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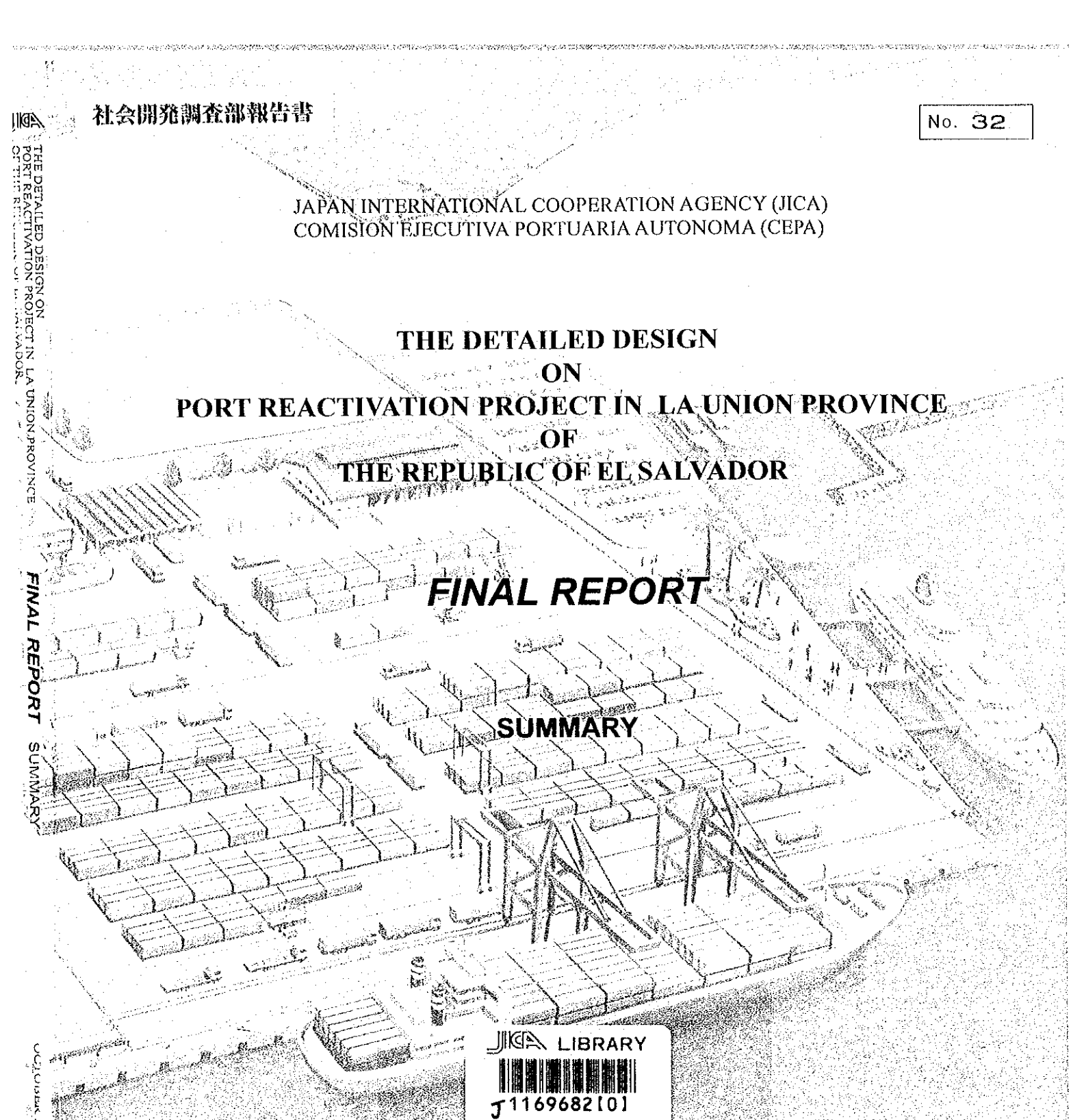
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
COMISION EJECUTIVA PORTUARIA AUTONOMA (CEPA)

THE DETAILED DESIGN ON PORT REACTIVATION PROJECT IN LA UNION PROVINCE OF THE REPUBLIC OF EL SALVADOR



FINAL REPORT

SUMMARY

OCTOBER 2002

NIPPON KOEI CO., LTD.

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
COMISION EJECUTIVA PORTUARIA AUTONOMA (CEPA)

THE DETAILED DESIGN
ON
PORT REACTIVATION PROJECT IN LA UNION PROVINCE
OF
THE REPUBLIC OF EL SALVADOR

FINAL REPORT

SUMMARY

OCTOBER 2002

NIPPON KOEI CO., LTD.

EXCHANGE RATE

1US dollar = 8.75 Colones = 120 Yen
(as of July, 2002)

PREFACE

In response to the request from the Government of the Republic of El Salvador, the Government of Japan decided to conduct the detailed design study on Port Reactivation Project in La Union province of the Republic of El Salvador and entrusted the study to the Japan International Cooperation Agency (JICA).

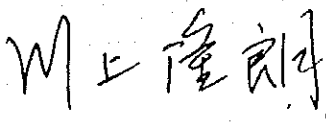
JICA dispatched a study team headed by Mr. Teruo Onuki of Nippon Koei Co., Ltd. to the Republic of El Salvador, several times between August 2001 and August 2002.

The team held discussions with the concerned officials of the Government of the Republic of El Salvador and conducted field surveys in the study area. Upon returning to Japan, the team conducted further studies and prepared this final report.

I hope that this report will contribute to the promotion of this project and to the enhancement of friendly relationship between our tow countries.

Finally, I which to express my sincere appreciation to the concerned officials of the Government of the Republic of El Salvador for their close cooperation extended to the study.

