11. LONG TERM DEVELOPMENT PLAN FOR THE PORT OF LA UNION

11.1 Physical Requirements in Planning

11.1.1 Standard Ship Size in Planning

1. Generally speaking, the standard ship size in planning should be determined, taking into consideration the size in future covering more than 80 % of the number of calling ships. (It isn't represented by an average size calling the port.)

2. The current ships calling at the Port of Acajutla are already relatively large based on the distribution of ship size in 1997 by October (see Table 3-1-5 to 3-1-9, PART I). The top 20% of general ship (with or without containers) are of 20,000 -30,000 DWT. That of dry bulk and liquid ship is of 30,000 -40,000 DWT and 40,000 -50,000 DWT, respectively. Top 5 of ship size by ship are as follows;

Table 11-1-1 Top 5 of Ship Size by Ship Type in 1998 by October

	Name	DWT	Length (m)	Breadth (m)	Draft (m)
General	ANDROMEDA	27,704	174.5	24.9	10.4
	HEIYO	26,320	166.4	27.7	9.7
	KAVO MALEAS	25,379	171.7	24.8	10.0
	WARALEE NAREE	25,413	160.8	25.2	10.2
	STAR MARY	24,523	159.9	24.6	10.0
Dry Bulk	FLORA	52,245	216.0	31.8	12.3
	ORIENTAL EXPRESS	45,342	190.0	32.2	-
	CARGO EXPLORER	37,990	193.8	27.6	10.9
	ANA L.K.	37,930	193.8	27.6	10.9
	SPRINGWOOD	37,694	188.0	28.1	10.8
Liquid Bulk	BRALI	48,481	182.8	32.0	13.1
	TRINIDAD	44,999	184.7	30.4	12.1
	TIKHVIN	40,727	181.0	32.0	-
	TOMSK	40,703	181.0	32.0	-
	ENIAS	38,987	191.6	27.5	11.2
Mix	METEOR	4,340	102.9	14.6	5.8

Source: CEPA and Lloyd's Maritime Directory

3. According to the " Technical Standards for Port and Harbor Facilities in Japan (1991)", the dimensions of ships (30,000- 50,000 DWT) by ship type are as follows;

Table 11-1-2 Standard Size of Ships

(unit: m)

Ship Type	DWT	Length	Breadth	Draft
Cargo Ship				
	30,000	186	27.1	10.9
	40,000	201	29.4	11.7
	50,000	216	31.5	12.4
Container Ship				
	30,000	237	30.7	11.6
	40,000	263	33.5	12.4
	50,000	280	35.8	13.0
Oil Tanker				
	30,000	185	28.3	10.9
	40,000	204	30.9	11.8
	50,000	219	33.1	12.7

Source: Technical Standards for Port and Harbor Facilities in Japan

4. Some ships pass through the Panama Canal. The maximum draft of the vessel which can transit the Canal is limited to less than 39.5 ft (12.04 m). (Its waterways and basins are generally designed as 42 ft (12.73 m) deep in consideration of the extent of oscillatory motion of the ship due to the natural conditions such as waves, winds and tidal currents, and the trim.)

5. Based on the fact mentioned above, the size of dry and liquid bulk ships in planning are already of Panamax, and that of a general ship would increase up to Panamax with its recent growth as explained in Table 3-1-8, PART I and the forecast of ship size in the previous chapter.

11.1.2 Berth Dimensions

6. Berth dimensions are determined on the basis of the standard ship dimensions. In general, the length and depth of a berth are required to exceed the standard ship dimensions to provide some allowance.

7. A modern container berth is planned in La Union, which has greater *reliability and efficiency* than the Port of Acajutla. That is, the port operation is free from a swell and the productivity of container handling is constantly maintained at a high level. It will serve (give priority to) not only full container ships but also general ships with containers. It should have a sufficient backyard area with necessary facilities like gantry cranes.

8. Table 11-1-3 shows two recent examples of container terminals which have been developed successfully in Central America. Both are located near the Atlantic entrance of the Panama Canal. One is Manzanillo, which has doubled its cargo volume every year since its opening, and handled more than 500,000 TEUs last year. The other, Coco Solo Norte, is being developped by Evergreen, one of the largest shipping companies in the world.

Table 11-1-3 Outline of the New Container Terminal Development in Central America

Terminal	Manzanillo Phase I	Coco Solo Norte Phase I
Number of Berths (1)	2	2
Berth Depth (m)	-13	-14
Berth Length (m)	600	612
Terminal Area (ha) (2)	25	25
Construction Schedule	1994-1995	1996-1998
(2)/(1) (ha/berth)	12.5	12.5

Source: Autoridad Portuaria Nacional (APN), Panama

9. According to the table, recent container terminals are equipped with berths of a depth of 13-14m and a length of 300m. The terminal area is around 12 ha per berth. In addition, the recent size of a Panamax container ship is reported to have a length of 295 m, a breadth of 32 m and a draft of 12 m.

10. Therefore, the terminal of La Union should be planned to have a berth of a depth of 13(-14 *) m and a length of 300 m, equipped with a back-up yard of 12 ha (300m x 400m). (Note: the figure with * is for future expansion at need.)

11. Other berths will be used mainly by dry and liquid bulk ships. Berth dimensions generally used in planning are summarized in Table 11-1-4. These are the same for dry and liquid bulk ships of 40,000-50,000 DWT. The berths are planned to have a berth of a depth of 13(-14*) m and a length of 260(-280*)m. (Note: the figure with * is for future expansion at need.)

12. It is desirable for the depth of the area behind the berths to be at least the same as that of the container terminal (400 m) from the viewpoint of the possibility for future expansion of the container terminal after the target year of the Master Plan.

Table 11-1-4 Standard Berth Dimensions in Planning

(unit: m)

Ship Type	DWT	Length	Draft
Cargo Ship			
	40,000	260	13.0
	50,000	280	14.0
Oil Tanker			
	40,000	260	13.0
	50,000	280	14.0

Source: Technical Standards for Port and Harbor Facilities in Japan

11.1.3 Cargo Handling Efficiency

13. As a basic physical requirement, ship size was determined in the previous section. Cargo handling efficiency is also an important factor. Cargo handling hours and berthing hours depend on the cargo volume to be handled and cargo handling efficiency.

14. In general, the cargo handling efficiency will be improved by the increase of handling volume per hour and shortage of the berthing time without cargo handling. The former is related to the cargo handling equipment and system and the latter is related to operational management.

15. The cargo handling efficiency target is set up taking into consideration

the past performance and the current improvement of cargo handling efficiency at Acajutla.

16. As to working hours, generally speaking, it seems to be reaching the level of the existing cargo handling capacity as long as the existing system is maintained without any drastic improvement and modernization (see Table 4-1-2, 4-2-1 and 4-2-2, PART I). Therefore, a similar system is assumed as a base, excluding container and dry bulk handling.

17. Regarding container handling, a *reliable and efficient* modern system should be introduced. It is important to attract and serve as many containers as possible as explained in the previous chapter.

18. A minimum of two gantry cranes is indispensable as main equipment to allow for maintenance and accidents. Based on practical examples in developing countries, the target of productivity could be set up as follows;

Handling capacity (on working hours)

i) For the Master Plan(2015)
24 cycle/hour x 0.8 (efficiency*) =19.2 box/hour/crane

ii) For the Short-Term Plan (2005)
20 cycle/hour x 0.8 (efficiency*) =16.0 box/hour/crane

(*) Necessary works such as moving hatch-covers other than loading and unloading are considered.

19. Basic specification of these cranes are shown as follows;

Type	:	Panamax type
Related capacity (under the spreader)	:	41 metric ton
Out reach	:	36.6 m
Rail span	:	30.5 m

(Note)
A wide rail span in the same level with super gantry cranes for over Panamax type vessels is adopted, considering the future possible replacement by any chance.

20. On the other hand, a conventional method using ship gear and movable hopper is adopted for dry bulk handling. Such a dry bulk handling system as equipped on Pier B of the Port of Acajutla is not considered. Limited financial resources should be forwarded to container handling at first. (Of course, private investment for exclusive equipment could be introduced under proper control of CEPA.)

21. As a result, cargo handling efficiency/working hour/ship in the target years are summarized by cargo type below;

Table 11-1-5 Cargo Movement/ Working Hour/ Ship
by Cargo Type

Cargo Type	2015	2005	1996	Remarks
General Cargo (ton)	100 (1.03)	100 (1.03)	96.7 (1.00)	
Container (box)	38.4 (3.84)	32.0 (3.20)	10 (1.00)	two(2) gantry cranes
Dry Bulk (ton)	100 (0.69)	100 (0.69)	145.8 (1.00)	conventional method
Liquid Bulk (ton)	150 (1.02)	150 (1.02)	146.6 (1.00)	depending on the ship pump

Note: Figures in 1996 are based on Table 4-2-2 and 4-1-2(container), PART I.
The figures in parentheses represent comparisons with 1996 rates.

22. Cargo handling efficiency is also largely affected by the ratio of working hours to berthing hours. A reduction in this rate would contribute a lot to the improvement of the cargo handling efficiency. Taking into consideration the past performance at Acajutla and other planning examples, the target is set up as shown below;

Table 11-1-6 Working Hours/ On-Berth Hours/ Ship by Cargo Type

Cargo Type	2015	2005	1996	Remarks
General Cargo	0.8 (1.20)	0.8 (1.20)	0.666 (1.00)	
Container	0.8 (1.20)	0.8 (1.20)	0.666 (1.00)	
Dry Bulk	0.8 (1.15)	0.8 (1.15)	0.694 (1.00)	
Liquid Bulk	0.9 (1.06)	0.9 (1.06)	0.85 (1.00)	

Note: Figures in 1996 are based on Table 4-2-2, PART I.
The figures in parentheses represent comparisons with 1996 rates.

23. Total cargo handling efficiency/ berthing hour, considering the rate of working hours for on-berth hours of ship, is calculated as follows;

Cargo Movement/ Berthing Hour/ Ship
= Cargo Movement/ Working Hour/ Ship (Table 11-1-5)
x Working Hours/ On-Berth Hours/ Ship (Table 11-1-6)

24. The results are as follows;

Table 11-1-7 Cargo Movement/ Berthing Hour/ Ship by Cargo Type

Cargo Type	2015	2005	1996	Remarks
General Cargo (ton)	80 (1.24)	80 (1.24)	64.4 (1.00)	
Container (box)	30.7 (4.58)	25.6 (3.82)	6.7 (1.00)	two(2) gantry cranes
Dry Bulk (ton)	80 (0.79)	80 (0.79)	101.2 (1.00)	conventional method
Liquid Bulk (ton)	135 (1.08)	135 (1.08)	124.6 (1.00)	depending on the ship pump

Note: The figures in parentheses represent comparisons with 1996 rates.

25. A container liner usually makes a one-day stop at a port. With the proposed efficiency, which would increase by around 400 % from 1996, 200 containers could be handled during the total stay (8 hours) including container handling (6.5 hours). It would be recognized as quite reasonable efficiency for container liner services.

11.1.4 Required Number of Berths

26. At present each berth is used by various types of ships. However, at the stage of the Master Plan, the utilization of each terminal will be specialized according to ship type as much as possible.

27. A container terminal will be used by container ships with priority.(In case of container cargo some will be transported by full container ships and others by conventional type ships as they are.) As well, a bulk terminal will be assigned for grain bulk carriers. Liquid bulk cargo is also handled using the equipment for liquid cargo at the bulk terminal.

28. Required number of berths is determined based on cargo volume and handling capacity. The required number of berths is calculated by the following formula.

$$N = Nc \;/ Ch \;/ (Dy \times Hd) / Ro$$

N : Required number of berth
Nc : Cargo throughput per year
Ch : Cargo volume per berthing time
Dy : Annual operation days
Hd : Working hours per day
Ro : Planning berth occupancy ratio

29. As to cargo volume, there are two future cases: Case 1 and Case 2, which were described in the previous chapter. The required number of berths depends on cargo throughput. Cargo volume to be handled is the same for Case 1 and Case 2 in 2005, while there is some difference between Case 1 and Case 2 in 2015.

30. Cargo volume per berthing time is obtained from Table 11-1-7. It is assumed that the port opens for 350 operating days (x 24 hours) and that planning occupancy ratio is 0.6 - 0.7 in reference to other port planning examples. The calculation procedure is summarized in Table 11-1-8. (Note: Oil is distributed by

small barges from the Acajutla center for the eastern region. In practice, one berth could serve a few barges at the same time.)

Table 11-1-8 Required Number of Berths

(a) Required Number of Berths (2015) for Case 1

	General	Container*	Dry Bulk	Liquid Bulk	Oil	Total
Cargo Volume ton(box*)/year	191,100	120,500	357,000	600,000	346,000	
Cargo Volume /Berthing Hour	80	31	80	135	135	
Required Berthing Time	2,389	3,923	4,463	4,444	2,563	17,781
Calculated Number of Berth	0.28	0.47	0.53	0.53	0.31	
Required Number of Berth	0.75		1.37			2.12
Number of Berth in Planning	1		2			3

(b) Required Number of Berths (2015) for Case 2

	General	Container*	Dry Bulk	Liquid Bulk	Oil	Total
Cargo Volume ton(box*)/year	164,100	99,500	357,000	531,000	295,000	
Cargo Volume /Berthing Hour	80	31	80	135	135	
Required Berthing Time	2,051	3,239	4,463	3,933	2,185	15,871
Calculated Number of Berth	0.24	0.39	0.53	0.47	0.26	
Required Number of Berth	0.63		1.26			1.89
Number of Berth in Planning	1		2			3

(c) Required Number of Berths (2005) for Case 1 and 2

	General	Container*	Dry Bulk	Liquid Bulk	Oil	Total
Cargo Volume ton(box*)/year	78,600	35,700	223,400	252,200	200,000	
Cargo Volume /Berthing Hour	80	26	80	135	135	
Required Berthing Time	983	1,395	2,793	1,868	1,481	8,519
Calculated Number of Berth	0.12	0.17	0.33	0.22	0.18	
Required Number of Berth	0.28		0.73			1.01
Number of Berth in Planning	1		1			2

31. The required number of berths by cargo type in 2015 and 2005 for Case 1 is equal to that for Case 2, and is summarized as follows;

Table 11-1-9 Required Number of Berths for Case 1 and Case 2

Year	Berth Type	Number	Ship of Priority
2015	Total	3	
	Container Berth	1	Container, General
	Bulk Berth	2	Dry, Liquid, and Oil
2005	Total	2	
	Container Berth	1	Container, General
	Bulk Berth	1	Dry, Liquid, and Oil

Note: Containers are also transported by many general ships. Oil is carried by small barges from Acajutla.

11.1.5 Turning Basin and Access Channel

32. The required depth of the basin and channel depends on the draft of ships and allowance which includes various related elements. In general, ten percent of the draft is required as expressed by the following formula;

$$d > 1.1 \times D$$

d : Water depth of water facilities
D : Draft of standard ships

33. A turning basin for a ship with tug boats should exceed an area of a circle with a diameter of twice as long as the ship length. The circle with diameter of 600 m is prepared to cover the maximum length (around 300m) of standard ship dimensions.

34. The draft of the basin is planned to be 13 m deep in accordance with the depth of the berth. (Here, the size and the draft of planning basins for general ships, container ships, dry bulk cargo ships and liquid bulk cargo ships happen to be almost the same.)

35. Subsequently, the channel is planned. The depth of the channel is

similar to that of the basin. However, it is recommended that its depth outside a breakwater (in an open sea) should not be less than that inside the breakwater.

36. As explained in PART I, the current channel is a natural one of a length of more than 10 km. It has a minimum depth of about 8 meters deep in the La Union Bay and is at least 2-3 meters deeper outside of it based on the bathymetric survey conducted by the JICA Study Team in 1997.

37. For the new deeper one, a lot of dredging would be necessary. (The dredged material seems to be too weak to be utilized for other purposes, which means that an expensive dumping site would have to be prepared for it.)

38. On the other hand, ships going to the port could use the tidal benefit as occasion demands. The amplitude of the tide is approximately 3 m at the spring tide and 1.8 m at the neap tide at the Port of Cutuco. (At the Port of Acajutla, the amplitude is two-thirds of that of Cutuco at the respective tide.)

39. On the basis of this natural condition, for example, the total time when the tide comes up beyond the level of +1.0 m is more than 7 hours at the spring and 8 hours at the neap per a 12 hour cycle tide. This could make the channel planning more economical.

40. Taking into consideration the above-mentioned, 12 m is adopted as the depth of the access channel in the La Union Bay, and 13 m is as that outside it for the Master Plan. (Ships with a draft of more than 12 m can enter the channel during the appropriate high tide.)

41. The width of the channel will be determined depending on the frequency of the ship traffic and the length of the channel. In general, it must be at least equal to the requires at least the same as the ship length.

42. The length of the planned channel is around 20 km with a depth of 12(in the La Union Bay)-13 m(outside the bay). It would take around one hour for a large ship to navigate there. However, according to the traffic projection, the number of larger ships to call the port would only be one to two a day in future.

43. According to experts of navigation safety, the width could be reduced to half of a ship length or five times as wide as a ship breadth under proper operational condition, taking into consideration such factors as mentioned above.

44. In this case, therefore, minimum 150 m is adopted as the width of the access channel. While some large ships such as Panamax type navigate there in one direction, however, other ships in the other direction should be subject to restriction. (The time when a few large ships occupy the channel one after another in one way is estimated at less than two hours.)

45. In addition, two tugboats of 3,000 HP and pairs of buoys placed at intervals of around 2 km and corners of turning basin and access channel are required as navigation aids.

11.2 Potential Sites for Port Development

11.2.1 Overview of the Bay of La Union as Project Site

1. Potential sites for the port development in La Union Bay will be identified and selected, taking into consideration the natural conditions and socio-economic activities. The areas for these sites could be generally characterized and summarized as follows;

(1) To the west of the Port of Cutuco

2. Neighboring the Port of Cutuco on the west, La Marina Nacional has a pier and a port captains office (Punta Ruca); the town area of La Union stretches 1-1.5 km along the coast. Several kinds of ports for small boats such as local fishing boats are located in the shallows. A mangrove forest spreads into the inner part of the bay.

(2) The Port of Cutuco

3. The port has been closed since 1996, because its structures are seriously timeworn and corroded. It is under the procedure of concession for reactivation, and waiting for offers which will be presented and opened at the end of April, 1998. Necessary procedures such as evaluation and approval will be finalized in August, 1998.

