]	Land acquisition would be involved
2.	Economic activities	Loss of bases of economic activities, such as land, and change of economic structure	[Y][N][?]	No significant loss is anticipated
3.	Traffic and public facilities	Impacts on schools, hospitals and present traffic conditions such as the increase of traffic congestion and accidents	[Y][N][?]	Potential iinterference to normal traffic due to construction traffic
4.	Split of community	Community split due to interruption of area traffic	[Y][N][?]	No effect (no split)
5.	Cultural property	Damage to or loss of value of churches, temples, shrines, archaeological remains or other cultural assets	[Y][N][?]	No known treasures, still be verified
6.	Water rights and rights of common	Obstruction of fishing rights, water rights, rights of common	[Y][N][?]	Some infterfernce to water vessel traffic during construction
7.	Public health condition	Degeneration of public health and sanitary conditions due to generation of garbage and the increase of vermin	[Y][N][?]	An issue of construction site management
8.	Waste	Generation of construction wastes, surplus soil and general wastes	[Y][N][?]	From construction site works
9.	Hazards (risk)	Increase in danger of landslides, cave-ins, etc.	[Y][N][?]	Construction safety management issue
Natural Environment				
10.	Topography and geology	Changes of valuable topography and geology due to excavation or filling work	[Y][N][?]	The plan is small-scale
11.	Soil erosion	Topsoil erosion by rainfall after reclamation and deforestation	[Y][N][?]	Surface erosion, a construction site management issue
12.	Groundwater	Contamination caused by damage and filtrate water in excavation work and lowering of groundwater table due to overdraft	[Y][N][?]	No effect (no interference to groundwater)
13.	Hydrological situation	Changes of river discharge and riverbed condition due to landfill and drainage inflow	[Y][N][?]	No effect on surface flow
14.	Coastal zone	Coastal erosion and change of vegetation due to coastal reclamation and coastal changes	[Y][N][?]	No coastal zone at project site
15.	Fauna and flora	Obstruction of breeding and extinction of species due to changes of habitat conditions	[Y][N][?]	Not significant as plan is small scale
16.	Meteorology	Changes of temperature, precipitation, wind, etc. due to large-scale land reclamation and building construction	[Y][N][?]	No effect (Plan is not that large scale)
17.	Landscape	Change of topography and vegetation due to reclamation. Deterioration of aesthetic harmony by structures	[Y][N][?]	No reclamation works
Pollution				
18.	Air pollution	Pollution cause by exhaust gas or toxic gas from vehicles	[Y][N][?]	Construction vehicles
19.	Water pollution	Pollution cause by inflow of silt, sand and effluent from factories, etc.	[Y][N][?]	No dredging works
20.	Soil contamination	Contamination caused by dust and asphalt emulsion	[Y][N][?]	During construction works
21.	Noise and vibration	Noise and vibration generated by vehicles	[Y][N][?]	During construction works
22.	Land subsidence	Deformation of land and land subsidence due to the lowering of groundwater table	[Y][N][?]	No interference to groundwater
23.	Offensive odor	Generation of exhaust gas and offensive odor by facility construction and operations	[Y][N][?]	Construction works
Overall evaluation: Necessity for implementation of IEE and/or EIA			[Y][N]	Preliminary EIA study is recommended

*1 Y: Yes
N: No
?: Unknown (To be confirmed)

Table 14.11.2 Checklist for Scoping-Coquira Master Plan

No.	Environmental Item	Evaluation	Reasons
Social Environment			
1	Resettlement	B	Land acquisition but no resettlement would be involved
2	Economic activities	D	The project will benefit passenger and port service. (D in evaluation means no adverse effect).
3	Traffic and public facilities	B	Some interference of construction work and traffic with regular traffic
4	Split of community	D	No community split is involved
5	Cultural property	C	Existence of treasures is not expected, but to be verified
6	Water rights and Rights of common	B	Construction works interference to existing right of water vessel passage rights is anticipated
7	Public health condition	C	Construction site worker related public health management
8	Waste	B	Generation of construction and facility operational waste
9	Hazards (risk)	C	Construction site safety management
Natural Environment			
10	Topography and geology	D	No significant adverse effect is anticipated
11	Soil erosion	B	A construction site management issue to be taken care of
12	Groundwater	D	No effect since project is not related to groundwater
13	Hydrological situation	D	No effect since project would not interfere with surface flow characteristics
14	Coastal zone	D	No coastal zone at project site
15	Fauna and flora	B	Some short–term adverse effect during construction is anticipated
16	Meteorology	C	Project has no effect though meteorology may effect construction works
17	Landscape	D	Plan is small enough to exert any significant change in landscape
Pollution			
18	Air pollution	B	Use of construction machinery, vehicles may cause air pollution
19	Water pollution	B	The construction works may cause some water pollution also proper facility management is required to mitigate operational water pollution
20	Soil contamination	D	No significant soil contamination is anticipated
21	Noise and vibration	B	Construction machinery and vehicles may produce noise and vibration
22	Land subsidence	D	No effect since project has no interference to groundwater
23	Offensive odor	D	There exists no significant source of offensive odor

Note 1: Evaluation categories:
A: Serious impact is expected
B: Some impact is expected
C: Extent of impact is unknown (Examination is needed. Impacts may become clear as study progresses.).
D: No impact is expected. IEE/EIA is not necessary.
Note 2: The evaluation should be made with reference to the "explanation of item" (Table 4-5)

14.12 Recommendations on Regional Economic Development

(1) Management of River Channel

Coquira Port is located at 25 km upstream from river mouth, and maintenance of the river channel is a very important factor for port management.

The ships calling Coquira at present are limited to the range from the fishing boats and ferryboats of outboard-motor boats to the small cargo ships of the dimensions of 50 - 100 GRT (with draught 1.2 - 1.5 m). The river channel of Rio Bayano provides sufficient dimensions of the channel width and water depth.

The depth of the river channel is maintained by the daily in-and-out flow in the channel caused by the tidal wave in Panama Bay with a big tidal range. The channel depth of LWS-2 m to -3 m and the channel width of 50 to 60 m is maintained in the Outer Bar Area out of river mouth (based on the bathymetric survey in January 2004).

On the other hand, the river channel is changing daily with erosion and accretion taking place. The bathymetric survey data of the river channel of Rio Bayano (refer to Figure 14.2.1) warns that the riverbed has been lowering and channel is in the process of erosion.

In order to trace the changes in the river channel and to secure the safety of the navigation in the river channel, periodic bathymetric survey of the river channel must be carried out. Based on the bathymetric surveys, the on-going efforts are still necessary to eliminate the navigational obstructions such as the excavation of dangerous sand bars in the channel.

(2) Improvement of Access Road from Chepo

The access road from Chepo, on the Pan-American Highway, to Coquira is paved, but it is a narrow and long and winding road.

Following the extension of the Pan-American Highway to Darien Province, Chepo is going to raise its importance as the logistics center in the eastern region of Panama. Increase of the traffic volume on the road from Chepo to Coquira is also expected. Hence, the improvement of this access road will be necessary in the future.