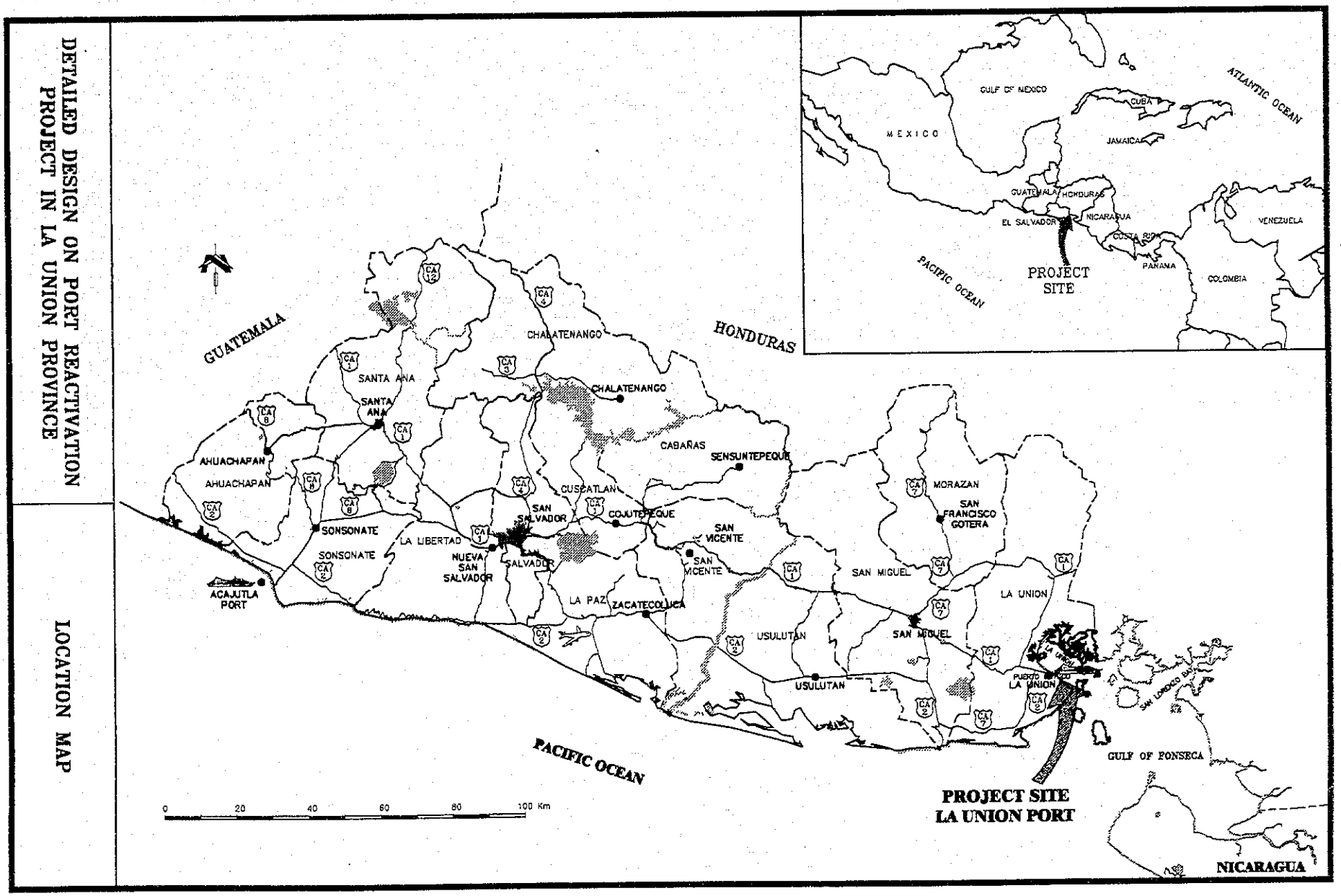
October 2002



Takao Kawakami
President
Japan International Cooperation Agency

DETAILED DESIGN ON PORT REACTIVATION PROJECT IN LA UNION PROVINCE

LOCATION MAP



DETAILED DESIGN ON PORT REACTIVATION PROJECT IN LA UNION PROVINCE	AERIAL PHOTO OF PROJECT SITE

ABBREVIATIONS TABLE

ABS	American Bureau of Shipping
ACI	American Concrete Institute
ADCP	Acoustic Doppler Current Profiler
AES	Power Generation and Distribution Corporation, USA
AIA	The American Institute of Architects
AIS	Automatic Identification System
AISC	American Institute of Steel Construction
AMAP	Port and Maritime Administration
AMSS	Metropolitan Area of San Salvador
ANDA	Administracion Nacional de Acueductos y Alcantarillados
ANEP	National Association of Private Enterprise
ANSI	American National Standard Institute
ANWA	American Water Works Association
ASHRAE	American Society of Heating, Refrigeration
ASHRAF	Air-Conditioning Engineers
ASIA	Asociacion Salvadorena de Ingenierous y Arquitectos
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing & Materials
AASHTO	American Association of State Highway and Transportation Officials
API	American Petroleum Industry
AWG	American Wire Gage
B/C Ratio	Benefit/Cost Ratio
BCIE	Bank of Central America for Economic Integration
BCR	Banco Cenral de Reseva
BCR	Reserve Central Bank
BOD	Biochemical Oxygen Demand
BS	British Standard
C.A.	Central America
CA-1	Pan-American Highway
CA-2	Littoral Highway
CAESS	Electrical and Illumination Company of San Salvador
CBI	Caribbean Basin Initiative
CBR/Value	California Bearing Ratio Value
CCTV System	Closed Circuit Television System
CDM	Cement Deep Mixing Method
CDL	Chart Datum Level
CEL	Comision Ejecutiva Hidroelectrica del Rio Lempa
CEPA	COMISION EJECUTIVA PORTUARIA AUTONOMA
CENDEPESCA	Centro de Desarrollo Pesquero
CFC	Conversion Factor for Consumption
CFS	Container Freight Station
CFSL	Conversion Factor for Labor
CFUL	Conversion Factor for Unskilled Labor
CH	Silty Clay
CIF	Cost, Insurance, and Freight
CITES	Convention on International Trade in Endangered Species of Wild

	Fauna and Flora
CL	Gravelly/Sandy Clay
CLESA	Santa Ana Electrical Company
CNR	Centro National de Registros
CNR	National Registry Center
CNRS	French National Research Organization Standard
CNT	Container Terminal
CNT	Containerization
CONACYT	Consejo Nacional de Ciencia y Technologia
CORSAIN	Corporacion Salvadorena de Inversiones
COD	Chemical Oxygen Demand
CPI	Consumer Price Index
CSA	Canadian Standard Association
CY	Container Yard
D/D	Detailed Design
DB	Dry Bulk
DELSUR	Electrical Distributor of the South
DL	Chart Datum Level
DOF	Degree of Freedom
DWT	Dead Weight Tonnage
DFPS	Differential Global Positioning System
E	East
ECW	Environmental Clerk or Works, provided by the Supervising Consultant to supervise Environmental ,matters
EEO	Empresa Electrica de Oriente
EIA	Environmental Impact Assessment
EIRR	Economic Internal Rate of Return
EMP	Environmental Management and Monitoring Plan
EMS	Environmental Management System
EMPORNAC	Santo Tomás de Castilla National Port Company
EPZ	Export Processing Zone
Epc	Environmental Permit Conditions
ESE	East South East
ETA	Estimate time of Arrival
ETD	Estimate time of Departure
F.D	Floating Dock
F/S	Feasibility Study
F/C Portion	Foreign Currency Portion
FCL	Full Container Load
FENADESAL	National Railway Company of El Salvador
FIRR	Financial Internal Rate of Return
FOB	Free on Board
FUSADES	Salvadorian Foundation for Economic and Social Development
GDP	Gross Domestic Product
GOES	Government of the Republic of El Salvador
GOJ	Government of Japan
GPS	Global Positioning System
GRT	Gross Registered Tonnage
GT	Gross Tonnage
H.W.L	Mean Springs High Water Level