(3) Between the Port of Cutuco and the Port of Punta Gorda

4. This is a shallow pocket bay called the Punta Cutuco Bay. Solid foundation was confirmed at the level of a depth of around - 30 m in the center of it

based on the JICA survey (1997). The western section of the land area belongs to the Port of Cutuco, while the eastern part is owned by CORSAIN (the Port of Punta Gorda).

(4) The Port of Punta Gorda

5. This port had not been able to be utilized since its construction. In December, 1997, however, it started to serve tuna boats as originally designated thanks to the settlement of international problems(, in addition to port cargoes transferred from Cutuco). Related investment was also promised by Spain in 1997.

(5) Between the Port of Punta Gorda and Pueblo Viejo

6. The coast to the east from the Port of Punta Gorda to a small village, Pueblo Viejo, forms a mild bay with a length of around 2 km, where swamps continue and the area on land is relatively high and steep. Solid foundation was found at the level of a depth of around - 35 m at the representative point in the water by the JICA survey(1997).

7. The west part belongs to CORSAIN, and the remaining parts are owned by private sectors. The following points should be remembered in planning the port development.

1) On the east side of the Port of Punta Gorda, a small marina for cruiser boats is under consideration by CORSAIN.

2) In the same way, a thermal power plant with a pier of a depth of 10-12m was planned recently by CEL. This project is waiting for private investment at present.

3) Near Pueblo Viejo, in the east part of this section, there are three small private piers in a line. The west pier is old and out of service, the central pier is in use now, and the east pier is under construction.

(6) Between Pueblo Viejo and Punta Chiquirin

8. Punta Chiquirin is a cape at the entrance of the Bay of La Union. The area is the foothill of the Volcano of Conchangua. Major part consists of steep cliffs and rugged beaches. The access on land to coastline is limited because of such natural conditions.

11.2.2 Selection of Alternatives for Port Development

9. Generally speaking, potential sites for the port development in the Master Plan should be identified under the following principle;

a) Sufficient area for port activities with future expansion
b) Functional separation with necessary transportation
c) Related plans, including utilization of existing facilities, if possible
d) Environmental consideration

10. Based on the present situation and the principles mentioned above, the following preconditions are adopted for port planning.

1) The Port of Cutuco is to be reserved as much as possible for new concessionaires.

2) The Port of Punta Gorda is to be expected to play its originally planned role as a tuna base.

11. Considering the above preconditions, a new port should be planned to cope with the requirements as explained in the previous section(*). The following alternative sites are examined for construction of a new port. Locations of each site are shown in Figure 11-2-1. In the figure, the size of one container terminal (300x350m to 400x500m) is also put to be associated with the required size of the sites.

(Note) Coordination will be necessary to ensure that proposed functions of the Port of Cutuco and those of the new port are not duplicated.

1) Alternative Site (A-1)

12. This alternative is located between the Port of Cutuco and the Port of Punta Gorda. The area seems to be a little too small to build a new port.

1) Alternative Site (B-1,2 and B-3)

13. This alternative is located between the Port of Punta Gorda and Pueblo Viejo. It could be classified into three alternatives, based on other projects explained in the previous sections.

1) Alternative Site (B-1)

14. This utilizes the area fully, without considering the projects of the marina (CORSAIN) and the power plant (CEL). It would not affect the existing private piers near Pueblo Viejo.

1) Alternative Site (B-2)

15. Only the marina (CORSAIN) is considered in planning. It might affect the existing private piers.

1) Alternative Site (B-3)

16. The power plant (CEL) is also considered in this alternative. The existing private piers would be relocated in an appropriate manner.

1) Other Sites

17. The area to the west of the Port of Cutuco and that between Pueblo Viejo and Punta Chiquirin are excluded from the potential sites for port planning because of natural or environmental conditions.

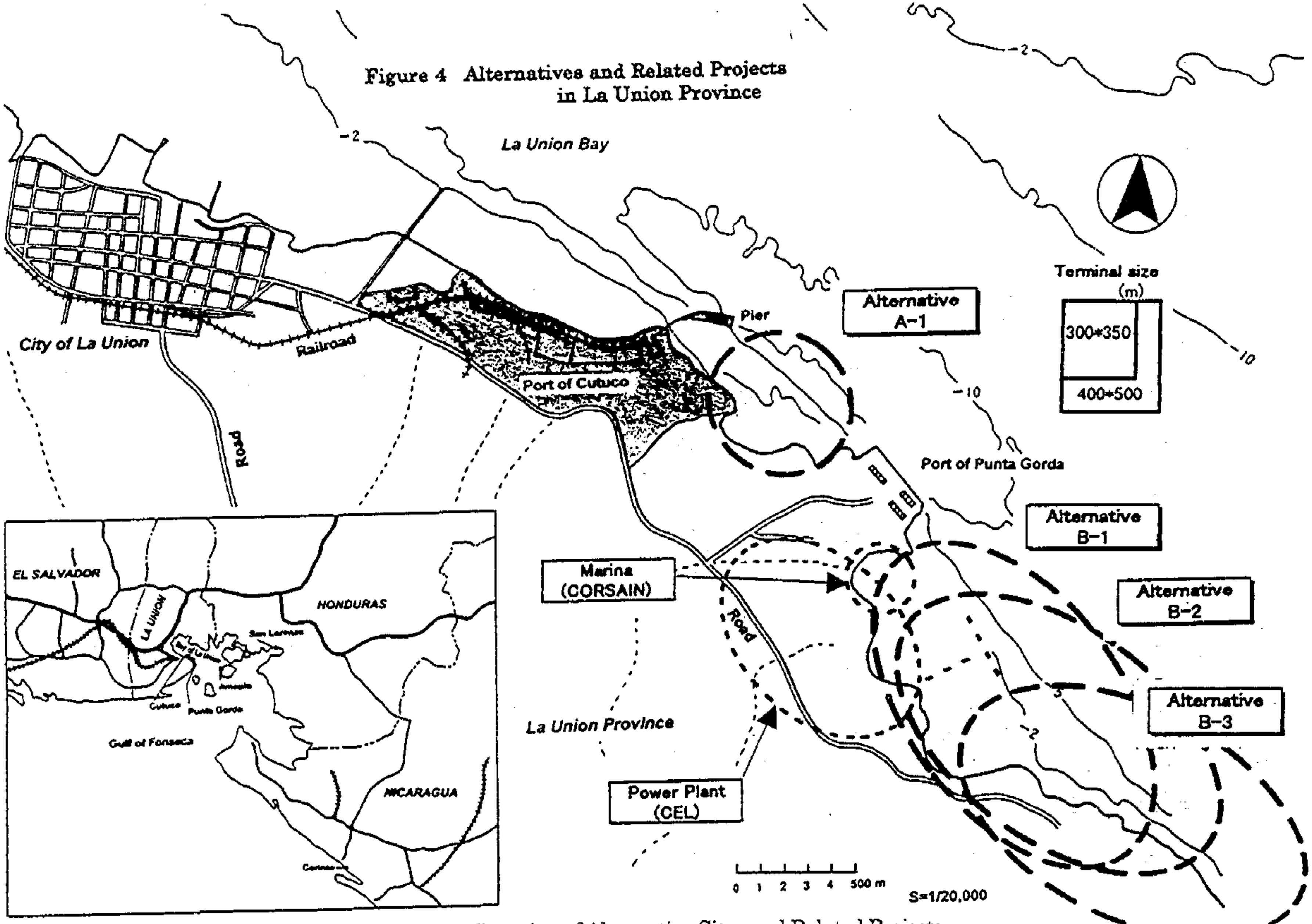


Figure 11-2-1 Location of Alternative Sites and Related Projects

11.3 Alternative Layout Plans

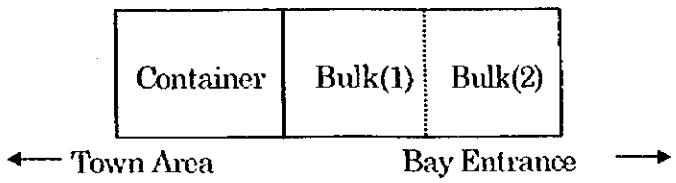
11.3.1 Berth Arrangement

1. Basically, the new port consists of a container terminal and a bulk terminal as described previously. The respective standard ship size in planning is almost the same for both terminals. The turning basin and access channel are common, and the berth depth is also the same.

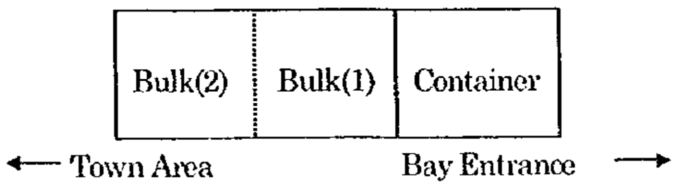
2. Taking into consideration the above, these berths are arranged consecutively in a line. They will be able to accommodate longer ships than designed, and let more smaller ships moor at the same time. In addition, it ensures flexibility for easy expansion of each terminal by berth extension.

3. The location of each terminal will be determined mainly based on the arrangement order, that is, which terminal is located in the western area or in the eastern area.

4. In this regard, two alternative ideas might be prepared as shown Figure 11-3-1. In one alternative (zoning plan 1), the container terminal is located in the western area and the bulk terminal in the eastern area. The other alternative(zoning plan 2) envisions the container terminal in the east and the bulk terminal in the west.



(a) Zoning Plan 1



(b) Zoning Plan 2

Figure 11-3-1 Berth Layout

5. Zoning plan 1 and zoning plan 2 are compared mainly from the following points of view;

1) Cargo type

6. The bulk terminal handles a lot of dry bulk such as grain and fertilizer, part of which might be blown by the wind in cargo handling. In addition, a lot of dangerous liquid bulk will be handled there. It is better to place it as far away from the town area as possible. In this case, the container terminal will be located on the west side. In planning, zoning plan 1 is recommended .

2) Investment

7. The container terminal has one berth. On the other hand, the bulk terminal consists of one berth for the Short-Term Plan and another for the Master Plan. From the viewpoint of the economic and financial analysis, larger investment should be put off as much as possible. The second berth of the bulk terminal should be located where larger investment will be necessary.

8. If the natural conditions are similar, the second berth at the west (zoning plan 2) might be expensive because of longer channel dredging. On the other hand, however, longer land access should be prepared for the Short-Term. Selection of the alternative will be made after the cost estimate is performed. Such a situation, in which zoning plan 2 is preferable in investment, could take place at all sites.

9. In conclusion, zoning plan 1 should be given priority from the planning point of view. Zoning plan 2 would be considered if necessary.

11.3.2 Container Terminal

10. At first, needless to say, container cargo handling should be focused on at this terminal. In addition, general cargo handling is examined, because containers are carried by general ships together with general cargoes in many cases(see Table 3-1-7, PART I). The required number of berths is calculated as one.

(1) Container Cargo

11. The number of container cargo which is handled through the container

terminal is 120,500 boxes for Case 1 and 99,500 for Case 2 in 2015, and 35,700 boxes for both cases in 2005. The requirement of other facilities in a container terminal are calculated based on the number of container boxes, TEU or tonnage at need.

(a) Container Yard

12. The total area of the yard including section roads could be set up based on the average yard area per storage slot of container. Required storage slot number of container is calculated by the following formulas as shown in Table 11-3-1.

$$Ml = (My \times Dw \times p) / Dy$$

Ml	: Required storage number of container (TEU)
My	: Annual container throughput (TEU)
Dw	: Average dwelling days (days)
p	: Peak ratio
Dy	: Operating days per year (days)

$$Sl = Ml / L$$

Sl	: Required number of ground slots
Ml	: Required storage number of container
L	: Stacking height of container

13. The peak ratio and operating days are assumed as 1.3 and 350 days. The dwelling days are assumed as 4 days for import, 3 days for export and 10 days for empty container. The stacking height is assumed as 2 for import and 3 for export and empty container.

14. Area per slot depends on container handling system and shapes of yard. According to some examples the area of container yards is approximately 35 m^2.

15. The total required number of ground slots in TEU is calculated as 1,200 for Case 1 and 1,000 for Case 2 in 2015, and 350 for both cases in 2005. Based on the average yard area per slot(35 m^2), 42,000 m^2 for Case 1 and 35,000 m^2 for Case 2 in 2015 is required as the yard, respectively. As well, 12,000 m^2 is required for both cases in 2005.

Table 11-3-1 Required Storage Slot for Container

(a) Required Storage Slot for Container (2015) for Case 1

	Import	Export	Empty	Total
Throughput(TEU) (My)	55,775	59,427	42,609	157,811
Dwelling Days (Dw)	4	3	10	
Peak Ratio (p)	1.3	1.3	1.3	
Operating Days (Dy)	350	350	350	
Required Number (Ml)	829	662	1,583	3,073
Stacking Height (L)	2	3	3	
Required Slots (Sl)	414	221	528	1,163

(b) Required Storage Slot for Container (2015) for Case 2

	Import	Export	Empty	Total
Throughput(TEU) (My)	45,734	49,386	35,181	130,301
Dwelling Days (Dw)	4	3	10	
Peak Ratio (p)	1.3	1.3	1.3	
Operating Days (Dy)	350	350	350	
Required Number (Ml)	679	550	1,307	2,537
Stacking Height (L)	2	3	3	
Required Slots (Sl)	340	183	436	959

(c) Required Storage Slot for Container (2005) for Case 1 and 2

	Import	Export	Empty	Total
Throughput(TEU) (My)	15,224	18,873	12,611	46,708
Dwelling Days (Dw)	4	3	10	
Peak Ratio (p)	1.3	1.3	1.3	
Operating Days (Dy)	350	350	350	
Required Number (Ml)	226	210	468	905
Stacking Height (L)	2	3	3	
Required Slots (Sl)	113	70	156	339

(b) Container Freight Station (CFS)

16. Required area for CFS is calculated by the following formula.
$A = (Mc \times Dw \times p) / (w \times r \times Dy)$

A : Required area of CFS (m^2)
Mc : Annual handling volume of container cargo through CFS (ton)
Dw : Dwelling days at CFS (days)
p : Peak ratio
w : Volume of cargo per unit area (ton/m^2)
r : Utilization ratio of CFS
Dy : Operating days per year (days)

17. The ratio of LCL (less than container load cargo) cargo at the port of Acajutla is around 20% for import and export cargo at present. The ratio of LCL cargo will remain the same in 2015 in the calculation. (In practice it would be expected to be decreasing in the future.)

18. The other parameters are assumed in reference to other similar cases, and the calculation procedure is shown in Table 11-3-2. As a result, required area of CFS is 4,400 m^2 for Case 1 and 3,700 m^2 for Case 1 in 2015, and 1,400 m^2 for both cases In 2005.

Table 11-3-2 Required Area of CFS

	2015		2005
	Case 1	Case 2	Case1, 2
Annual Handling Volume (ton)	735,440	618,470	225,152
Ratio of LCL	0.2	0.2	0.2
Annual Volume of LCL (ton)	147,088	123,694	45,030
Dwelling Day at CFS	6	6	6
Peak Ratio	1.3	1.3	1.3
Volume of cargo per Unit Area (ton/m^2)	1.5	1.5	1.5
Utilization Ratio of CFS	0.5	0.5	0.5
Operating Days per Year	350	350	350
Required Area of CFS (m^2)	4,371	3,675	1,338

(c) Maintenance Shop

19. Required area for maintenance shop depends on factors such as rate of damaged container, type and number of cargo handling vehicles and machines to be used in the terminal. Generally, size of maintenance shop is 800 to 1,000 m^2 per berth. An area of 1,000 m^2 is assigned for the maintenance shop.

20. Next to the maintenance shop, a 1,000 m^2 area of container cleaning space will be provided.

(d) Terminal Office

21. Terminal office is planned next to the terminal gate for management and operation of the container terminal. Generally, the area of a terminal office is 1,200 to 1,500 m^2 per berth. An office of 1,500 m^2 is planned in the terminal.

(e) Terminal Gate

22. Terminal gate is set up near access roads, and in the center of the container yard. Gate facilities are generally made up of 4 gate lanes (2 for entering and 2 for exiting) and two truck scales per berth.

(f) Empty Containers Stack

23. Space for empty containers stack should be secured in the terminal. Empty containers will be gathered by each shipping company and densely stacked up to four layers.

24. In general, an additional area of a few hectares is necessary outside the terminal. In this study, the area filled up next to the terminal or the existing area behind the terminal which is not in use will be utilized for it.

(g) Basic Facilities for Container Cargo

25. Based on the requirements mentioned above, basic facilities for container cargo are summarized as follows;

Table 11-3-3 Container Cargo Facilities

Facility	Size		
	2015		2005
	Case 1	Case 2	Case 1,2
Number of Berth	1 (300 m in length)		
Gantry Crane	2 (Panamax type)		
Apron	50 m x 300 m		
Container Yard	42,000 m^2 (1,200 slots*)	35,000 m^2 (1,000 slots*)	12,000 m^2 (350 slots*)
CFS	4,400 m^2	3,700 m^2	1,400 m^2
Maintenance Shop	1,000 m^2		
Terminal Office	1,500 m^2		
Terminal Gate	4 lanes		

Note: Reefer plugs should be equipped as necessary
(e.g., for 100TEU containers).

(h) Container Handling Equipment

26. Two gantry cranes will be installed at the terminal as aforementioned. The layouts of container terminals depend on the container handling system. Three typical systems are Chassis System, Straddle Carrier System and Transfer Crane System. Their model layouts are shown in Figure 11-3-2. There also exist many kinds of variations.

27. Recently, transfer crane system has been widely adopted. As chassis system requires a very wide area, more than 20 ha for one terminal, it seems impossible to secure such a wide space around sites restricted by natural conditions. Straddle carrier system also needs a relatively wide space and frequent maintenance. Therefore, transfer crane system is recommendable at La Union.

28. In the yard, two types of cargo handling are required: one is at quay side, and the other is outside of the terminal. Transfer cranes are used for both types. Tire mount type transfer crane with the span of 23 m (for 6+1 row) and a height of four layers clearance is one of the most popular cranes.