$H_{1/3}$	Significant Wave Height
HWONT	High Water Level of Ordinary Neap Tide
HWOST	High Water Level of Ordinary Spring Tide
ICB	Interlocking Concrete Block
ICB	International Competitive Bidding
IEEE	The Institute of Electrical and Electronic Engineers Standard
IESNA	Illuminating Engineering Society of North America
IPI	Industrial Price Index
IUCN	International Union for the Conservation of Nature and Natural Resources
IVA	Impuesto al Valor Agregado
JBIC	Japan Bank for International Cooperation
JICA	Japan International Cooperation Agency
JIS	Japan Industrial Standards
L.W.L	Mean Springs Low Water Level
LCL	Less than Container Load
LOA	Length Overall
L/C Portion	Local Currency Portion
LPG	Liquid Propane Gas
LWONT	Low Water Level of Ordinary Neap Tide
LWOST	Low Water Level of Ordinary Spring Tide
Lux	Illumination Unit
MARN	Ministry of Environment and Natural Resources
MCM	Mille Circular Mil
MMG	Mathematical Modeling Grouped
MOP	Ministry of Public Works
MPT	Multi-purpose Terminal
MSL	Mean Sea Level
MSPAS	Ministry of Public Health and Social Assistance
MSS	Model for Slow and Shallow Motions
MT	Metric Tonnage
Max	Maximum
Min	Minimum
N	North
NAD 27	North American Datum 1927
NCD	New Chart Datum
NK	Nippon Koei
NE	North East
NEC	National Electrical Code
NEMA	National Electrical Manufactures Association
NFPA	National Fire Protection Association
NPC	National Plumbing Codes
NPV	Net Present Valve
NSO	National Council of Science
NTU	Nephelometric Turbidity Unit (NTU)
NW	North West
ODA	Official Development Assistance
OECD	Organization for Economic Cooperation and Development
OHS	Occupational Health and Safety Plan
OM	Operations Manual

ONAN Type	Oil Natural, Air Natural
OIRSA	Regional International Organism of Agriculture and Cattle Health
OPAMS	Planning Office of the San Salvador Metropolitan Area
PC	Personal Computer
PCC	Pure Car Carriers
PEU	Port Environmental Unit to be formed by CEPA
PIANC	Permanent International Association of Navigation Congresses
PPL	Pennsylvania Power and Lighting
PPP	Puebla Panama Plan
PSI	Pound Per Square Inch
PVC	Polyvinyl Chloride
PCO	Navigation Control Office
PRO-ESA	Promotion of El Salvador
R.C	Reinforcement Concrete
RASA	Petroleum Refinery of Acajutla
RH	Relative Humidity
RO/RO	Roll on Roll off
RTG	Rubber Tired Gantry Crane System
S	South
SAND	Natural Protected Areas System
SANP	Natural Protected Area System
SC	Straddle Carrier
SCF	Standard Conversion Factor
SE	South East
SG	Gravelly Sand
SIGET	Superintendence of Electricity and Telecommunic ations
SHS	Trailing Suction Hopper Dredger
SMB	The Sverdrup Munk Bretschneider
SPT	Standard Penetration Tests
SP-SM	Poorly Graded Sand with Silt
SS	Suspended Solid
SW	South West
TBM	Temporary Bench Mark
TEU	Twenty Feet Equivalent Container Units
TSS	Total Suspended Solids
UDL	Uniformly Distributed Live Loads
UL	Underwriter's Laboratories, Inc.
UN	United Nation
USA	United States of America
UTM	Universal Transverse Mercator
UTP Network	Unshielded Twisted-Pair Network
VAC	Ventilation and Air-Conditioning
VHF	Very High Frequency
VTS	Vessel Traffic Service
W	West
WB	Word Bank
WGS 84	World Geodetic System 1984
WNW	West North West
WWTP	Waster Water Treatment Plant
XLPE/PVC	Polyvinyl Chloride Cross-Linked Polyethylene Insulated

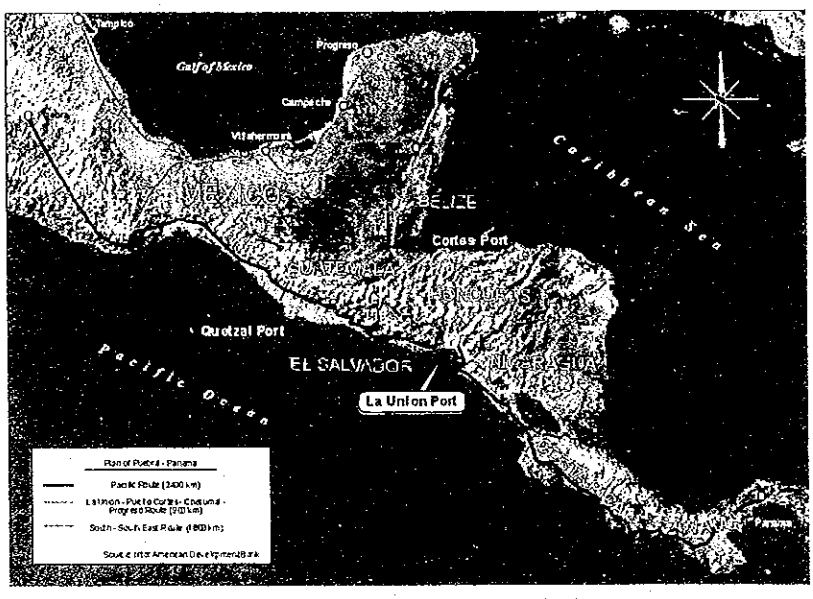
EXECUTIVE SUMMARY

PROFILE

In early 2001 "Puebla Panamá Plan" was envisioned to accelerate integration and development of the region from Southeast México to Central America. The eastern port of El Salvador is in a strategic pivotal point of highlighted transport integration projects within the Pacific Coast Corridor and the Dry Canal Corridor connecting to Puerto Cortés in Honduras. So, the Government of El Salvador (the GOES) decided to develop a new port in La Unión province for the development of the eastern region of El Salvador.

According to the Study, the cargo traffic volume passing through the La Unión Port in 2015 is estimated at 840,000 MT for general and bulk cargo, and 275,000 TEUs for containers. To accommodate this cargo traffic volume, the total required berth length is calculated at 560 m for the main berths with a depth of –14 m, and 240 m for the passenger berth with a depth of –9.5 m. Regarding the access channel, the inner channel is planned to be –14.0 m deep and 140 m wide, and the outer channel to be –14.5 m deep and 137 m wide. The total construction cost is estimated at 116.3 million US$.

Judging from the economic viewpoint, the La Unión Port will be useful for not only El Salvador but also neighboring countries in Central America. The La Unión Port is expected to start operating in 2006.



CHAPTER 1 INTRODUCTION

The existing Cutuco Port is located in the southeast region of El Salvador facing the Gulf of Fonseca. Due to significant deterioration of its facilities, the Cutuco Port was closed in 1996. All the outdated port facilities are beyond repair to meet modern port requirements.

Considering the advantageous location and well sheltered conditions of the Gulf of Fonseca, the GOES has drawn up the port reactivation project in La Unión Province. The GOES has then carried out the Master Plan and Feasibility Study with technical assistance of the Government of Japan (the GOJ) in 1998. The plan recommended the construction of one (1) Container Berth, one (1) Multi-purpose Berth, and one (1) Passenger Berth together with port service facilities. The Study confirmed the viability of the Project, and the GOES requested further assistance from the GOJ for the detailed design of the Project.

The JICA Study Team was dispatched to prepare the detailed designs for the port reactivation in La Unión Province. The Study was carried out in close cooperation with the COMISION EJECUTIVA PORTUARIA AUTONOMA (CEPA), the government agency responsible for the development and management of ports in El Salvador, which acted as the counterpart agency on behalf of the GOES.