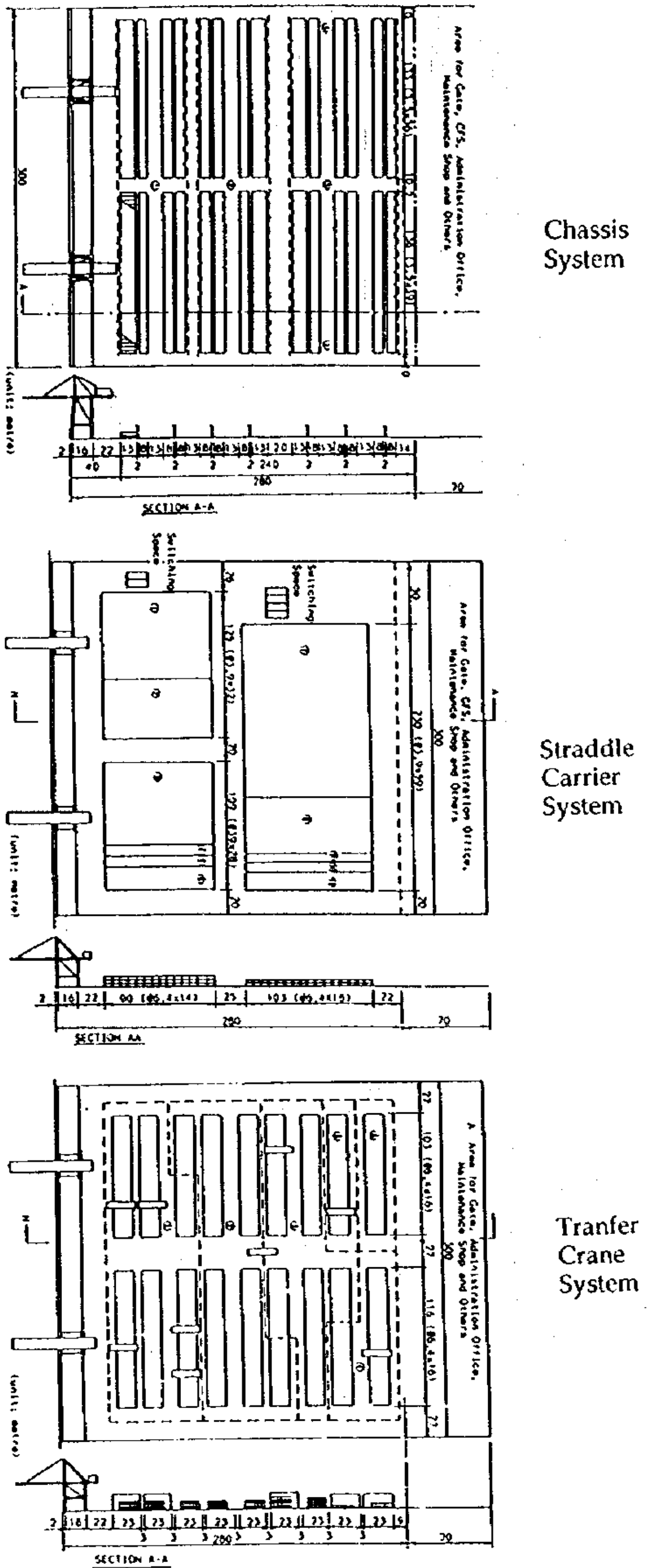


Figure 11-3-2 Model Layout of Container Terminal
Source; Japan Port and Harbor Association

29. These two handling operations could take place independently and simultaneously. Its average handling capacity is usually a little lower (18 boxes/hour) than that of the gantry crane (around 20 boxes/hour). To cope with the handling capacity of two container cranes, at least three(3) transfer cranes are necessary for the operation at quay side.

30. For the other operation, the necessary number of transfer cranes is calculated based on its capacity and the number of containers which are carried from the outside and to be handled in operating hours (see Table 11-3-4).

Table 11-3-4 Required Number of Transfer Cranes related to the Gate Operation

Target Year	2015		2005
	Case 1	Case 2	Case 1, 2
Annual Throughput of Containers Carried from the Outside (Boxes)	120,467	99,467	35,655
Number of Containers to be Handled in One Operating Hour (Boxes)	56	47	17
Required Number of Transfer Cranes	3	3	1

Note 1: Gate operating days are assumed as 350 days and 8 hours respectively. Peak ratio is assumed as 1.3.

Note 2: Quay side transfer cranes could be utilized for the outside operation while they are not engaged.

31. In total, 6 cranes are necessary for the year of 2015, and 4 cranes for 2005.

32. Simply speaking, required number of tractors and chassises depend on the distance between the center of the apron and the deepest corner of the yard. In general, however, four(4) sets of them are required for one(1) gantry crane. Ten(10) sets are prepared for two gantry cranes.

33. A few top-lifters are necessary for empty container handling, while a few forklifts are the main equipment inside CFS; some tractors and chassises are required between the yard and CFS at need.

34. The combination of container handling equipment in the terminal for Case 1 is equal to that for Case 2, and is summarized as follows;

Table 11-3-5 Container Handling Equipment for Case 1 and Case 2

Equipment	Number of Unit	
	2015	2005
Gantry Crane	2	2
Transfer Crane	6	4
Tractor	8	8
Chassis	8	8

(2) General Cargo

35. In addition to containers, general cargoes will be handled through this terminal.

(a) Apron

36. The width of the apron should be checked to ensure safe and smooth cargo handling between the front line of the berth and the transit shed or open storage area.

37. Various factors such as main cargoes, cargo handling equipment, land transportation, and the types of transit sheds and warehouses are considered in determining the apron width. The common apron with a width of 50 meters for container handling would be sufficient for the multi-purpose use in the future. (Generally, a width of 30 meters is adopted.)

(b) Transit Shed and Sorting Yard

38. Transit shed and sorting yard are also planned in this terminal area. Transit shed and sorting yard are used for tentative storage. Required area of storage facilities is calculated by the following formula.

$$Ab = (Mb \times p) / (Rt \times w \times r)$$

where Ab : Required area (m^2)
Mb : Volume through transit shed or sorting area (ton/year)

p	: Peak ratio (1.3)
Rt	: Turnover ratio (times/year) (50)
w	: Volume of cargo per unit area (ton/m²) (2.5)
r	: Utilization ratio of storage facilities (0.7)

39. Cargo volume through transit shed or sorting area is calculated by multiplying the annual cargo volume by ratio of such tentative storage facilities. The ratio is assumed as 0.9 for efficient cargo handling.

40. Required area of tentative storage facilities is 2,600 m^2 for Case 1 and 2,200 m^2 for Case 2 in 2015, and 1,050 m^2 for both cases in 2005 as shown in Table 11-3-6. These figures should be divided into the areas for the transit shed and for the sorting yard by cargo type.

Table 11-3-6 Required Area of Transit Shed and Sorting Area

	2015		2005
	Case 1	Case 2	Case1, 2
Annual Handling Volume (ton)	191,100	164,100	78,600
Ratio of the Facilities	0.9	0.9	0.9
Volume through the Facilities (ton)	171,990	147,690	70,740
Peak Ratio	1.3	1.3	1.3
Turnover Ratio	50	50	50
Volume per Unit Area (ton/m^2)	2.5	2.5	2.5
Utilization Ratio	0.7	0.7	0.7
Required Area (m^2)	2,555	2,194	1,051

(c) Warehouse and Open Shed

41. Next, warehouse and open yard are planned in the terminal area. The warehouse and open yard will be used for long term storage. Required area of storage facilities is calculated by the same formula as transit shed. It is assumed that half of the cargo through the terminal is storage in the port area.

42. Required areas of tentative storage facilities is 4,600 m^2 for Case 1 and 3,900m^2 for Case 2 in 2015, and 1,900 m^2 for both cases in 2005 as shown in Table 11-3-7 with parameters used in calculation. These figures should be divided into the areas for the warehouse and for the open yard by cargo type.

Table 11-3-7 Required Area of Warehouse and Open Shed

	2015		2005
	Case 1	Case 2	Case1, 2
Annual Handling Volume (ton)	191,100	164,100	78,600
Ratio of the Facilities	0.5	0.5	0.5
Volume through the Facilities (ton)	95,550	82,050	39,300
Peak Ratio	1.0	1.0	1.0
Turnover Ratio	12	12	12
Volume per Unit Area (ton/m^2)	2.5	2.5	2.5
Utilization Ratio	0.7	0.7	0.7
Required Area (m^2)	4,550	3,907	1,871

(d) Requirement of General Cargo

43. Based on the requirements of each of the above elements, the area for general cargo in the terminal is summarized. The physical requirement for aprons, transit sheds and sorting areas, warehouses and open sheds is as follows;

Table 11-3-8 General Cargo Facilities

Facility	Size		
	2015		2005
	Case 1	Case 2	Case 1, 2
Number of Berth*	1 (300 m in length)		
Apron*	50 m x 300 m		
Transit Shed and Sorting Yard	2,600 m^2	2,200 m^2	1,050 m^2
Warehouse and Open Shed	4,600 m^2	3,900 m^2	1,900 m^2

Note: Berth and apron is common with container cargo.

44. Basic layout of major facilities in the container terminal is roughly indicated and proposed in Figure 11-3-3 for the Master Plan. This should be flexibly revised attending to the actual situation of yard operation.

45. It also contains the area for general cargo and for future expansion. The latter area could also be utilized for vehicle storage or stacking of empty

containers for the time being. Inner access space should be kept wide enough for smooth transportation of containers. Reefer containers will be assigned at the most inner row with reefer plugs.

46. Gantry cranes should be able to move to the next berth for flexible assignment.

11.3.3 Bulk Terminal

47. The cargo transported by dry and liquid ships including oil barges are handled through this terminal. The required number of berths is calculated as two(2) for the Master Plan and one(1) for the Short-Term Plan.

48. These bulk cargoes are assumed to be immediately conveyed to respective storage facilities. For example, dry bulk cargo is handled with ship gear, movable hopper and vehicle just behind the front line of the berth, and then directly transported to silos. Liquid bulk cargo and oil are transported to tanks by a pipeline system installed at the berth.

49. The width of the apron should be adequate for safe and smooth cargo handling or installation of cargo handling equipment. Therefore, the same width of 50 meters as the container terminal, where the gantry crane and tractors/chassises could work is adopted, taking into consideration the flexible multi-purpose use in the future.

50. Next to them, as much open storage as possible should be arranged for future use of flexibility. Permanent facilities such as warehouses and silos should be installed as far from the quay face as possible.

51. Most tanks in which flammable materials are stored should be gathered together in a proper area under control. An area as far from human activities as possible should be allotted.

52. Required capacity for cargo storage in the port area is as follows. Some parameters are assumed, because the sufficient data has not been obtained as these kinds of port activities at Acajutla are already privatized.

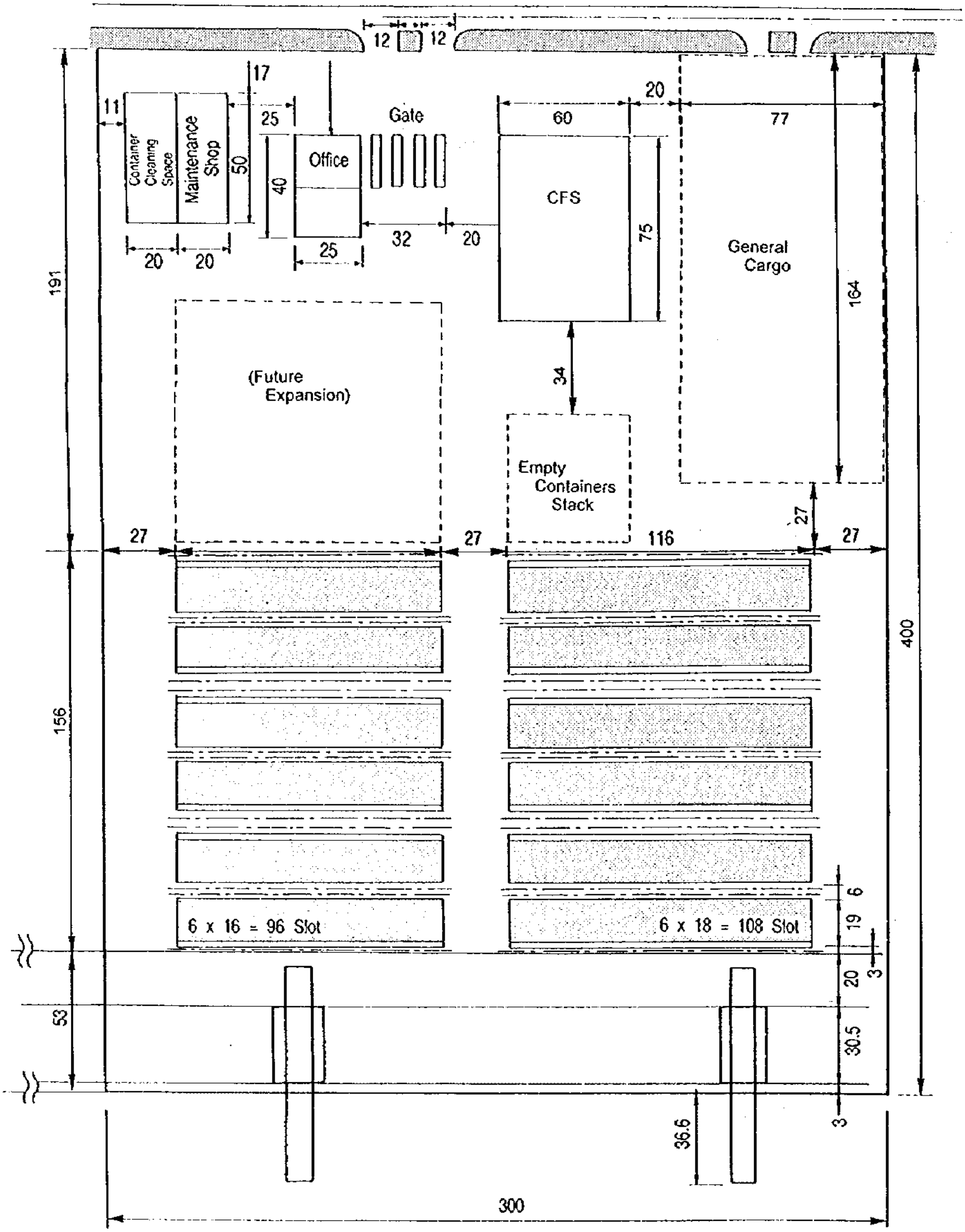


Figure 11-3-3 Layout Plan of the Container Terminal (Case 1)

53. These kinds of activities are suitable for the private sector. The details including the way of its participation should be planned between CEPA and the persons interested.

(1) Dry Bulk Cargo

54. The total cargo volume is forecasted as 357,000 tons in 2015 and 223,400 tons in 2005 for both Case 1 and 2. Required storage capacity is 17,850 tons in 2015 and 11,170 tons in 2005 based on the assumption that the turnover ratio is 20 times/year. These figures should be divided into the areas for warehouse/open storage(fertilizer) or silo(grain) by cargo type.

(2) Liquid Bulk Cargo and Oil

55. The total cargo volume is forecasted as 946,000 tons for Case 1 and 826,000 tons for Case 2 in 2015, and 452,200 tons for both cases in 2005. Required storage capacity for tank is 47,300 tons for Case 1 and 41,300 tons for Case 2 in 2015, and 22,610 tons for Case 1 and 2 in 2005 based on the assumption that the turnover ratio is 20 times/year. These figures should be divided by cargo in planning tanks.

(Note)

56. The experience at the Port of Acajutla could be utilized for rough calculation of the area necessary for cargo handling and storage of dry bulk cargo and liquid bulk cargo.

57. Concerning these cargoes, almost all the related activities are concentrated around the port. Warehouses, silos and tanks are located in the southern and the eastern areas of the port, surrounding the central facilities of CEPA.

58. The maximum cargo volume handled in a recent ten-years period is 890,000 tons in 1996 for dry bulk cargo and 760,000 tons in 1995 for liquid bulk cargo. The former could have been handled in the warehouses or silos are located in the lots of around 30 ha (the area of FERTICA for expansion is excluded), and the latter could have been in the tanks in the lots of around 8 ha (the area of CEL is excluded).

59. As a result, the utilization is estimated at 30,000 tons per ha for dry bulk cargo, and 95,000 tons per ha for liquid bulk cargo. Based on these figures, the required area is calculated as follows;

Table 11-3-9 Required Area

(a) Dry Bulk Cargo

	2015	2005
	Case 1, 2	Case 1, 2
Cargo Volume Stored*	357,000 ton	223,400 ton
Utilization	30,000 ton/ha	
Required Area (Lot)	11.9 ha	7.4 ha

(b) Liquid Bulk Cargo and Oil

	2015		2005
	Case 1	Case 2	Case 1, 2
Cargo Volume Stored	946,000 ton	826,000 ton	452,200 tons
Utilization	95,000 ton/ha		
Required Area (Lot)	10.0 ha	8.7 ha	4.8 ha

Note: Oil, which is distributed by small barges from Acajutla, is included.

60. In total, 21.9 ha and 20.6 ha in 2015 is necessary for Case 1 and 2, respectively. In 2005, 12.2 ha is required for both cases. On the other hand, 20.8-22.4 ha (520-60m x 400m) and 10.4-11.2 ha (260-80m x 400m) are prepared in planning as aforementioned. The shortage could be covered by the utilization increase of facilities or by considering the area outside of the terminal such as an existing area of around 4 ha for propane gas tanks behind the Port of Punta Gorda.

11.3.3 Turning Basin and Access Channel

61. In planning the layout, the channel is planned to be as straight as possible, passing the deeper water. The channel at a curve around the entrance to the La Union Bay is widened enough for the smooth navigation of a ship in order not to change the direction with an angle of more than 30 degrees at a curve. Entire plan of the channel is shown in Figure 11-3-4.

62. Along the approaching line, the stopping distance of five times as long as a ship length (1,500 m) is assured between the main channel and the continuous turning basin in front of the terminals. The water area in front of the terminals will be planned as shown later in Figure 11-3-5 ,6, 7 and 8.

63. Dredging shall be done in accordance with the stages of the development of new berthing facilities. For economical implementation, the dredging of the channel outside the Bay could be divided into that of up to - 12 m, the same as the inner channel, at the Short-Term Stage, and the remaining of up to -13 m.

64. Similarly, the turning basin could be dredged up to - 12 m at the Short-Term Stage. However, the berthing place in front of the pier (50 m x the corresponding pier length) should be kept at -13 m.

11.3.4 Road to Port

65. The number of necessary lanes for road from/to the port is basically calculated based on the cargo volume in future. However, the space for roads of at least four lanes should be assured taking into consideration the usage of large vehicles and the future traffic increase in many cases. The road network around the port is arranged considering the land use in the port.

66. The traffic volume is calculated by each terminal based on the following formula. Average tonnage per truck is assumed as 8 tons for general cargo, 1 box for container cargo, and 11 tons for dry and liquid bulk cargo and oil based on data at Acajutla and other planning examples. As well, the other parameters are assumed as follows.

$$N = V \times a / W \times (b / 12) \times (c / 30) \times (1 + d) / e \times f$$

N : Proposed traffic volume (cars/hour)
V : Annual cargo volume
a : Share by vehicle(1.0)
W : Average tonnage per truck
b : Monthly variation(1.3)
c : Daily variation(1.5)
d : Related vehicle rate(0.5)
e : Real load rate(0.5)
f : Hourly variation(0.12)

67. The generated traffic volume is shown in Table 11-3-10. In 2015, total 513 cars (Case 1) and 444 cars (Case 2) per peak hour will be generated from/to the container terminal and the bulk terminal, respectively. Total number of cars amounts to 209(Case 1, 2) in 2005.

68. This volume might be managed by a road of 2 lanes the capacity of which is assumed to be 500 cars per hour, taking into consideration the peak time divergence of each type of traffic. However, the space for a road with 4 lanes is reserved here, considering that the traffic volume may exceed 500 sooner or later and the recommendation mentioned earlier.

Table 11-3-10 Generated Traffic Volume

(unit: cars/hour)

	2015		2005
	Case 1	Case 2	Case1, 2
Container Terminal	282	234	89
Container	235	194	70
General	47	40	19
Bulk Terminal	231	210	120
Dry Bulk	63	63	40
Liquid Bulk	106	94	45
Oil	61	52	35
Total	513	444	209

69. The existing roads from/to the town area will be utilized as much as possible. However, it should be widened to at least 3.25-3.50 m per lane and paved for large vehicles. The existing road through the new port should be modified in alignment to pass just behind the terminals as a main access road.

11.3.5 Alternative Layout Plans

70. Based on the above, four layout plans for Alternative Site (A-1), (B-1), (B-2) and (B-3) are prepared as follows;

1) Alternative Plan A-1 (see Figure 11-3-5)

71. The container berth is 300 m long, and the bulk berths are 260(+20) m

long per one berth. The total length necessary for these is 860 m, which contains the allowance for future expansion of bulk berths (20x20m). The area of this site is just large enough for the above provisions. In other words, there is no room left for the future expansion after the target year (the Post-Master Plan).

72. For the usage of the Port of Cutuco, the space for ship maneuvering is secured in the front of its pier. As a result, the quay face line is close to land. More dredging would be necessary near the land where hard rock is found at a shallow depth.

73. On the other hand, this plan makes the most of the existing deeper water around Cutuco and Punta Gorda for the turning basin and channel. In addition, the wide flatland behind the terminals (around 30 ha, excluding the main area of Cutuco) would be available for related activities. An access road is able to be secured easily. However, it includes part of the land area for the concession.

1) Alternative Plan B-1 (see Figure 11-3- 6)

74. In planning, this is one of the most desirable layouts in this site. It has advantages such as a wide useable area behind the terminal (more than 50 ha), easy road access, a shorter navigation channel and an area for future expansion.

75. However, the survey revealed that the construction of pier structures would be expensive because of the existence of a relatively thick weak layer of subsoil around it.

1) Alternative Plan B-2 (see Figure 11-3- 7)

76. Considering the water space for the marina (CORSAIN) and assuming the existing solid layer of subsoil at the proper level from the viewpoints of economical construction (around a depth of a little deeper than - 14 m), the layout totally moves to the east and to the land side. On land, however, there is a relatively high place, which limits development. An area of around 10 ha is easily secured by reclamation on the west, where easy access is also arranged.

1) Alternative Plan B-3 (see Figure 11-3- 8)

77. Owing to the project of the power plant (CEL), this alternative is the Alternative Plan B-2 which totally moves to the east. There is scarcely any useable

area neighboring the terminals. In addition, it is necessary to demolish the existing private piers at Pueblo Viejo. Some proper compensation for it would be necessary. (The existing Port of Punta Gorda or Cutuco could be also alternatives for it.)

78. The project of the power plant is equipped with a pier of a depth of 10-12m for a 20,000 - 30,000 DWT ship, which might require some dredging of the common area for the basin and channel. In this case, generally, the construction cost will be shared between the project of the Study and the project of the power plant.

(Note)
79. Through the above alternatives, exclusive piers aren't planned for service boats such as tugboats and launches. They are so small that they can use the end of the berth or the side of the terminal.

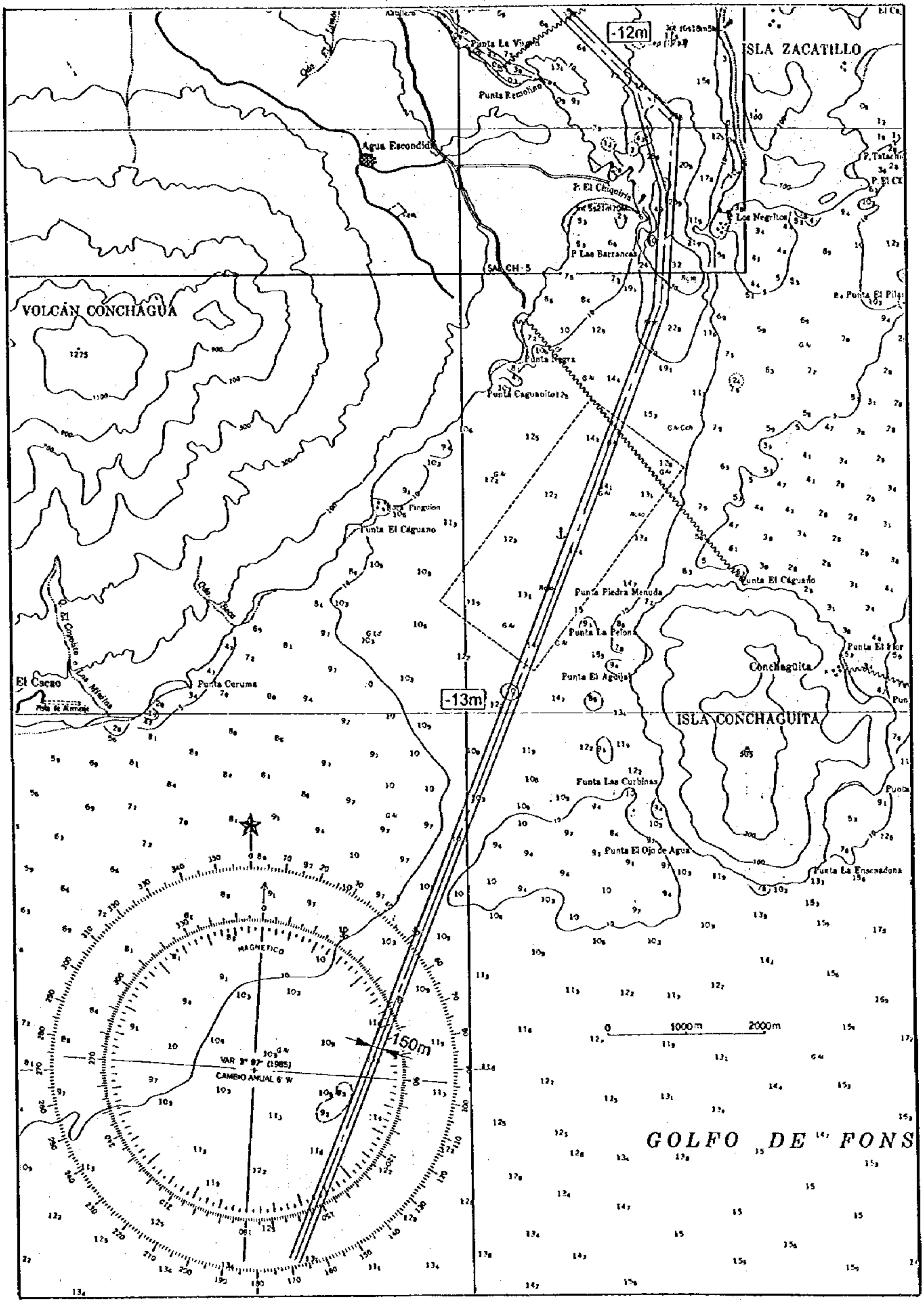


Figure 11-3-4 (1) Entire Plan of the Channel (outside the Bay of La Union)

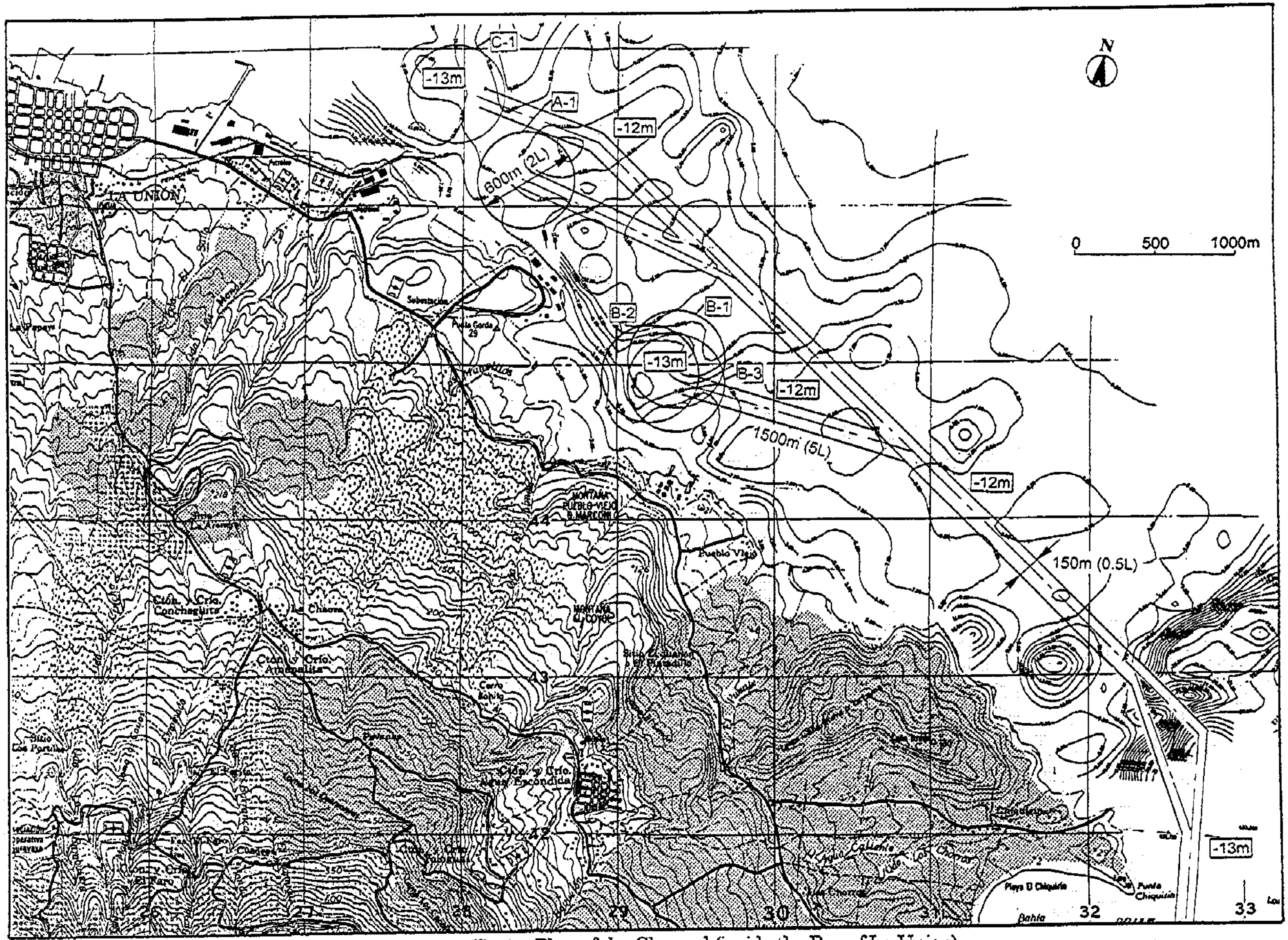


Figure 11-3-4 (2) Entire Plan of the Channel (inside the Bay of La Union)

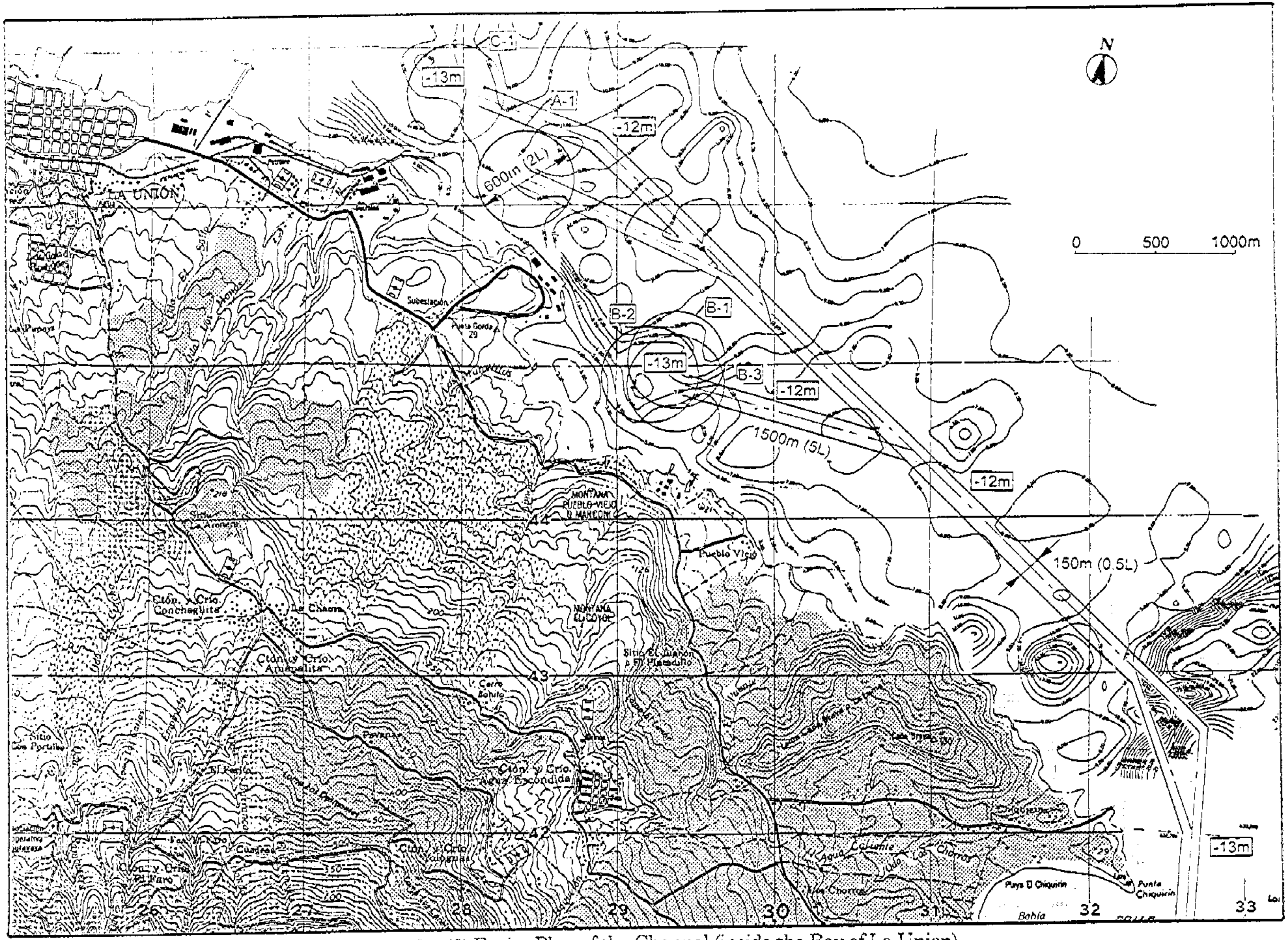


Figure 11-3-4 (2) Entire Plan of the Channel (inside the Bay of La Union)

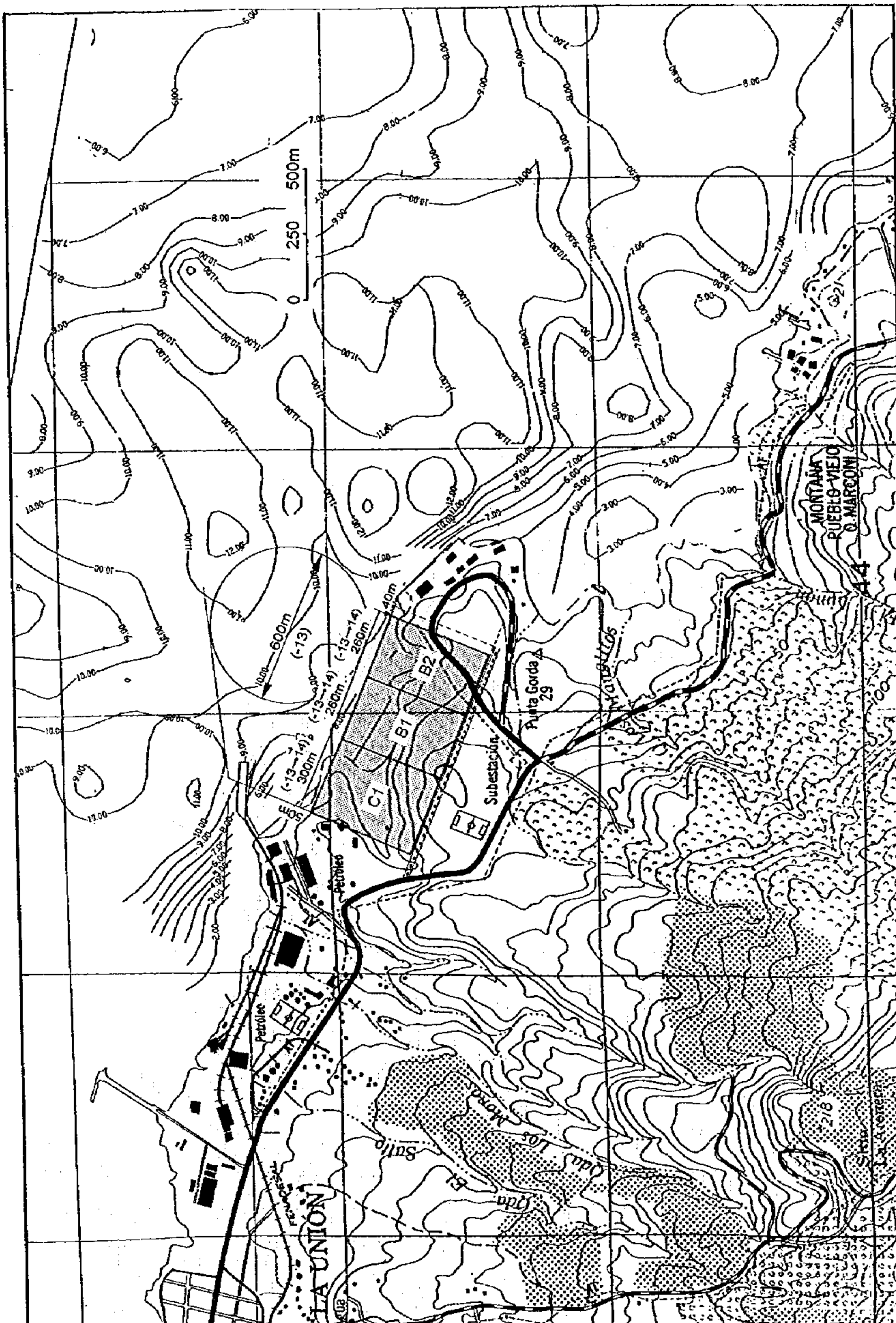


Figure 11-3-5 Layout Plan for Site (A-1)