CHAPTER 2 EXISTING CONDITIONS

In the period of 1996-2000, the Salvadorean economy has shown steady growth with an average annual rate of 3.5% in total Gross Domestic Product (GDP). As to GDPs by sector, the Industrial Sector indicated the largest growth with 5.0% per annum in the same period, followed by Services (3.3%), and Agriculture (1.7%). Among the industrial sectors, the Manufacturing Sector showed the highest growth with 5.2% in the same period. By the year 2000, El Salvador experienced a slowdown in economic activities with a growth rate of 2.0% against the preceding year. Despite the economic slowdown as a whole, the Manufacturing Sector showed a comparatively high growth rate of 4.5% on a year-to-year basis

CHAPTER 3 TERMINAL PLANNING

The JICA's F/S Report in 1998 was reviewed and updated using the latest statistics, economic and social indices available up to the year 2000. Two methods (macro and micro forecasts) were employed to forecast the entire cargo volume to be handled at the Salvadorean commercial ports of La Unión and Acajutla.

The following table shows the forecast non-container cargo volume in metric weight tons and the number of containers in TEUs in the years 2005, 2010, and 2015.

Forecast Cargo Volume	Target Years		
	2005	2010	2015
General, dry bulk, liquid bulk cargo (Ton)	624,700	727,100	841,200
Containers cargo (TEU)	121,000	185,000	275,000

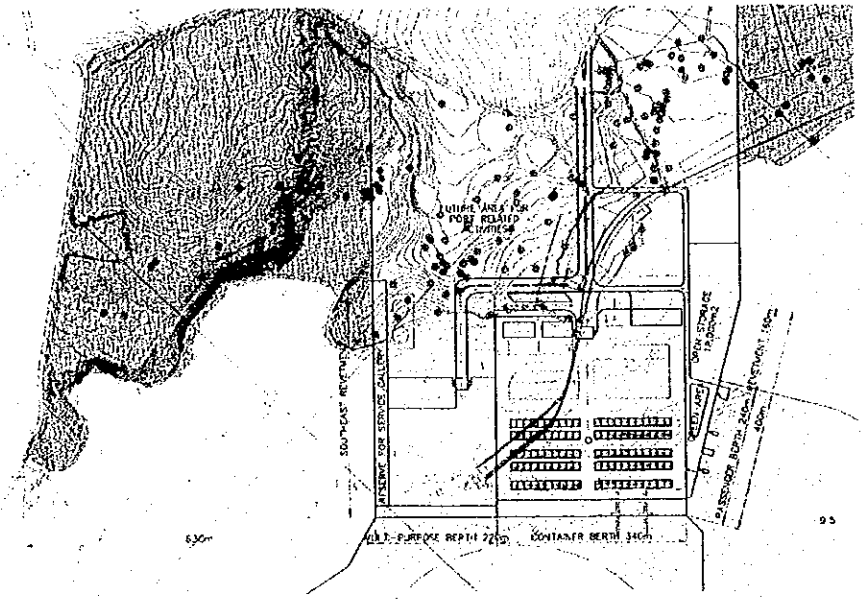
Based on the projected cargo to be handled at La Unión Port, the total number of ship calls estimated for each ship type is summarized below.

Ship Calls	Target Years		
	2005	2010	2015
Container vessel	208	208	208
Bulk carrier	38	46	53
Car carrier (Ro-Ro)	15	22	33
Passenger ship	1	1	1
Total (Calls)	262	277	295

The following table shows the dimensions of the three berths determined based on the characteristics of ships expected to call at the La Unión Port. The total berth length is 560 m for the Container and Multi-purpose Berths, and 240 m for the Passenger Berth.

Berth	Ship Size	Berth Length (m)	Berth Water Depth (m)	Crown Height (m)
Container Berth	55,000 DWT	340 m	- 14.0 m	+5.0 m
Multi-purpose Berth	50,000 DWT	220 m	- 14.0 m	+5.0 m
Passenger Berth	25,000 DWT	240 m	- 9.5 m	+5.0 m

Several container handling systems are required for container terminal operation such as Straddle Carrier System, Rubber Tired Gantry Crane System (RTG), Reach Stacker System, and Forklift System. Among those systems, the RTG system is recommended in consideration of its long service life, low maintenance cost, and adaptability to the computer management system.



As for the Multi-purpose Cargo Terminal, the Terminal is to be operated by a selected concessionaire, and the cargo handling equipment and necessary facilities such as office, storage yard arrangement, and other onshore utilities will be provided to tally by the concessionaire or partially by the port users. Crane rails (73 kg/m) for gantry cranes and quay-side cranes are to be installed under the project.

CHAPTER 4 DESIGN OF CIVIL WORKS

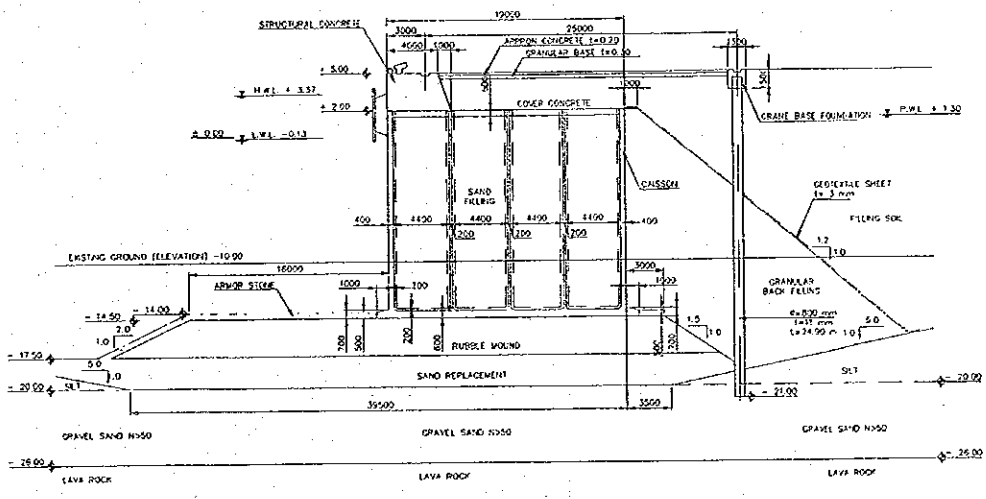
The civil works are designed considering the natural condition in the project site and referring to the authorized design standards, codes, and manuals. The seismic coefficient adopted in the design is 0.20G taking into account the latest earthquake data. The geological and geotechnical conditions in the project site are investigated by core boring and laboratory tests.

Five alternatives, namely concrete caisson, vertical steel pile, combined steep pile, steel sheet pile and steel sheet pile cellular cofferdam types are examined for the Container, Multi-purpose and Passenger Berth structure. The comparison study is made in aspects of construction cost, durability and maintenance cost. The caisson type is recommended for the Container and Multi-purpose Berths. The dolphin type with retrial steel piles is applied for the Passenger Berth.

As for the revetments, the rubble mound type is selected as the most economical and stable structure.

The proposed port area is located offshore in front of the existing Cutuco Port, having a land area of approximately 27 ha. The volume of soil to be filled is approximately 3.0 million m^3 and the soil obtained from the proposed access channel dredging will be used for reclamation fill.

Soil improvement is required to minimize ground subsidence in the terminal area. The displacement method is finally selected through comparison of various soil improvement methods.