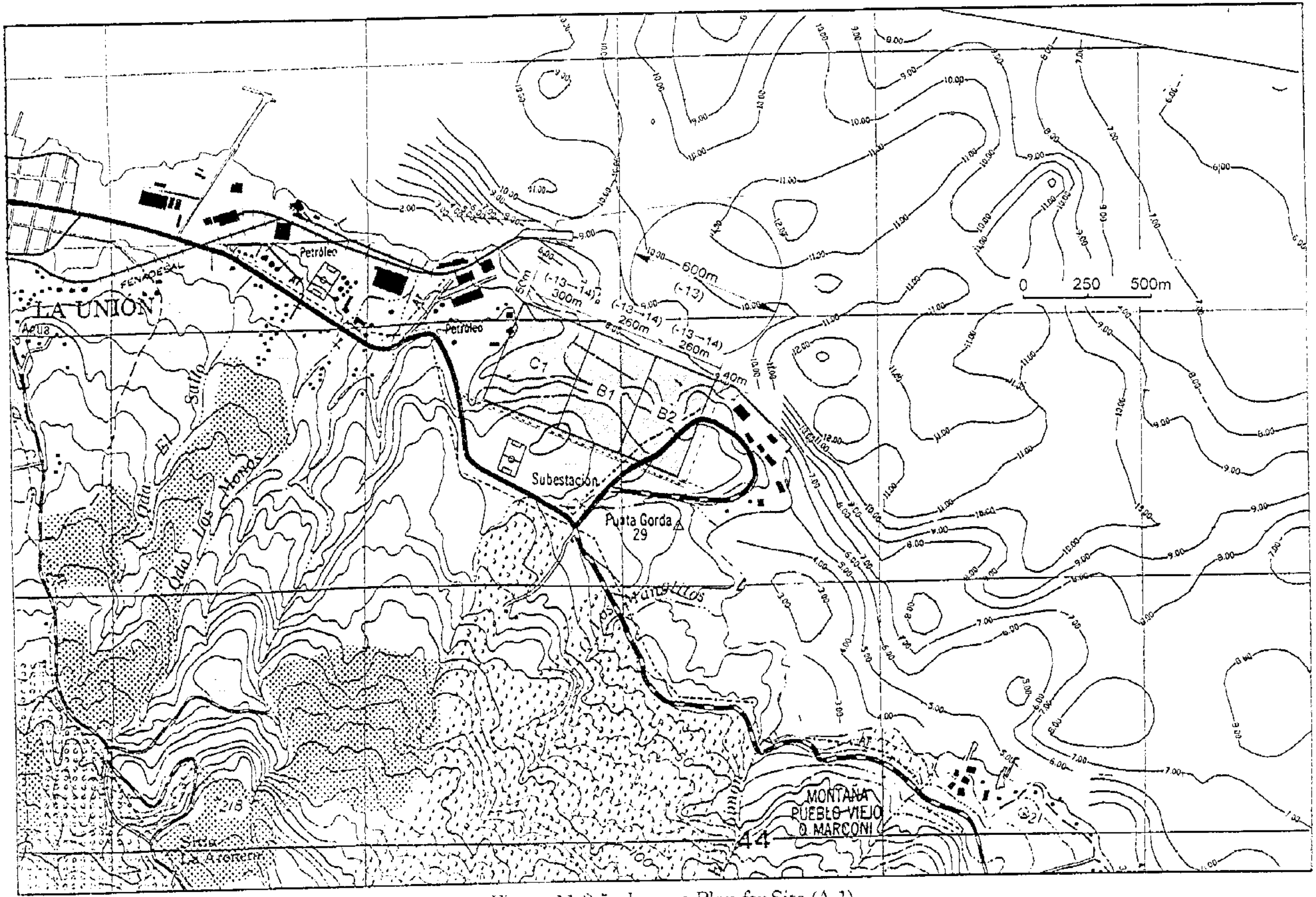


Figure 11-3-5 Layout Plan for Site (A-1)

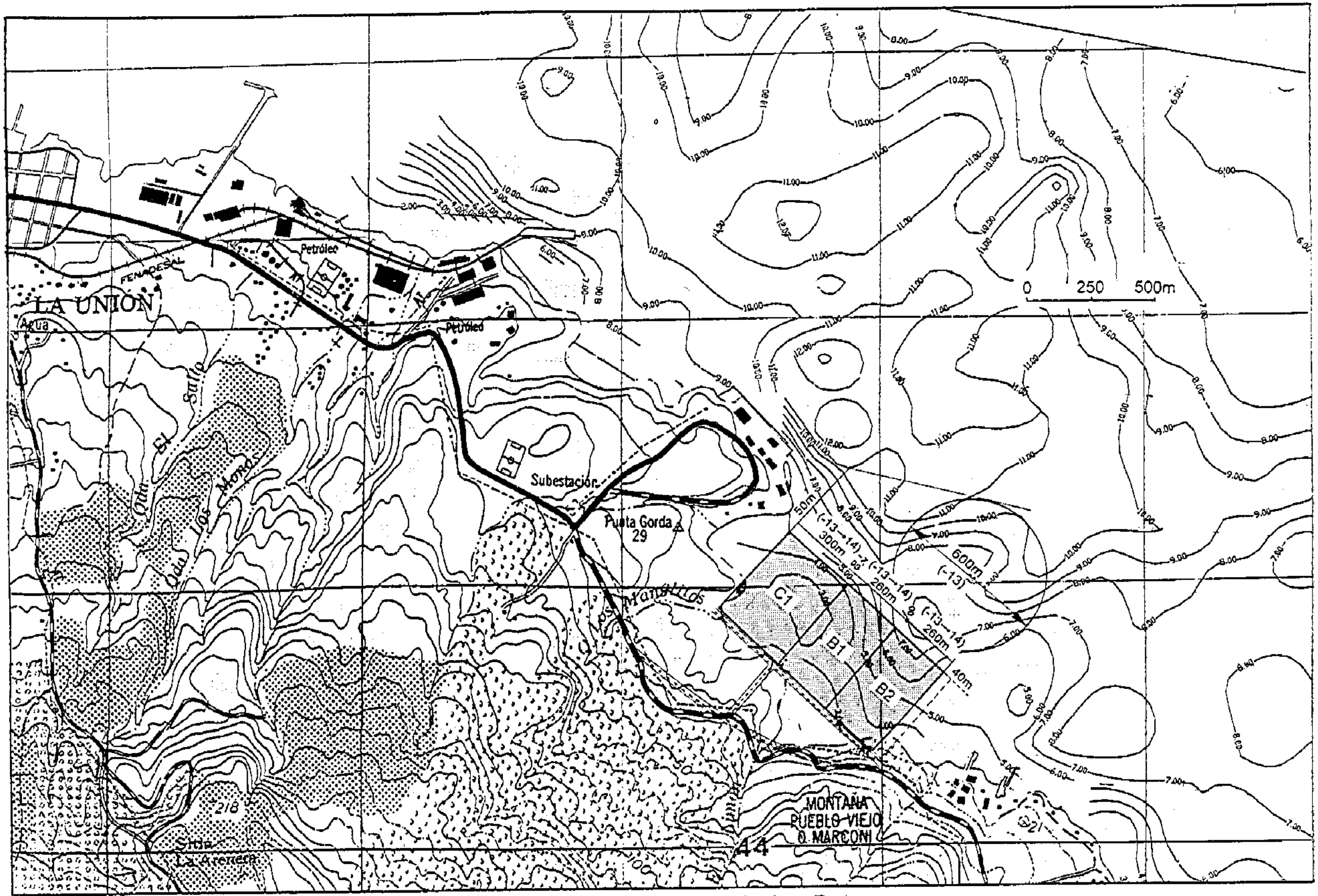


Figure 11-3-6 Layout Plan for Site (B-1)

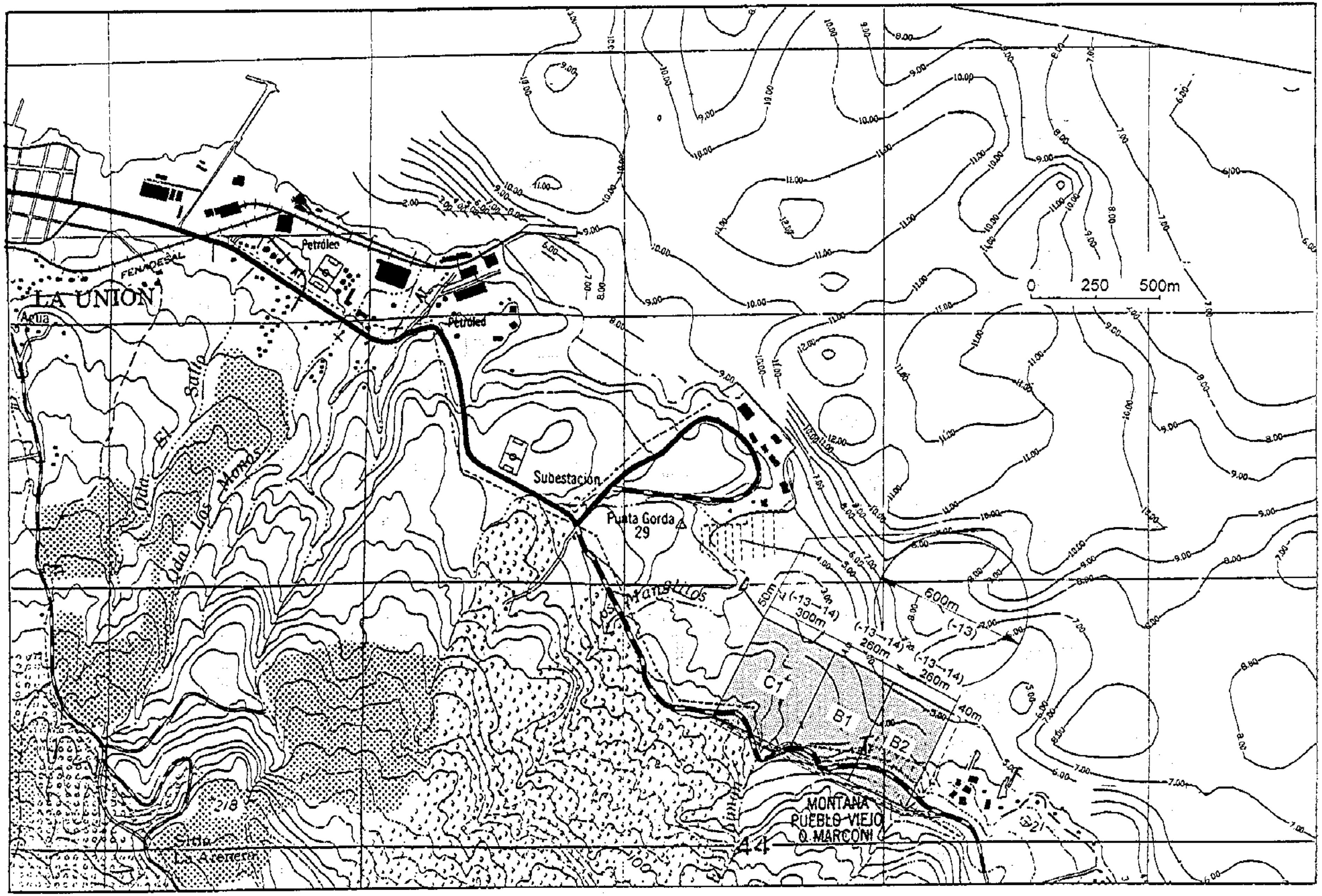


Figure 11-3-7 Layout Plan for Site (B-2)

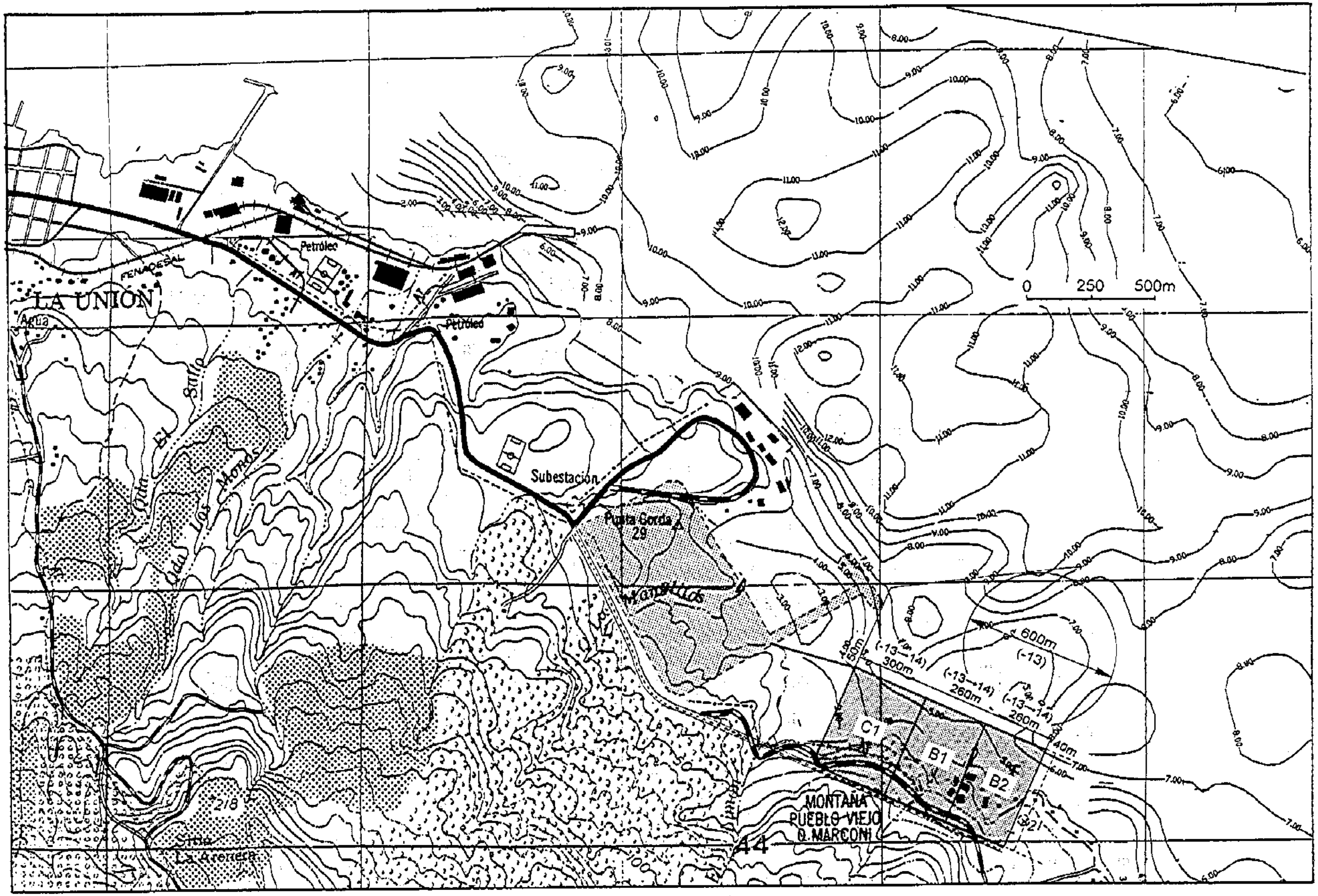


Figure 11-3-8 Layout Plan for Site (B-3)

11.4 Road Network Development and Land Use Plan

11.4.1 Road Network Development

1. The existing road behind the port also runs through the town area The corresponding sections are too narrow for large vehicles and too congested with a lot of citizens. In order to avoid an accident and secure smooth access from/to principal national roads, a new road bypassing it should be constructed as soon as possible.

2. From the viewpoint of nationwide collection of cargoes, especially containers, the principal national road network should be improved at the same time. In particular, improving the road network of the eastern region should be given special attention, which will also contribute to regional development.

11.4.2 Land Use Plan

3. The area near the port has the potentiality to attract many types of business. They will vitalize both the port activities and the regional economy, utilizing a large amount of space undeveloped near the port area and/or in the eastern region.

4. Among them, port administration facilities should be located in close proximity to the port from the viewpoint of its efficient management. Smooth communication between CEPA and other organizations such as government offices (CIQ) and shipping agencies is important for good service to port users. The zone for them is planned at the center of the port area (between the container terminal and the bulk terminal).

5. In addition, EPZs are considered and proposed as one of the most attractive types of land use for port related activities. The main functions of EPZ are to process the goods imported from abroad for posterior re-export mainly through the port. Therefore, it is favorable and beneficial to set up EPZs near the port.

6. As mentioned in Part I, a new EPZ of a total area of around 100 ha could be developed in the eastern region, based on the past performance of EPZs in the western and central region in El Salvador. As a matter of fact, construction of a new EPZ in Usultan has started recently.

7. As well, EPZs requires labor force at a certain level of quality, public infrastructures and services development, which will also contribute a lot to the comprehensive development of the eastern region.

8. The area near the port or along access roads to it could be allocated for EPZs. Significant part of the goods to be processed in these EPZs would pass through the port thanks to its advantageous location.

9. Of course, other types of port related industries could be located for the mutual convenience and development on a preferential basis.

11.5 Planning Stage and Development Schedule

1. The Master Plan consists of three main berthing facilities as follows;

1) Construction of Container Terminal
2) Construction of Bulk Terminal (1st Stage)
3) Construction of Bulk Terminal (2nd Stage)

2. These facilities shall be constructed in order to meet the demands. The construction schedule is proposed as shown in Table 11-5-1.

Table 11-5-1 Main Berthing Facilities

Phase	Main Berthing Facilities	Target Year	
		Case 1	Case 2
Short-Term Development (2005)	Container Terminal	at once	the same as Case 1
	Bulk Terminal (1st Stage)	as soon as possible	the same as Case 1
Long-Term Development (2015)	Bulk Terminal (2nd Stage)	2009(*)	2010(*)

Note (*): In this year, the total berth occupancy ratio for two terminals would exceed the critical value of 1.4, therefore the third terminal should be in operation before this time if possible.

3. The construction of the container terminal is urgent in order to collect as many containers as possible, get a sure grip on a large custom, and occupy an indisputable position on the Pacific in Central America at the early stage.

4. As to the bulk terminal, one berth shall be constructed at the Short-Term Stage, and the other shall be extended continuously at the next stage.

5. Besides, works and installations such as dredging of the channel and the turning basin, land reclamation, pavement, roads, cargo handling equipment, navigation aids and tugboats shall be included in accordance with the staged development of the above main facilities.

6. The planning stage just explained above will be employed as a basic case for the calculation of the project feasibility in this Study. In practice, it is important to cope with events which aren't expected to take place; for example, drastic increase of cargo volume or impressive enlargement of vessel. The plans and the development schedule proposed in the Study can be modified with relative ease to meet such a case.

12. ROUGH STRUCTURAL DESIGN

12.1 Design Conditions and Criteria

12.1.1 Design Conditions and Criteria (La Union)

(1) Oceanographic Conditions

Oceanographic conditions at the site are set as follows.

1) Tides

High tides in La Union are characteristic compared to the sea level of Acajutla Port. The following tidal levels are observed at La Union based on the chart datum. The Mean High Water Spring (M.H.W.S.) reaches +3.05m over the chart datum (C.D.L.).

- Mean High Water Spring (M.H.W.S.) +3.05m
- Mean High Water Neap (M.H.W.N.) +2.44m
- Mean Low Water Neap (M.L.W.N.) +0.61m
- Mean Low Water Spring (M.L.W.S.) +0.03m

The M.H.W.S. is adopted as the design high water level (H.W.L.) in consideration of the records of water levels at La Union. And the datum level (DL) is determined to be the same as the chart datum.

H.W.L. +3.1m
DL ±0.0

2) Waves

There are two types of hurricanes, the Pacific Ocean generated type and the Atlantic one. (See, 1.2.2) The former has not ever affected to El Salvador. According to the meteorological records, the latter once brought the strong winds to the coastal area of El Salvador in 1974. But, those winds were off-shore ones, and did not cause the high waves.

In this study, the design waves are estimated from the record of deep-water waves in the Pacific Ocean.

However, as mentioned in 5.4.3 (4), La Union Bay is well sheltered by many isles and capes, and consequently all the waves at La Union Bay are expected to be less than 0.3m in height

(2) Subsoil Conditions

2. Subsoil conditions in La Union are typically different in the following two areas.

- Water areas at both sides of Punta Gorda Port
- Water area around the jetty of Cutuco Port

1) Water areas at both sides of Punta Gorda Port
Based on the results of the subsoil surveys carried out by this study in 1997 and by CEPA in 1954, subsoil conditions at water area between Cutuco Port and Punta Gorda Port are generally characterized as follows.

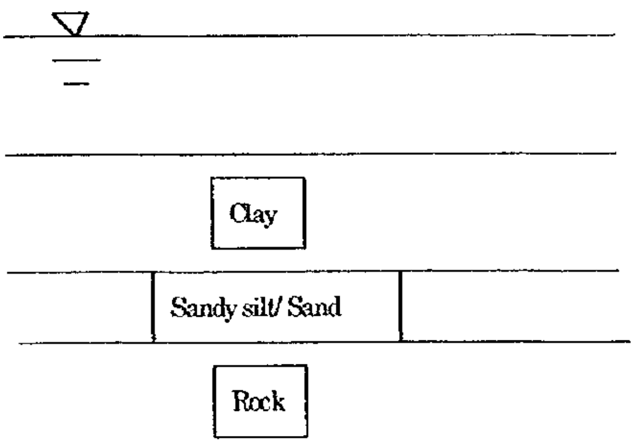


Figure 12-1-2-1 Soil Characteristics at La Union

Upper layer consists of clay, and its thickness ranges between 15-20m. This layer is very soft with N-values indicating almost zero (0). Under this clay layer, sandy silt/sand layer exists with the thickness around 5m. N-values of this layer are large (some 50) and defined as rock in the preceding survey. (See, Figure 5-4-6(2) Section-3) The contour lines of hard (rock) layer were estimated by the above survey. (See, Figure 5-4-6(1)

Subsoil conditions between Punta Gorda Port and private jetties (Astillero) seem to be almost same as between Cutuco and Punta Gorda judging from the result of the boring carried out by this study as well as the geological situation.

Subsoil layers of this area are presumably composed of soft clay layer and hard layer (rock) underneath. Although hard (rock) layer all over this area are not confirmed by borings directly, the similar trend observed between Cutuco and Punta Gorda is assumed as well. The contour lines of hard layers are estimated as shown in Figure 12-1-1-2. As a result, design soil conditions at the area is set as follows.

Table 12-1-1-1 Design Soil Conditions at the Both Sides of Punta Gorda Port

Stratum	Symbol	Soil Characteristics	N-value	Unit Weight (t/m3)
Clayey stratum	OL	Clay with silt, soft to very soft, high plasticity.	0	1.45
Sandy silt/Sand stratum	SP	Sandy silt/ Silty sand	30-50	1.80
Gravel/Sand stratum	SP+G	Gravel and sand	>50	1.80

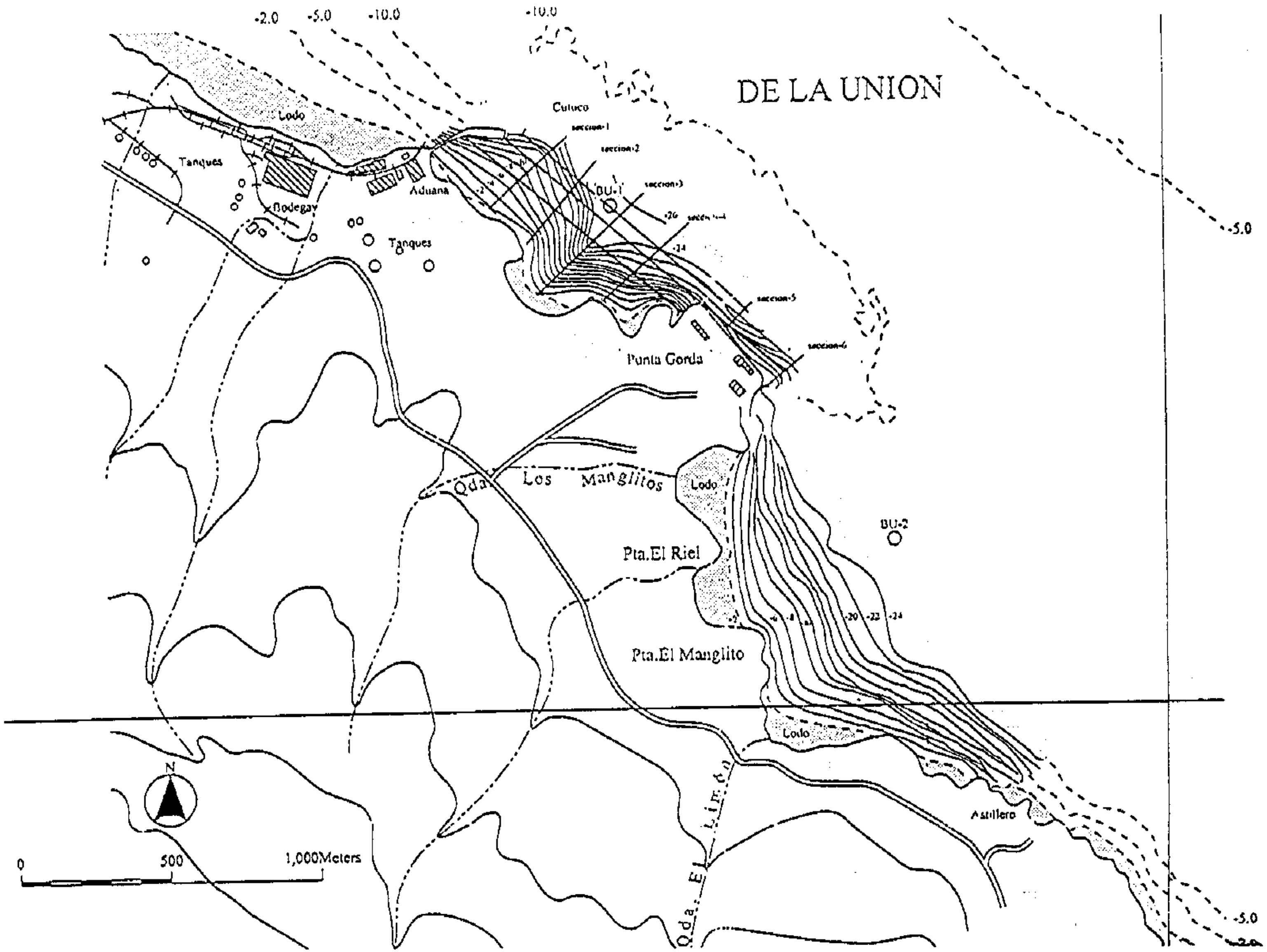


Figure 12-1-1-2 Estimated Hard Layer Depth at Port Site

2) Water area around the jetty of Cutuco Port

In 1977, ten (10) borings were conducted around the jetty of Cutuco Port. The results (N-values) are summarized in Figure 12-1-1-3. (Note: "Off-Shore" means the off-shore side of Cutuco jetty, and "On-Shore" means the on-shore side of Cutuco jetty.)

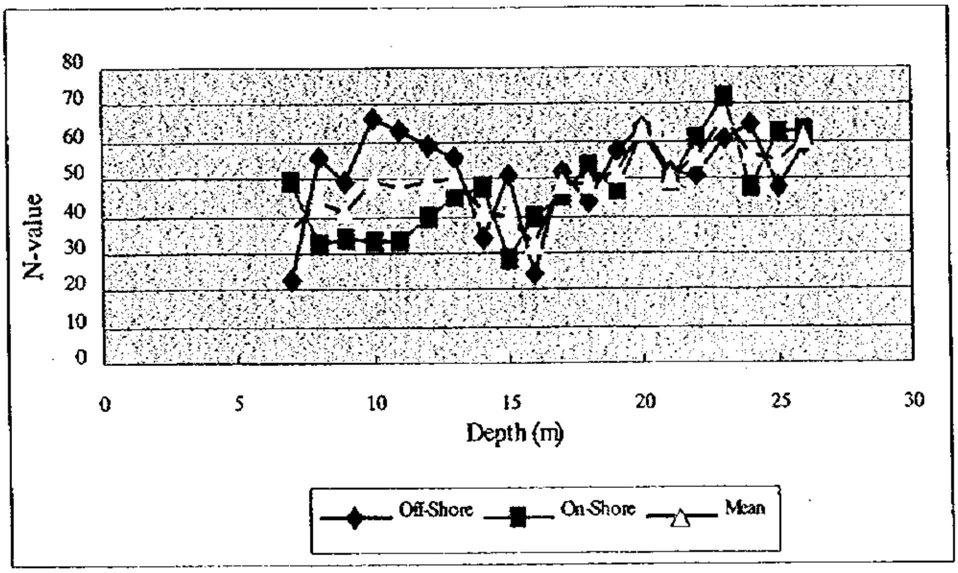


Figure 12-1-1-3 Average N-values at Cutuco Port

According to these results, N-values in the off-shore side are larger than the on-shore side. Generally, N-values tend to become larger at the deeper layers. However, N-values larger than 30 are found from the surface of seabed in some places. The average of the total N-values shows 48. The existence of hard layer is expected at the deeper places. Although there are some fluctuations of N-values locationally, the design soil conditions at the site are assumed as follows.

Table 12-1-1-2 Design Soil Conditions around the Cutuco Port

Stratum	Symbol	Soil Characteristics	N-value	Unit Weight (t/m3)
Sandy silt/Sand stratum	SP	Sandy silt/ Silty sand	30-50	1.80
Gravel/Sand stratum	SP+G	Gravel and sand	>50	1.80

(1) Design Seismic Coefficient

3. There is a "Technical Standard for Earthquake Design" in El Salvador published by the Ministry of Public Works. But, this standard is to be applied to buildings. Those special structures such as bridges, tunnels, piers and others are not regulated by this standard and must be designed based on the known international rules. The seismic coefficient method will be adopted in the facility design. In this method, the design seismic coefficient (kh) shall be determined in accordance with the following formula considering the classification of region where structures are planned, that of the subsoil condition and the degree of importance of the structure.

Design seismic coefficient = Regional seismic coefficient x Factor for subsoil condition x Coefficient of importance

The design seismic coefficient is proposed in accordance with the local conditions as follows.

Design seismic coefficient:	0.15
Regional seismic coefficient:	0.15
Factor for subsoil condition:	1.00
Coefficient of importance:	1.00

(2) Dimensions of Planned Ships

4. The maximum dimensions of vessels for the new berth are determined in the previous chapter of the Master Plan.

Table 12-1-1-3 Dimensions of Planned Ships

Ship Type	DWT	Length(m)	Breadth(m)	Draft(m)
Container Ship	40,000	295	32.0	12.0
Bulk Carrier	50,000	216	31.5	12.4

(5) Dimensions of Berth

5. The water depth of design, that is design depth, should be appropriate no less than the full load draft of the coming vessels plus some allowance. The draft of the vessels depends on the dead weight ton (DWT) of the vessels, and the allowance varies with such natural conditions as seabed, waves, seabed materials and etc., in front of the berth. Taking allowance as 0.6-1.0m, the design depth is planned as -13.0m for container berth and bulk berth in the short-term plan. However, the design depths will be set as -14.0m considering the larger vessels in the master plan.
The crown heights of berths are generally planned by the following values above H.W.L.

Table 12-1-1-4 Crown Heights of Berths above H.W.L.

Berth Dimension	Tidal Range 3.0m or more	Tidal Range less than 3.0m
Berth for Large Ship (with A water depth of 4.5m or more)	0.5-1.5m	1.0-2.0m
Berth for Small Ship (with A water depth of less than 4.5m)	0.3-1.0m	0.5-1.5m

In La Union, the crown heights of container berth and multi-purpose berth are set as +4.5m. (1.4m above the H.W.L.)

(6) Berthing Velocity and Tractive Force

6. Design berthing velocity is determined as follows in consideration of the dimensions of planned ships and the availability of the tugboats. The tractive force on a bit is assumed as follows corresponding to the planned ship size, acting in all directions.

Table 12-1-1-5 Berthing Velocity and Tractive Force

Ship Size (DWT)	Berthing Velocity (cm/sec)	Tractive Force (ton)
40,000-50,000	10	70

(7) Surcharge on Berth

7. Following design surcharge and live loads are presumed by the structural type for the berthing facilities.

Table 12-1-1-6 Design Surcharge Loads

Structural Type		Concrete Caisson Type		Steel Pile Open Type	
Berth		Container	Bulk Berth	Container	Bulk Berth
Ordinary Condition	Surcharge	3t/m2	3t/m2	3t.m2	3t/m2
	Live Load	Container Crane	Straddle Carrier	Container Crane	Straddle Carrier
Earthquake Condition	Surcharge	1.5t/m2	1.5t/m2	1.5t/m2	1.5t/m2
	Live Load	Container Crane	Straddle Carrier	Container Crane	Straddle Carrier

Live loads are assumed as follows.

Container Crane:

Table 12-1-1-7 Wheel Load

(Unit:t/wheel)

Position		Water Side		Land Side	
Direction		Vertical	Lateral	Vertical	Lateral
Condition	In service	36	3.0	35	3.0
	Out of service	33	3.5	45	3.5
	Earthquake	48	3.7	48	3.7

Straddle Carrier:

Total weight : 80t
Dead weight : 42t
Load : 38t

12.2 Structural Design

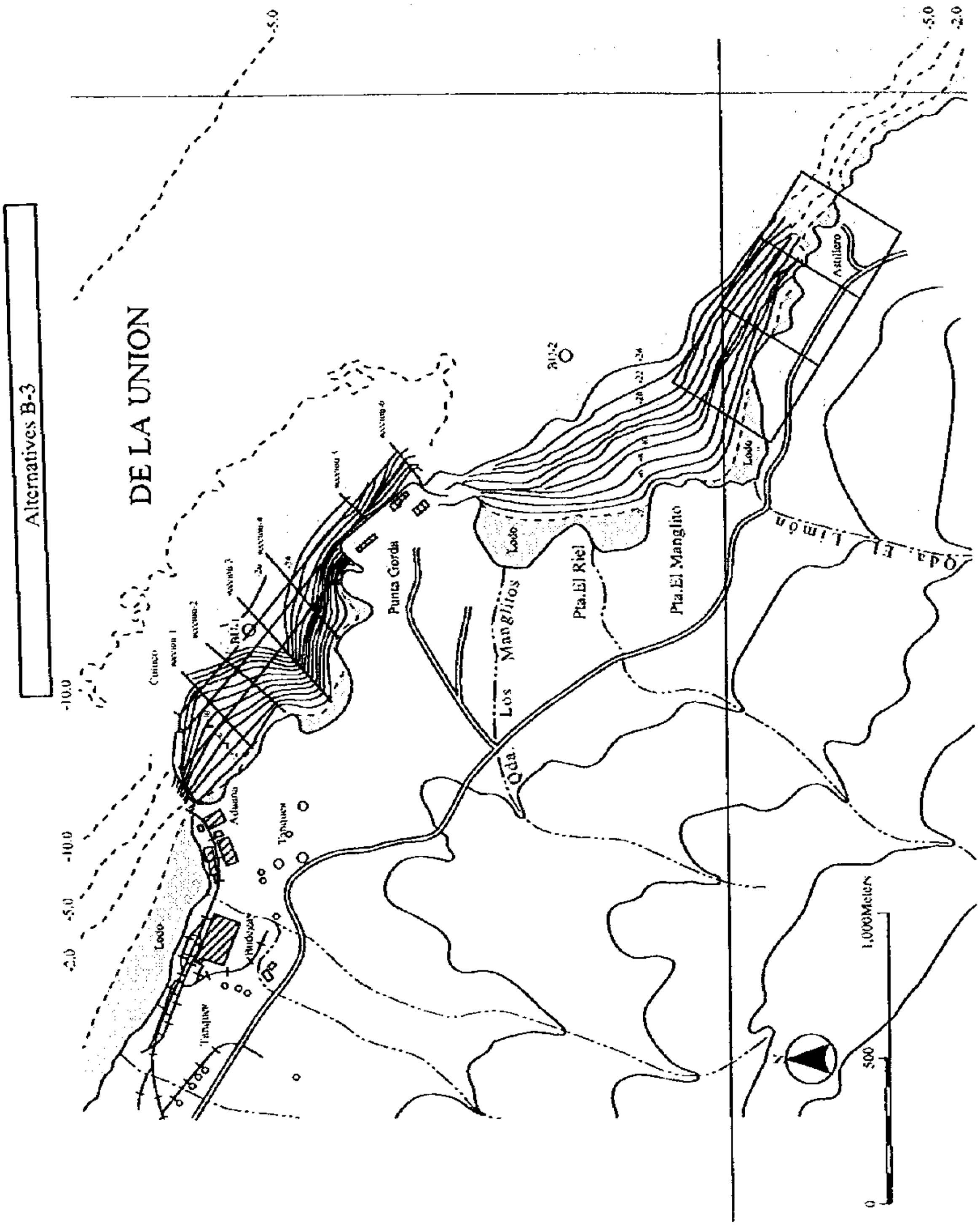
1. There are some alternatives for the facility layout plan. Soil conditions are one of the most important factors in determination of the suitable structural type in each alternative.
The following three structural types are examined as possible structural types applicable for the deep water berths in this project.