CHAPTER 5 DESIGN OF ACCESS CHANEEL

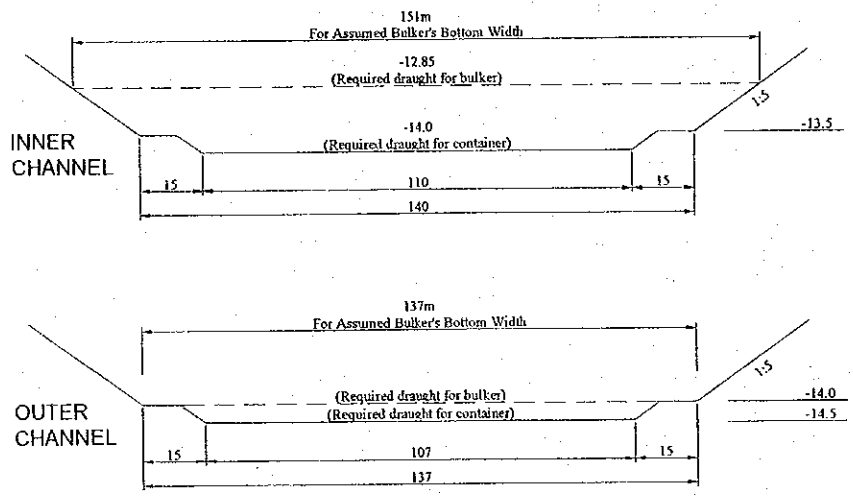
The access channel is designed in consideration of the expected ship sizes, natural conditions, and expected ship passage pattern. Due to low traffic and required initial dredging cost, the channel configuration is designed as one way navigation. The total underkeel clearance for the channel is determined taking into account the vertical motion induced by waves, squat and disastrous net underkeel clearance.

The channel has a bend at the point of Zachatillo Island where a lighthouse will be installed to aid navigation.

In order to determine horizontal alignments under severe tidal current, a fast time ship maneuvering simulation is conducted. The design ship size, water depth, winds, waves and currents are incorporated into the simulation under with/without tugboat assistance conditions.

The following table shows the required widths of the access channel based on the results of the fast time ship maneuvering simulation.

Ship Type	Container		Bulker	
	Outer	Inner	Outer	Inner
Required Width of Channel	130 m	140 m	137 m	151 m



CHAPTER 6 DESIGN OF BUILDINGS AND UTILITIES

The supporting facilities such as buildings, infrastructure, and utilities are constructed on-shore.

The building floor areas are determined to accommodate the number of persons and their utilization. The materials for buildings construction are selected in consideration of availability of local products in order to achieve easy and low maintenance cost. The structural design is carried out on the basis of geographic data, climatic conditions of the proposed site and considering building values, materials and stress/load

combinations in order to accomplish safe and economical structure. All buildings are finished with local made products in order to achieve easy and low maintenance cost of the building facilities. Building design is considered to give an attractive appearance and to match the environment. The port Administration Building is designed to present a symbolic impression and partially finished with a local made slate stone masonry, while container gates at the main entrance into the port area are designed with a motif of sea wave on their exterior face.

CHAPTER 7 DESIGN OF EQUIPMENT

In order to handle 275,000 TEUs of containers expected in 2015, two units of gantry cranes capable of loading/unloading containers to/from Panamax type container vessels are installed in the Container Terminal. The performance specifications of the cranes are designed to handle 35 boxes per hour on average. The cranes are of rail mounted single rifting gantry crane with rope trolley type.

Also considering hard oceanographic conditions such as high current speed and rough waves, 22 km single way approach channel, and assistance in turning basin, it is concluded to procure two units of tugboat (3,600 PS) to be stationed in and used exclusively by the Port.

CHAPTER 8 CONSTRUCTION AND IMPLEMENTATION SCHEDULE

The Project works consist of the following three (3) components:

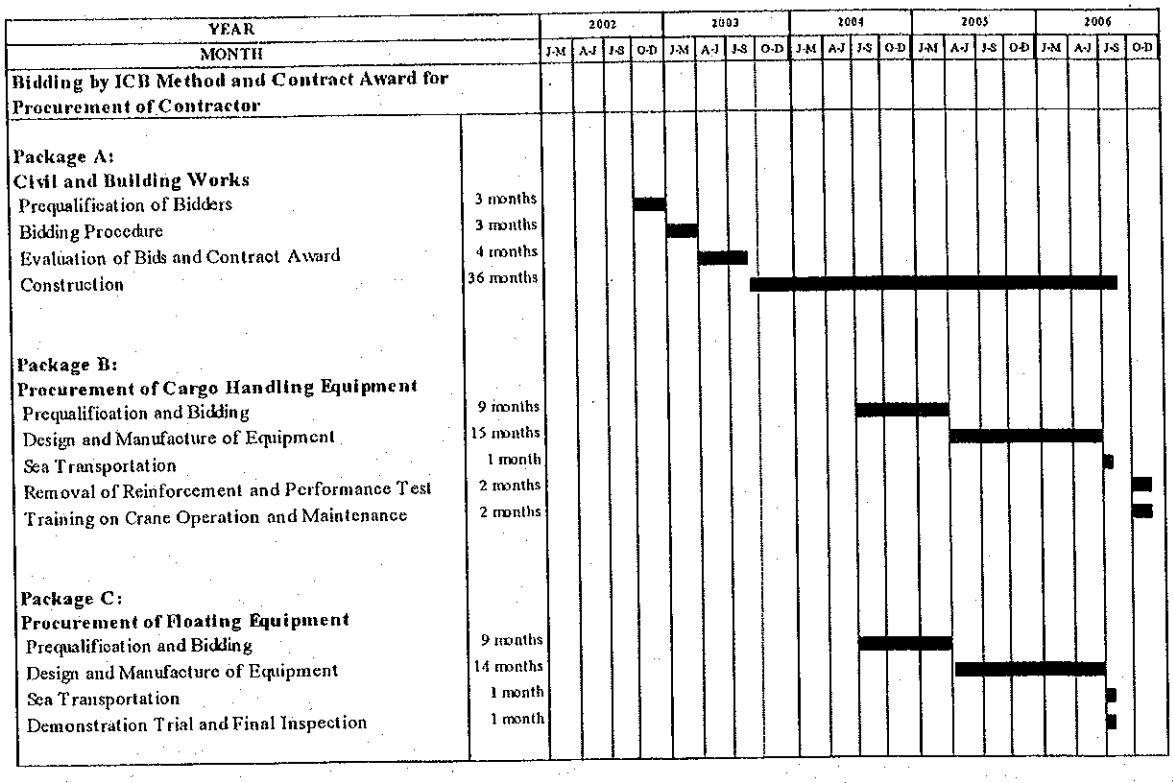
(1) Civil and Building Works
(2) Procurement of Cargo Handling Equipment
(3) Procurement of Floating Equipment

The financing of the project costs is expected to be made by JBIC and BCIE. The procurement of services and goods will be proceeded basically in accordance with the JBIC guidelines

CEPA will procure a consulting firm for the construction supervision through the short-listing method. A contractor will be selected based on the JBIC guidelines through international competitive bidding (ICB). The construction period of Civil and Building Works is expected to be 36 months.

For procurement of the cargo handling equipment and floating equipment manufacturers will be selected through international competitive bidding (ICB). The contract period for the cargo handling equipment is 20 months and that for the floating equipment is 16 months.

The overall work execution and procurement schedule is shown in the chart below.