- Concrete caisson type berth
- Concrete block type berth
- Open type berth with steel piles

2. It is clear from the subsoil survey results that there exists clay layer with the thickness of some 10 m and hard layer beneath them at both sides of Punta Gorda Port. However, this clay layer can not be expected to have any bearing capacity. So, the gravity type structures using the hard layer are chosen for the mooring facilities and revetment. (Figure 12-2-1~12-2-4)
As for the concrete block type, one of the gravity type, the more the water depth deepens, the more the construction cost increases compared to other types because of its increased concrete volume.
Therefore, the concrete caisson type is the most applicable one for this site.

3. While, at the site around the jetty of Cutuco Port, the relatively hard sandy layers with N-values larger than 30 are recognized from the surface of the seabed. So, open type with steel piles is advantageous for this site. Same types have been adopted for the existing Cutuco Port and Punta Gorda Port. Table below shows a comparison of concrete piles and steel piles concerning some items. As the result of comparison, the open type with steel piles is recommendable to the mooring facilities at this site.

Figure 12-2-5 and Figure 12-2-6 show the typical cross sections of the open type with steel piles, respectively.


Alternatives B-3
DE LA UNION
Punta Gorda
Los Manglitos
Qda.
Pta.El Riel
Pta.El Manglito
Qda. El Limón
Lodo
Lodo
Lodo
Aduana
Astillero
-2.0
-5.0
-10.0
-10.0
-5.0
-5.0
-2.0
0
500
1,000Meters

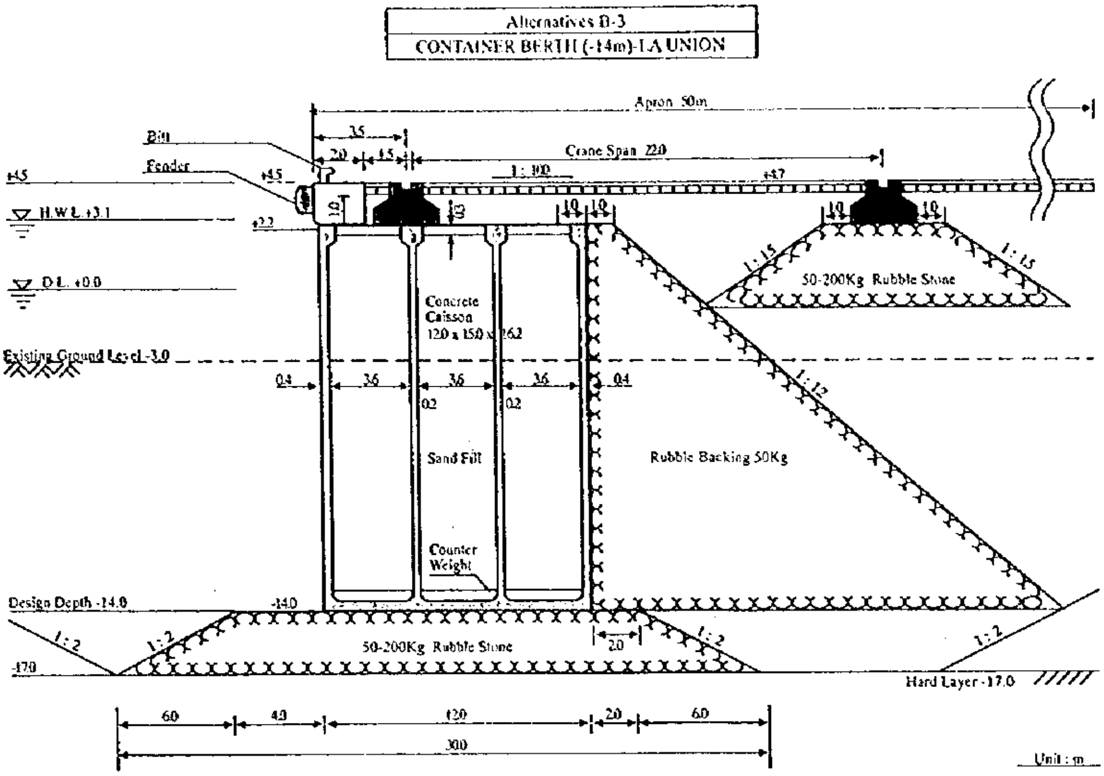


Figure 12-2-1 Concrete Caisson Type Container Berth (-14m)

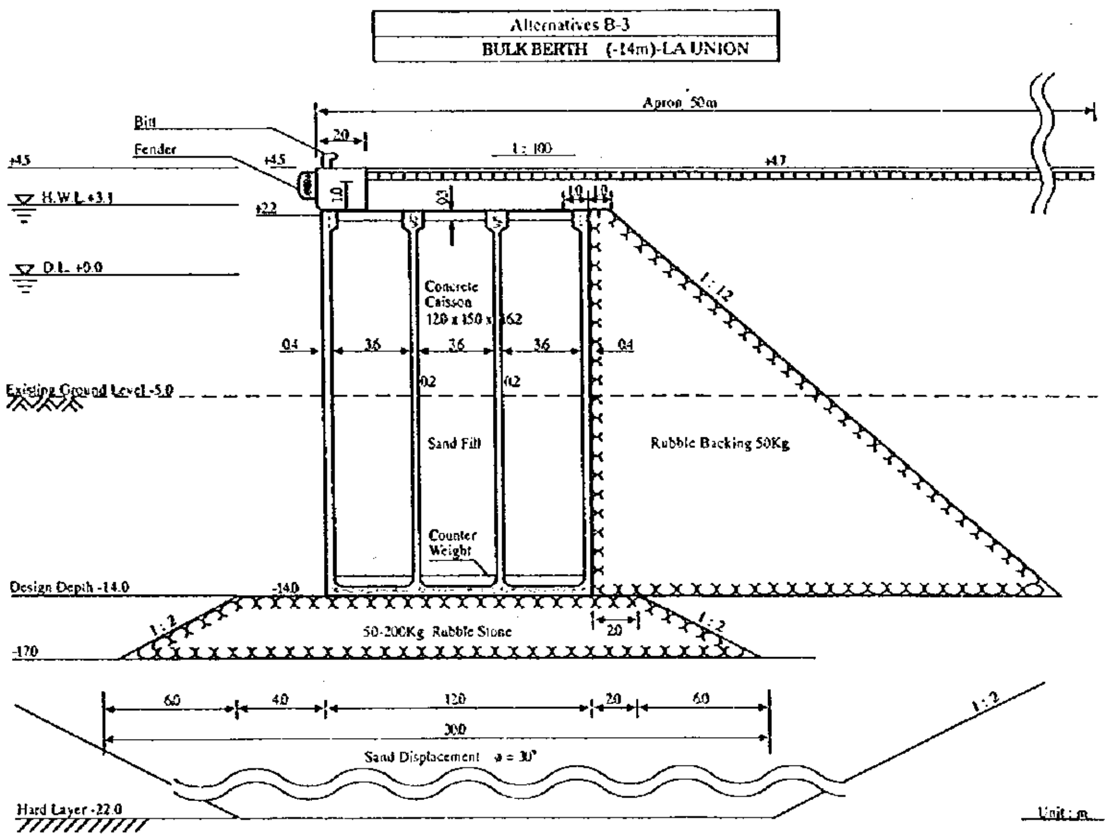


Figure 12-2-2 Concrete Caisson Type Bulk Berth (-14m)

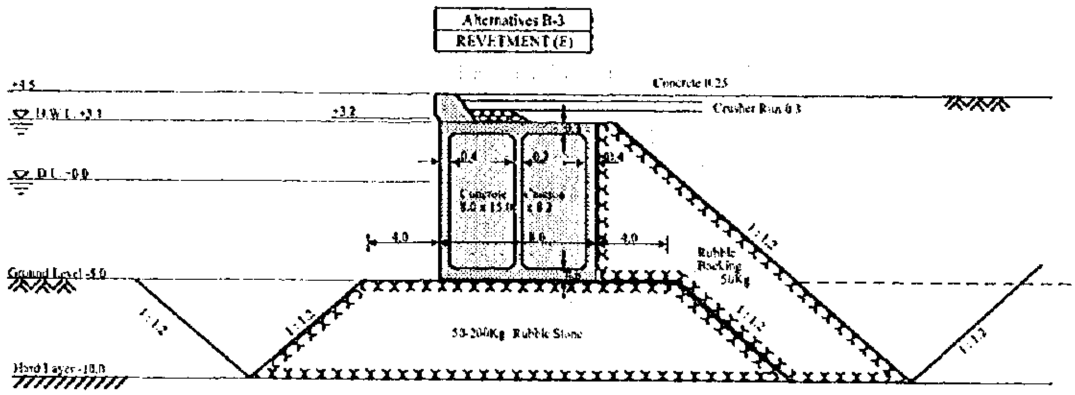


Figure 12-2-3 Concrete Caisson Type Revetment (-5m)

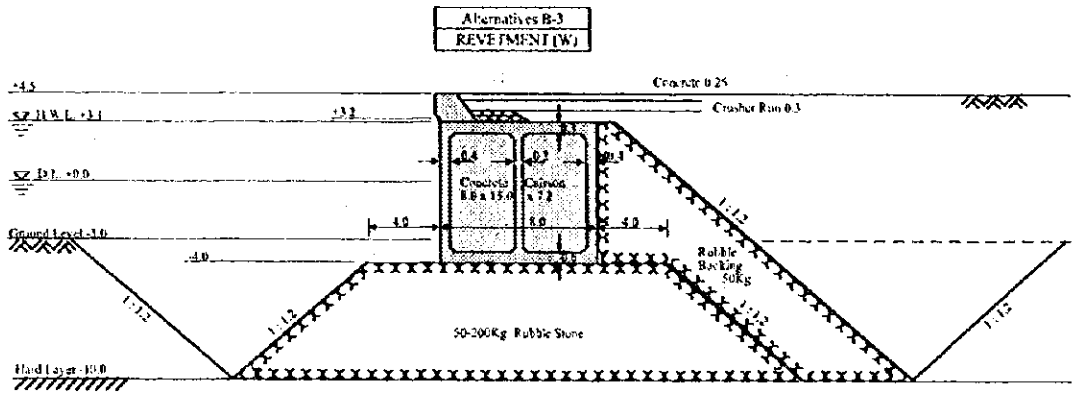


Figure 12-2-4 Concrete Caisson Type Revetment (-3m)

13. IMPLEMENTATION WORK AND ROUGH COST ESTIMATE

13.1 Implementation Work Plan

13.1.1 General Construction Situation

1. Based on the foregoing limitations and restrictions, the following factors have been assumed in assessing the amount of available working time for the estimation of the costs of construction.

2. Working time will be lost because of public holidays, weather and sea limitations.

(1) Workable Days of Major Work Activities

1) Sundays and public holidays

3. For the purpose of construction schedule and cost estimation, it has been assumed that the following days will be not worked;

- Sunday — 52 days per year
- Official Public Holiday — 15 days per year
- Physical conditions(Rainfall or Wave) — 20 days per year

2) Working hours

Eight hour per day : From 7:30 a.m to 12:00 a.m
: From 1:00 p.m to 4:30 p.m

3) Wet weather

4. Generally only work on land will be affected by wet weather. Daily rainfall figures are recorded at La Union Province. It is estimated that the annual water average is 1,800 milliliters and much of rainfall occurs in the form of thundershowers in the coast or mountain area.

4) Sea conditions

5. All offshore work will be affected to some degree by strength of the wind, the height of the waves and the speed of the tidal currents. However, proposed sea area will be calm by the shelter of some islands. The monthly average wind velocity is assumed at 2.6 m/sec and the monthly maximum wind velocity is assumed at 4.2 m/sec.

6. The maximum current velocities at the project site are approximately 1 m/sec. It seems that the current condition does not affect the ship maneuvering at the water area.

5) Tidal conditions

7. The tidal differences are about 3 m at springs and 2.3 m at neaps.

6) Natural conditions affecting workability of construction

8. The degree of workability against operation of construction equipments is shown in Table 13-1-1

(2) Construction Materials

9. Main materials necessary for the project at the Port of Cutuco are stones, cement, aggregates for concrete, sand and reinforced steel bars., etc. Steel materials such as H-shaped sheet pile, steel cube pipe pile, steel sheet pile, angle and iron rods., etc. are generally imported from abroad.

10. There are some quarry sites around La Union province and stone produced by crusher have been used for construction works so far. Moreover, Armor stone adopted for the protection of the revetment have to be produced at some quarries and transported to the site.

11. Ready mixed concrete is also available from the temporary concrete plant facilitated by private contractors.

Table 13-1-1 Workability of Construction

Workability of Construction Equipment by Natural Conditions

Category	Name of Work	Type or Capacity	Conditions affecting Work Day	
			Wind Velocity (m/sec)	Wave Height (m)
Dredging work	Cutter suction pump dredger	Steel Diesel 1350ps	>10	>0.4
		Steel Diesel 2600ps	>10	>0.4
		Steel Diesel 3200ps	>10	>0.5
		Steel Diesel 4000ps	>10	>0.5
	Grab dredger(pontoon mounted without hopper)	Steel Diesel 120 ps Grab: 1.5 cu m	>10	>0.4
		Steel Diesel 350 ps Grab: 4.0 cu m	>10	>0.4
	Bucket dredger	Steel Diesel 150 ps 200ton	>5	>0.3
		Steel Diesel 400 ps 800ton	>10	>0.4
	Dipper dredger	Steel Diesel 350 ps Bucket: 2.3 cu m	>5	>0.3
		Steel Diesel 1000 ps Bucket: 4.0 cu m	>10	>0.3
	Rock breaking ship	Dropping hammer type 10t	>5	>0.3
Works at sea	Filling rubble inside structure	(including rubble discharging from carrier)	>10	>0.4
	Diving works	(excluding installation of blocks)	>5	>0.3
	Installation of structures	Towing caisson inside port area	>10	>0.4
		Towing caisson outside port area	>10	>0.5
		Installation of caisson	>10	>0.6
		Installation of blocks by crane barge diesel type which less than 30ton	>10	>0.3
		Installation ofb blocks by crane barge diesel type which larger than 50ton	>10	>0.4
	Piling work by pile driving barge	Piling steel sheet pile	>5	>0.3
		Piling steel pipe pile or concrete pile	>5	>0.3
	Concrete works using concrete mixing barge with carrier	Form work	#	>0.2
		Concrete mixing,transporting and placing	#	>0.3

Category	Name of Work	Type & Capacity	Wind Velocity (m/sec)	Rainfall (mm/h)
Works at land	Earth work	Cutting or embankment	#	>10
		Compaction of pavement works with roadroller, tire roller and vibrating roller	#	>10
	Piling work by pile driving rig or piling machine of crawler type	Steel sheet pile or steel pipe pile or concrete pile	>10	>10
	Concrete	Forming, fabrication of steel bar, mixing concrete, transport and placing of plain or reinforced concrete	#	>3
		Concrete pavement	#	0
	Cutting or welding steel Painting for unti-corrosion	at site	#	>85% air humidity

Reference Book: Cost Estimate of Port Construction
Economic Research Committee, Japan

13.1.2 Available Construction Machine and Condition

(1) Construction Equipment and Machinery

12. As for the construction equipment and machinery, standard type and size of construction machines have been used for civil works such as road, bridge and building on the land are available in the country. On the contrary, offshore construction equipment are not available in local even though crane barge and flat barges. Offshore construction equipment will be procured from abroad, United States of America, United Mexican States and Japan., etc.

13. The built year of these onshore construction equipment are comparatively new one except special equipment.

14. According to the information and data collection from the government of El Salvador or the general contractors, following construction equipment will be available in the country.

Table 13-1-2 Construction Equipment for Onshore Activity

No	Equipment	Capacity
1	Earth and Quarry Works	
	1) Bulldozer	140 ~ 40 HP
	2) Grader	135 ~ 200 HP
	3) Road Roller	8 ~ 20 ton
	4) Backhoe	0.7 ~ 1.2 cu.m
	5) Wheel Loader	0.1 ~ 7.9 cu.m
	6) Crushing & Screening Plants	85 ~ 400 t/h
2	Transportation	
	1) Dump Truck	11 ~ 15t
	2) Platform Truck	6t
	3) Semi Trailer	20 ~ 40t
	4) Agitator Cars	4 ~ 12cu.m
	5) Fuel Tanker	10 ~ 33t
	6) Land Cruiser	HP

3	Lifting	
	1) Truck Crane	15 ~ 35t
	2) Mobile Crane	15 ~ 60t
	3) Tower Crane	2.4 ~ 8.0t
4	Concrete Work	
	1) Batching Plant	25 ~ 70 cu.m
	2) Truck Mounted Concrete Pump	60 ~ 80 cu.m/h
5	Asphalt Work	
	1) Mixing Plant	50t/h
	2) Asphalt Distributor	6,700 L
	3) Asphalt Paver	65 HP
6	Miscellaneous	
	1) Giant Breaker	1,300 kg
	2) Air Compressor	5.8 ~ 6.0 cu.m/min
	3) Generator	125 KVA
	4) Drilling Equipment	

13.1.3 Execution Program

15. Construction schedule of port development for Master Plan is as shown in Figure 13-1-4 and procedure of port construction is as shown in Fig 13-1-5

13.1.4 Major Construction Activity

(1) Dredging

16. Dredging work is to remove soft soil from sea bottom for foundation of wharf or revetment and to form navigation channel and turning basin.

17. Dredging and disposal of dredged material will be 24 hours operation. During dredging operation, safety measures such as marker buoys for identification of working area, safe guard,. etc. will be provided and maintained.

Figure 13-1-4 Port of Cutuco

CONSTRUCTION SCHEDULE FOR LONG TERM DEVELOPMENT

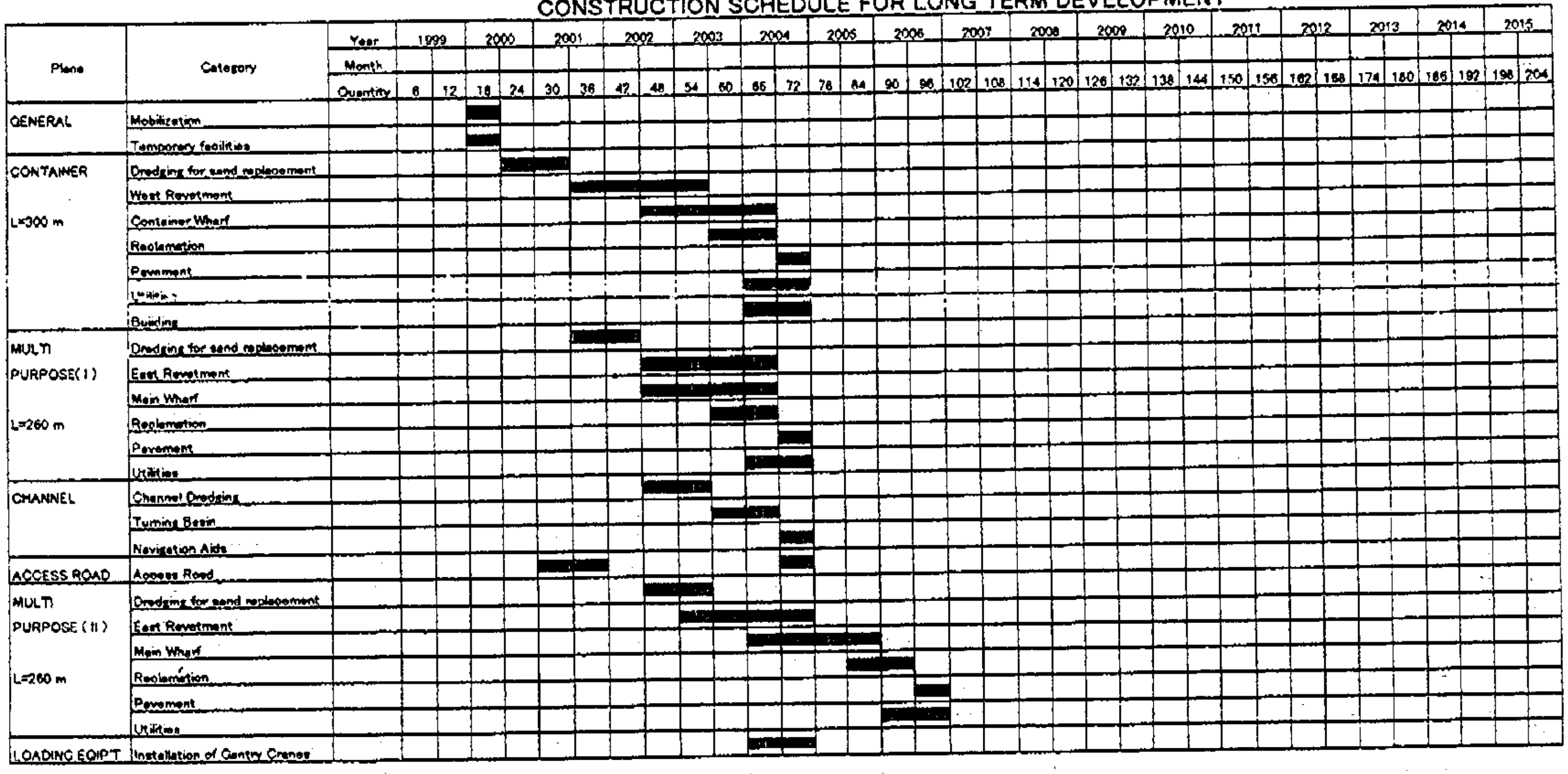
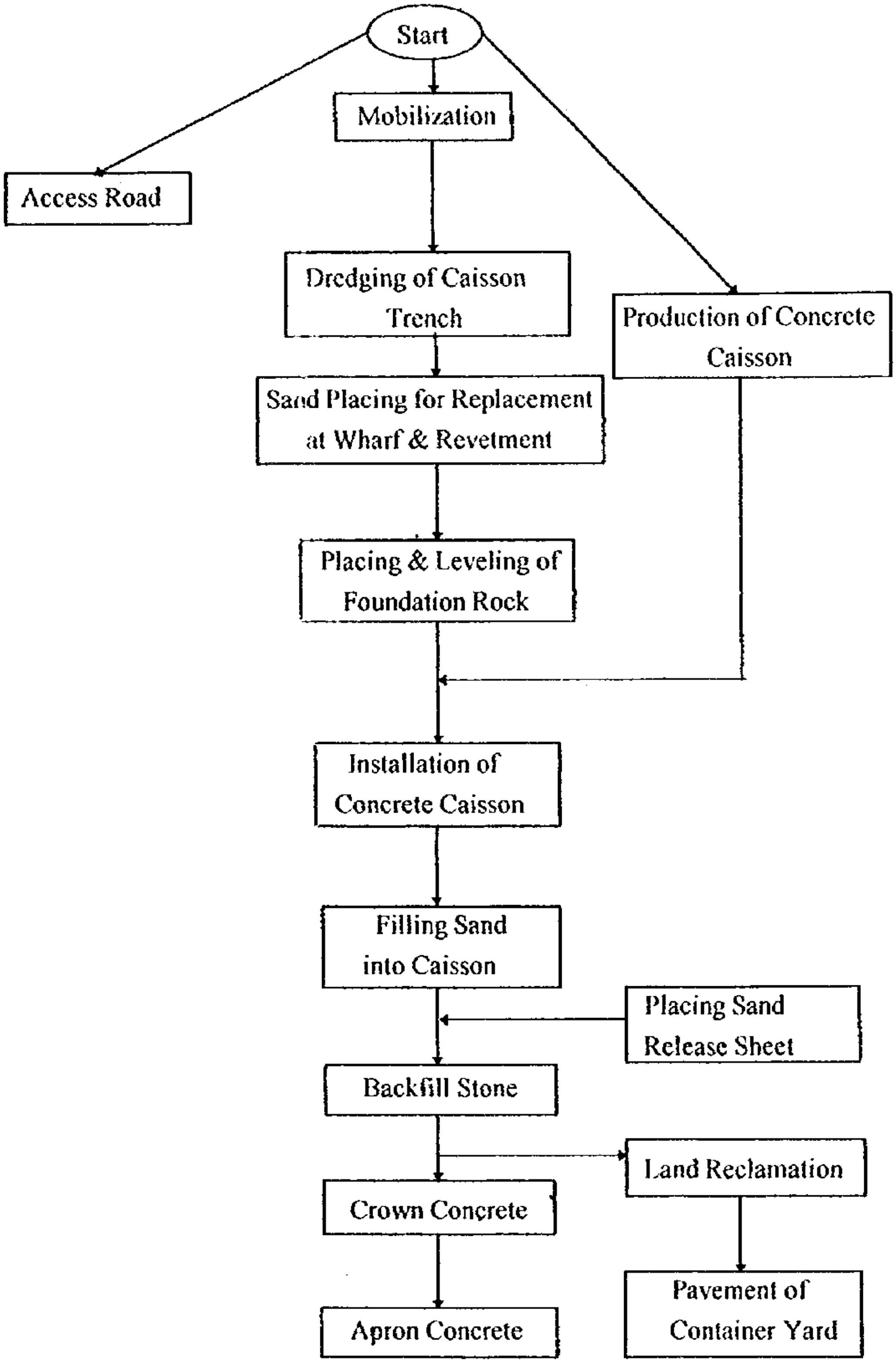


Figure 13-1-5 Construction Procedure of New Port



18. The following equipment will be employed for dredging work.

Grab Dredger Fleet

1)	Grab Dredger	:	18 cu.m
2)	Pusher /Tug Boat	:	250 G.T 3,200 PS
3)	Hopper Barge	:	1,200 cu.m & 1,500 cu.m
4)	Anchor Boat	:	330 PS

19. Dumping of dredged materials will be spread evenly as much as possible in the disposal area at the designated location where is approved by the Government of El Salvador.

(2) Placing of Replacement Sand for Trench of Wharf / Revetment

20. Sand material will be transported from borrow area in where the quality of suitable sand material will be confirmed to the Specification.

21. Dumping and placing of replacement sand will be carried out by using Hopper Barge from West end of the quay wall. Replacement sand will be spread evenly as much as possible.

(3) Placing of Rubble Rock for Caisson Foundation

22. Rubble rock for Caisson foundation will be supplied from Quarry site and transported to the temporary stock yard by dump trucks. Rubble rock will be re-transported

23. to the loading site by dump-trucks and loaded onto Gutt Barge.

Following loading onto Gutt-Barge:

1)	Dump Truck	:	10 ton class
2)	Bulldozer	:	21 ton class
3)	Gutt-Barge	:	499 t, 600 cu.m

24. Loaded rubble rock will be transported to specified position and placed.

25. Placing will be controlled by divers who will survey each section immediately prior to and after each bucket has been unloaded.

26. After placing rubble rocks, following plant and equipment will be employed

for leveling of surface of rubble rock base.

1)	Flat Barge with Crawler Crane	:	300 t
2)	Diver boat and/or pontoon	:	30 PS

(4) Caisson Manufacture

27. The caissons will be manufactured on the Floating Dock moored to the temporary quay. Mooring facilities will be located in order to prevent big damage to the existing quay of Cutuco.

28. Following plant and equipment will be employed for the caisson manufacture.

1)	Floating Dock	:	4,800 t loading capacity
2)	Flat Barge	:	600 t
3)	Mobile concrete pump	:	100 cu.m/hr
4)	Statically concrete pump	:	60 cu.m/hr
5)	Crawler crane	:	80 t & 35 t

29. Other tools and equipment such as vibrator, bar bender, bar cutter, pump, generator., etc. will be also provided properly.

(5) Launching of Caisson and Installation

30. Launching of Caisson will be carried out by submerging the Floating Dock to a designated depth after completion of casting and curing of concrete for two (2) Caissons on the Floating Dock.

31. When Caisson will be sufficiently afloated as the result of submersion of the floating dock, they will be towed out by tug boat assisted by anchor handling boats.

32. After towing-out operation, launched Caisson will be shifted to the installation area at where the Foundation Rubble Rock Mound will be already prepared.

33. Caisson will be towed by Tug Boat after launching from Floating Dock to the installation area.

34. Installation for Caisson will be commenced from West end of the main quay wall.

35. Filling sand will be placed evenly in each chamber of the Caisson. After placing and leveling of sand filling, quarry run beneath the crown concrete will be placed over the sand fill.

(6) Backfilling Stone of Caisson

36. After adjacent Caisson will be placed, the sand release protection sheet will be installed. The backfill stone will be placed to the line and levels indicated.

(7) Crown Concrete

37. After completion of backfilling behind Caisson, concrete placing will be carried out twice so as to devide the lower part and upper part due to the mass volume of the concrete and shape of crown concrete.

(8) Apron

38. After completion of the reclamation work behind the quay wall, the subgrade will be leveled and compacted by using motor grader and tire roller. Crusher run applying to the sub-base course will be transported from quarry site and graded during stock-pilling at yard.

39. Delivered sub-base course material will be spread by bulldozers so as to obtain material thickness and compacted by tire rollers and macadam rollers.

40. Base course will be carried out to specified elevation using motor graders, and compaction

41. will also be carried out by tire roller and macadam rollers.

42. After base course finished, the reinforcing bars for concrete pavement will be set in the specified position and tightly. Concrete will be placed directly from agitator trucks and / or other means to prevent segregation. Discharged concrete will be leveled roughly, and then leveled and compacted immediately by machine and tools.

(9) Land Reclamation

43. Transportation and dumping of sand material from sand borrow pits will be carried out by dump trucks and bulldozers. Dumping of reclamation sand material will be spread evenly as much as possible in the reclamation area.

44. Before closing the revetment, the required reclamation sand will be stocked at the existing land side, After completion of revetment, the material will be pushed in the remaining reclamation area for the completion of reclamation works.

45. Upon completion of reclamation work, final leveling will be carried out.

13.2 Rough Implementation Cost

13.2.1 Basic Conditions for Cost Estimation

(1) Following premises and conditions are adopted for the cost estimate:

1) Costs are estimated considering that the construction works are carried out in accordance with international tender regulations.

2) The exchange rate of the foreign currency is assumed as follows:

1 US$ = 8.75 Colons
1 US$ = 130 Yen

3) The information on the market prices of labor, construction materials and the rental charges of the construction equipment and machinery,. etc. are collected verbally
from construction companies as well as the government and CEPA.

4) Construction costs are divided into a foreign currency portion and a local portion, which are defined basically in accordance with the following categories:

Foreign portion:

- Imported construction equipment, materials, and goods for the purpose of this project.
- Imported materials such as fuel procured in the local market.
- Salary allowance and indirect cost for the foreign staff.

Local portion

- Construction equipment and machinery procured locally.
- Construction materials and goods procured locally.
- Salary allowance and indirect cost for the local staff.

5) The rate of physical contingency is estimated at 10 %.

6) Taxes/Duties on the imported equipment are excluded from the cost estimate.

7) The cost of land acquisition is excluded from the cost estimate.

13.2.2 Preliminary Cost Estimate

(1) Labor force for the construction works

1. Laborers required for construction works are available any time in the country excluded marine worker.

Normal unit cost of labor is as shown in Table 13-2-1

Table 13-2-1 Basic Labor Cost per Day

(Unit : Colon)

	Type of Occupation	Direct Cost per Day
1	Common worker	48.15
2	Watch man	48.15
3	Night watch man	48.15
4	Brick layer	57.80
5	Carpenter	57.80
6	Assembler	57.80
7	Plumber	57.80
8	Tin-man	57.80
9	Painter	57.80

(2) Construction Material Cost

2. Unit cost of main construction materials is as shown in Table 13-2-2

Table 13-2-2 Unit Cost of Materials

(Unit : Colon)

	Material	Type	Unit	Unit Cost
1	Fuel	Kerosine	gallon	9.36
2	Fuel	Regular gasoline	gallon	13.94
3	Ready Mixed Concrete	210kg.sq.m	cu.m	745
4	ditto	240	cu.m	775
5	ditto	260	cu.m	810
6	ditto	300	cu.m	885
7	ditto	350	cu.m	896
8	ditto	400	cu.m	971
9	Portland Cement	CESSA	42.5kg	30.1
10	ditto	MAYA	42.5kg	30.0
11	ditto	CESSA5000	42.5kg	34.46
12	Coarse Aggregate(40mm)		cu.m	150
13	Gravel		cu.m	150
14	Crushed Stone		cu.m	150
15	Fine Aggregate		cu.m	175
16	Sand		cu.m	100
17	River Sand		cu.m	80
18	Asphalt		ton	550

(3) Cost of Main Construction Equipment

3. Cost of main construction equipment procured in local is as shown in Table 13-2-3

Table 13-2-3 Rental Charge of Construction Equipment

(Unit : Colon)

	Category	Equipment	Unit	Cost
1	Earth/ Rock Moving	1) Bulldozer 15t 141ps	day	3,600
		2) Grader 3.7m 151ps	day	3,600
		3) Tire Roller 8 ~ 20t	day	3,200
		4) Backhoe 0.7~1.2cu.m	day	3,600
		5) Loading Shovel 3.5 cu.m	day	3,600
2	Transportation	1) Dump Truck 11~15t	day	2,000

		2) Platform Truck	6t	day	1,600
		3) Semi Trailer	20t	day	2,000
3	Lifting	1) Truck Crane	35t	day	4,000
		2) Crawler Crane	15~50t	day	6,000
		3) Tower Crane	2.4~8t	day	4,000
4	Concrete Work	1) Batching Plant	58cu.m/h	day	8,000
		2) Concrete Pump	60cu.m/h	day	3,200
		3) Agitator Car	3 cu.m	day	2,200
5	Asphalt Concrete	1) Mixing Plant	50t/h	day	8,000
		2) Asphalt Distributor	6,700L	day	2,000
		3) Asphalt Paver	65ps	day	6,000
6	Miscellaneous	1) Generator	125KVA	day	3,200
		2) Air Compressor 6.0cu.m/min 37kw		day	2,400
		3) Giant Breaker	1,300kg	day	2,400

Offshore equipment is not available in local and procured from abroad.

(4) Rough Implementation Cost

4. A summary of preliminary cost estimation is presented in Table 13-2-4 to determine a reasonable layout of Port Master Plan in Cutuco.

Table 13-2-4 Comparative of Alternative Plan Port of Cutuco

Stage	Category	Plan A-1	Plan B-1	Plan B-2	Plan B-3
Short Term 2005	Mobilization	1,315	1,309	1,005	1,097
	Container	3,553	4,963	2,922	4,408
	Bulk (1)	2,940	4,406	3,389	2,982
	Channel	5,198	2,317	2,664	2,428
	Road	270	210	164	150
	Engineering Fee	1,328	1,321	1,014	1,107
	Contingency	1,460	1,453	1,116	1,217
	Total	16,064	15,978	12,274	13,389
Long Term 2015	Mobilization	265	490	388	352
	Bulk (2)	2,411	4,407	3,497	3,080
	Berth Pocket	23	47	55	68
	Engineering Fee	270	494	392	350
	Contingency	297	544	431	385
	Total	3,266	5,982	4,737	4,235
	Loading Equip't	2,033	2,033	2,033	2,033
	Total	2,033	2,033	2,033	2,033
	Grand Total	21,363	23,993	19,044	19,657

(Note) Exchange Rate: 1 US Dollar = 8.75 Colon = 130 Yen