CHAPTER 9 COST ESTIMATE

The unit rates and prices for labor, materials, plant and equipment are estimated based on the current price level of July 2002.

The exchange rate used in the estimates is 1 US$ = JY 120.00

and 1 US$ = ¢ 8.75

The price escalation factor applied to the local currency between the time of preparation of this estimate and the project implementation period is estimated at 2 %.

The total Project Cost is estimated at 116.3 million US$.

CHAPTER 10 PORT OPERATIONS AND MANAGEMENT

The La Unión Port will have three types of marine terminals: One Container Terminal, one Multi-purpose Terminal, and one Passenger/Ro-Ro Terminal.

Under the strong privatization policy undertaken by the GOES, it is expected that CEPA will administrate the Port and function as a Landlord while the port services will be solely provided by private operators based on a concession agreement.

The concessionaires of the Container Terminal and Multi-purpose Terminal might be separated into two different entities. Under this same privatization scheme it is also recommended that the tugboats procured under the Project be handed over to a private operator to provide stevedoring services on a license agreement.

CHAPTER 11 ECONOMIC AND FINANCIAL EVALUATION

The economic evaluation for the Project is made under the assumptions of the base year of 2001 and the project life of 30 years. The economic viability expressed in Economic Internal Rate of Return (EIRR) is computed and an EIRR of 16.4% is obtained for the base case.

The financial viability of the Project is examined from the viewpoint of capital investment. The Financial Internal Rate of Return (FIRR) on gross capital bases is calculated and compared with the assumed average interest rate of the funds. The resulting FIRR of the Project is 13.4% in the base case.

The weighed average of interest rates of JBIC Loan, BCIE Loan, and Local Bank Loan is estimated to be 4.11%.

CHAPTER 12 ENVIRONMENTAL MANAGEMENT AND MONITORING PLAN

The environmental assessment for the Project was completed and approved by MARN on 15 December 2000 (Resolution MARN-N 400-2000) with the following conditions:

- Implementation of 14 Mitigation Measures
- Posting of Security Guarantee by CEPA
- Implementation of 18 Environmental Conditions

The following additional environmental surveys are conducted to collect additional information required for the study and predictions of sediment dispersion behavior.

1) Ecological survey in the reclamation area (benthos, marine biology)
2) Ecological survey in the borrow area (terrestrial plant and animal)
3) Offshore ecological survey in the dredging area (tidal current, water quality, seabed material, benthos)
4) Offshore ecological survey in the dumping area (water quality, seabed material, benthos)
5) Fishery activity survey
6) Present condition survey (water quality, seabed material, benthos)
7) Air quality observation
8) Water quality for future monitoring purpose (water quality)

Based on the additional environmental study, certain Mitigation Measures and Permit Conditions are proposed to be amended including the following major items:

- Omit from **Mitigation Measure 6** the incinerator to treat solid waste from the operating port;
- Omit from **Mitigation Measure 8** the use of silt curtains around the dredger and disposal site; Shift the location of the offshore dumping site closer to the dredging area; Monitor turbidity instead and set Trigger Levels to protect any

sensitive areas, with dredging being required to cease if Trigger Levels are reached.

- Add **Mitigation Measure 16** relating to dumping of dredged spoil, which limits reclamation to 27 ha for the port and 31 ha for the onshore dumping areas.
- Amend **Permit Condition 13** to allow port construction to commence before the La Unión bypass has been completed. Instead, an alternative route of access shall be provided for the port traffic before at road is finished, to keep heavy traffic out of La Unión City.

The above proposed conditions were agreed by MARN.

CHAPTER 13 CONCLUSION AND RECOMMENDATION

- It was confirmed that viability of the Project is quite sound and feasible from the technical, economic, and financial aspects. The early implementation of the Project is prerequisite and CEPA must extend strong port sales for potential port users to assure and expand the port cargo.
- To allow the port development to play an important role in the country and in Central America, and to contribute economic and financial benefits, CEPA shall coordinate with relevant authorities and governments concerned in the implementation and promotion of the Project.
- Periodical monitoring of the depth of the channel and turning basin shall be performed by CEPA during the construction and operation stages. Since the estimated soil deposit volume is significant and the approach channel is a vital facility of the port, CEPA shall prepare a future maintenance scheme based on the monitoring results.
- CEPA shall proceed with a privatization scheme as early as possible so that necessary change in the yard layout plan of the Terminals can be accommodated in relation with the cargo handling system to be introduced by the concessionaire before the Project starts;

  Buildings

  —Port administration building
  —CFS
  —Maintenance and repair shop

  Yard layout

  —Container stacking area
  —Pavement

Summary of changes item in Detailed Design Study from FS Study

Item	FS	D/D	Reason
Traffic Forecast	Traffic volume in 2015 Dry and Liquid Cargo 1,496,500 ton Container 157,812 TEU	Traffic volume in 2015 Dry Cargo 841,000 ton Container 275,000 TEU	
Design Ship	Container Berth 40,000DWT Multi-purpose Berth 50,000DWT Passenger Berth 15,000GT	Container Berth 55,000DWT Multi-purpose Berth 50,000DWT Passenger Berth 25,000DWT	Reviewing the design ship, the size of container and car carrier (RoRo) are increased.
Berth	Depth and Length Container Berth –13m 300m Multi-purpose Berth –13m 260m Passenger Berth –7.5m 220m	Depth and Length Container Berth – 14m 340m Multi-purpose Berth – 14m 220m Passenger Berth – 9.5m 240m	-ditto
Access Channel	Width 150m (Inner and Outer) Depth - 11.0m (Inner and Outer)	Width 140m (Inner) 137m (Outer) Depth - 14.0m (Inner) - 14.5m (Outer)	Widths of Access Channel are reduced based on the results of Ship Maneuvering Simulation. Water Depth is determined with conditions of no tidal restrictions.
Dumping Area of Dredged Materials	Dumping area was located at around 4km offshore from berth area.	Offshore dumping area is determined at around 25km from berth area. Onshore dumping areas are set at both sides of berth area.	Despite of the recommendation of F/s, MARN designated the offshore dumping area at around 50km from the berth area. But the distance is reduced to 25km taking consideration of environmental study made in detailed design stage.
Planning Location	The west corner of main berth was set at in the distance of 360m from the end of Punta Gorda Berth.	The west corner of main berth was set at the distance of 630m from the end of Punta Gorda Berth.	From the results of geological survey, soft soil layer was found to be thicker near the Punta Gorda Berth. Through the comparison of alternative port layouts, the final location is determined.

THE DETAILED DESIGN ON PORT REACTIVATION PROJECT IN LA UNION PROVINCE OF THE REPUBLIC OF EL SALVADOR

FINAL REPORT

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CHAPTER 1 INTRODUCTION

1.1 Background of the Project

El Salvador has three ports: the Acajutla and Cutuco Commercial Ports and the Punta Gorda Fishing Port. The Acajutla Port, which commenced operation on 1961 is the sole international commercial port in the country, and it handles solid bulk, liquid bulk, and container cargo traffic. However, this port faces the Pacific Ocean and suffers from swells. Due to unsuitable for efficient container cargo handling, at present about 75 % of Salvadorean container cargo is handled through the Quetzal Port.

Before the civil war, the Cutuco Port had played an important role in export of coffee and raw cotton. The existing single jetty with associated loading yards, storage sheds and other facilities was built between 1912-1915. Due to significant deterioration of its facilities, the Cutuco Port was closed in 1996. All port facilities are outdated and beyond repair to meet modern port requirements. Since its closure the functions of this commercial port were transferred to the Punta Gorda Fishing Port. Which was opened from 1987. The Punta Gorda Port, located about 1 km southeast of the Cutuco Port, mainly serves fishery activities.

In order to offer and efficient port services, considering the advantageous location and well sheltered conditions of the Fonseca Gulf, the Government of El Salvador (GOES) plotted the port reactivation project in La Unión Province.

The GOES then carried out the Master Plan and Feasibility Study with technical assistance of the Government of Japan (GOJ) in 1985. The Study concluded that one (1) Container Berth, one (1) Multi-purpose Berth, and one (1) Passenger Berth together with port-related facilities will be constructed as a short-term port development plan.

1.2 Implementation of the Project

The GOES decided to implement the Project and requested further financial assistance from the GOJ. The GOJ agreed to provide a loan through the Japan Bank for International Cooperation (JBIC) for the implementation of the first phase of the Project. Supporting the implementation of the project, the detailed design of the Project was also provided through technical assistance by Japan International Cooperation Agency (JICA).

The COMISION EJECUTIVA PORTUARIA AUTONOMA (CEPA) is the government executive agency responsible for the development and management of the port, and the implementing agency of the Project.

1.3 Study Area

The study area covers La Union City, La Union Province and its vicinity under the influence of the Project.

1.4 Scope of the Study

The detailed design work can be divided into six phases:

1st Phase: Preparatory Work in Japan

2nd.Phase: F/S Review and Investigations in El Salvador

3rd. Phase: Basic Design in El Salvador

4th Phase: Detailed Design in El Salvador

5th Phase: Finalization of the Study and Bidding Documents in Japan

6th Phase: Concession Plan

The scope of work for each phase is as follows:

(1) 1st Phase: Preparatory Work

1.1 Collection and Analysis of Relevant Data and Information

1.2 Formulation of Study Plan, Work/Investigation Method, Work Schedule, etc.

1.3 Preparation of Inception Report

(2) 2nd Phase: F/S Review and Investigations

2.1 Submission and Discussion of Inception Report

2.2 Review on Cargo and Passenger Traffic Forecast

2.3 Review on Requirements of Major Port Facilities

2.4 Review on Characteristics of Calling Ships

2.5 Review on approach Channel and Basins

2.6 Review on Cargo and Passenger Handling System

2.7 Review on Port Layout including On-lan Facilities

2.8 Study on Port Operation and Management System

2.9 Preparation of Technical Specifications and Program for Field Investigation

2.10 Field Investigations

2.11 Environmental Survey

2.12 Preparation, Submission, and discussion on Progress Report (1)

(3) 3rd Phase: Basic Desing

3.1 Ship Simulation and Preparation of Ship Maneuvering Plan

3.2 Channel Sedimentation Analysis

3.3 Diffusion Analysis of Suspended Solid during Dredging Works

3.4 Study on Navigation Facilities

3.5 Basic Design of Civil Works

3.6 Basic Design of Land Reclamation and Dredging Works

3.7 Basic Design of Building Works

3.8 Basic Design of Utility

3.9 Basic Design of Cargo Handling Equipment and Tug Boat

3.10 Preliminary Construction Plan and Schedule

3.11 Preliminary Project Cost Estimate

3.12 Preparation of Environmental Study Repor t

3.13 Preparation of Basic Design Report

(4) 4th Phase: Detailed Design

4.1 Economic and Financial Evaluation of the Project

4.2 Detailed Design of Channel, Basin and Navigation Aids

4.3 Detailed Design of Civil Works

4.4 Detailed Design of Building Works

4.5 Detailed Design of Utility Works

4.6 Detailed Design of Cargo Handling Equipment and Tug Boat

4.7 Detailed Construction Plan and Schedule

4.8 Additional Environmental Study

4.9 Preparation, Submission and Discusion on Progress Report (2)

4.10 Port Operation and Maintenance Plan

4.11 Detailed Project Cost Estimate

4.12 Preparation of Project Implementation Plan

4.13 Preparation of Tender Documents

4.14 Preparation of Assessment and Recommendations on the Project

4.15 Preparation, Submission, and Discussion on Draft Final Report

(5) 5th Phase: Finalization of Study and Tender Documents

5.1. Finalization of Study Report and Tender Documents

(6) 6th Phase: Concession Plan

6.1 Preparation of Plan for Concession

6.2 Study on Concession Plan

6.3 Preparation, Submission and Discussion on Report of Concession Agreement for the Management and Operations

Figure 1.1 shows the flow chart of the Study indicating each activity.

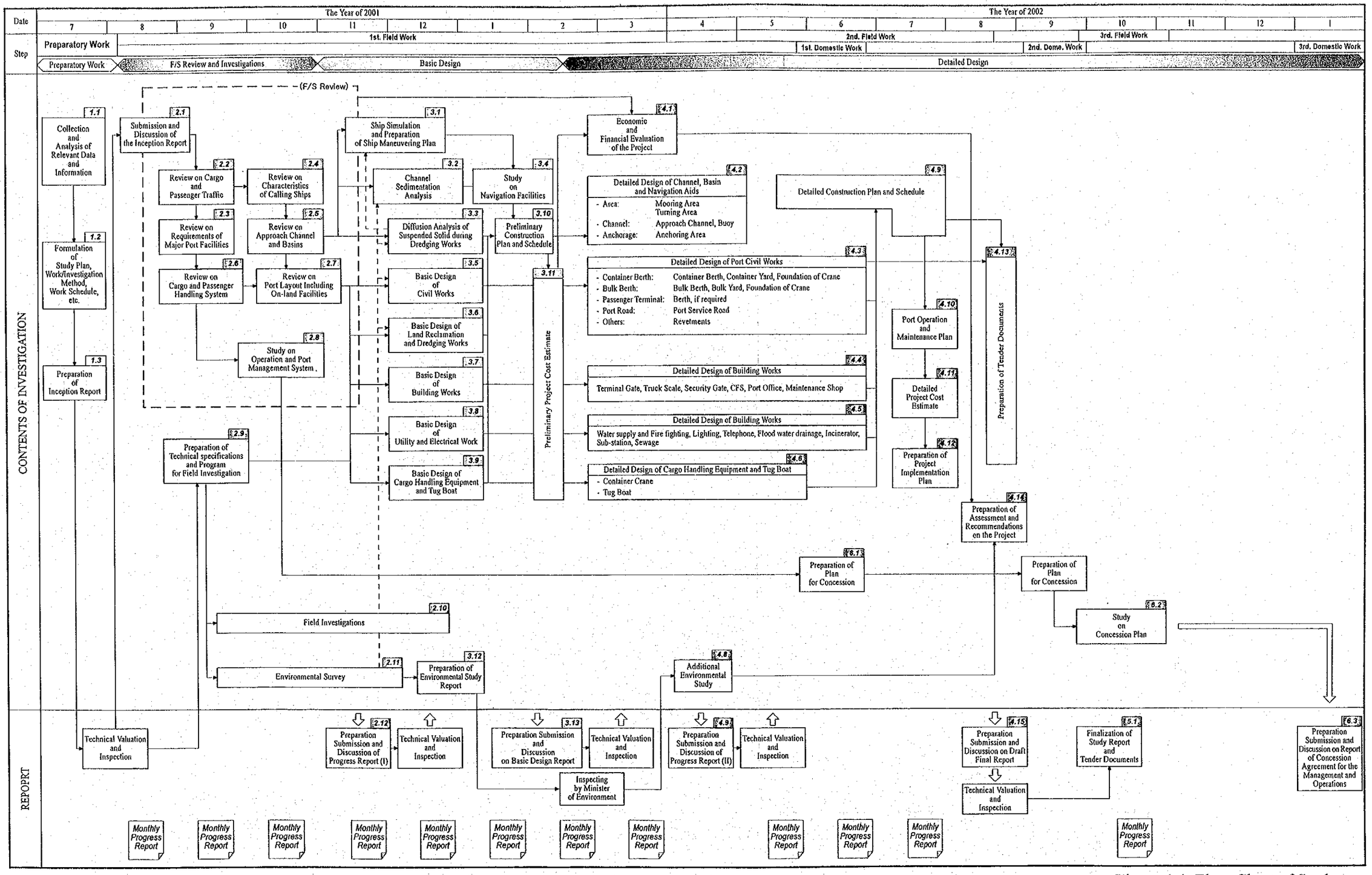


Figure 1.1 Flow Chart of Study

1.5 Outline of the Project

(1)	**Dredging**	
	1) Outer Channel	4,160,000 m^3, depth -14.5 m, width 130 m
	2) Inner Channel	4,469,000 m^3, depth -14.0 m, width 140 m
	3) Turning Basin	2,860.000 m^3, depth -14.0 m/-9.5 m
	4) Navigation Aids	1 lighthouse, 17 light buoys, and 3 beacons
(2)	**Demolition of Existing Facilities**	Jetty, sheds & others
(3)	**Container Berth**	340 m, Caisson Type
(4)	**Multi-Purpose Berth**	220 m, Caisson Type
(5)	**Passenger Berth**	240 m, Dolphin Type
(6)	**Revetment**	
	1) Revetment	650 m
	2) Temporary Revetment & Bund	1,640 m
(7)	**Reclamation**	
	1) Reclamation	3,005,000 m^3
	2) Removal of Soft Soil	481,000 m^3
(8)	**Pavement**	
	Concrete Pavement	8,600 m^2, RTG Lane
	Concrete Pavement	71,200 m^2, Container Yard
	Asphalt Pavement	19,000 m^2, Port Road, etc.
	Macadam Pavement	72,000 m^2, Open Storage
(9)	**Drainage**	
	Pipe	3,500 m
	Trench	6,020 m
(10)	**Building**	
	Port Administration Building	2,540 m^2
	Container Freight Station	2,420 m^2
	Maintenance & Repair Shop	1,440 m^2
	Container Gate	245 m^2
	Cargo Gate	205 m^2
	Power Supply Station	450 m^2
(11)	**Container Cargo Handling Equipment**	2 units
(12)	**Tugboat**	2 units

1.6 Project Cost

Table 1.1 shows the summary of the project costs.

Table 1.1 Shows the Project Cost

(Unit: 1,000 US$)

Description	F/C Portion	L/C Portion	Total	Amount of JBIC Loan	% of JBIC Finance
1. Civil and Building Works	38,200 (4,584)	52,655 (6,319)	US$ 90,855 (Y 10,903)	US$ 68,141 (Y 8,177)	75 %
2. Procurement of Cargo Handling Equipment	12,766 (1,532)	0 (0)	US$ 12,766 (Y 1,532)	US$ 12,766 (Y 1,532)	100 %
3. Procurement of Tugboats	7,000 (840)	0 (0)	US$ 7,000 (Y 840)	US$ 7,000 (Y 840)	100 %
4. Consulting Services	5,650 (678)	0 (0)	US$ 5,650 (Y 678)	US$ 5,650 (Y 678)	100 %
5. Grand Total	63,616 (7,634)	52,655 (6,319)	US$ 116,271 (Y 13,953)	US$ 93,557 (Y 11,227)	

Note : Figures in parentheses are equivalent Yen amounts (million) converted at the exchange rate 120 Yen = 1 US$

CHAPTER 2 EXISTING CONDITIONS

2.1 Socio-economic Condition of Project Area

(1) Administrative Division

El Salvador is divided into 14 provinces and 262 municipalities. It neighbors on Honduras to the North, Guatemala to the West, Nicaragua to the East, and faces the Pacific Ocean to the South. La Unión Province, located in the eastern part of the country, is divided into 18 municipalities grouped into two districts: Santa Rosa de Lima in the mountain area, and La Unión in the Gulf area.

(2) Economy

In the period of 1996-2000, the Salvadorean economy showed steady growth with an average annual rate of 3.5% in total Gross Domestic Product (GDP). By the year 2000, El Salvador showed a slowdown in economic activities with a growth rate of 2.0% against the preceding year of 1999. Despite the economic slowdown as a whole, the Manufacturing Sector showed a comparatively high growth rate of 4.5% against the preceding year.

(3) Population

The total population of La Union Province was estimated at 289,021 in 2000. The population density in the year 2000 grew to 139 persons/km^2. The annual population growth rate in 1998 was 2.18%, which is similar to the country's growth rate of 2.1% in 1992.

(4) Industry

Agriculture is the main economic activity of La Unión, followed by commerce, manufacturing, cattle raising, fishing, and salt production. The major products are maize and beans followed by sesame, henequen, rice, sugar cane, vegetables, and watermelon at a small scale. Also an important economic activity in La Unión is salt production. There are 850 hectares allocated for salt production, representing 27.4% of the national total salt production area.

There are some domestic industries, such as canned seafood factories, daily commodities farming, fishery, palm tree hats and mats, brooms, clay bricks and tiles, pottery, etc. Marine artesanal fishery is the main income source of the municipalities on the coastal area. In 1992, the artesanal fishery accounted for 20% of the gross domestic product, or equivalent to 43% of the national artesanal fishery.

2.2 Natural Conditions

La Unión Province belongs to the tropical rain forest and subtropical forest zones in the South of the northern mountainous area which belongs to the subtropical forest zones. The rainy season is from May to October and the dry season is from November to April. The total annual rainfall varies from 1,300 to 2,100 mm and the annual average is 1,780 mm. La

Union has an average of 117 rainy days with highest average occurrence of 23 days of rain in September.

The temperature in La Unión City has a range from 27°C to 30°C. The maximum of the last five years (1996-2000) was recorded in April 2000 at 37.2°C and the minimum over the same period was recorded in January 1997 at 18.1°C.

The monthly average wind velocity at La Union City is about 3 m/s from January to April and 2 m/s from May to December. The predominant wind direction is NE from November to February and SW from March to October.

2.3 Oceanographic and Geological Conditions

The tidal pattern in the port area is semi-diurnal, with the occurrence of two high waters a day and the tidal range in spring tides is about 3 meters.

The maximum current speed in the project area occurs in the inner channel with a speed of 1.8 m/s. In the outer channel the current speed is between 0.8 to 1.6 m/s.

Eighty percent of the waves in the gulf area are between 1.0 and 1.5 meters high and occur in the NE to SW direction. Waves higher than 3.25 m are extremely rare with occurrence of less than 2%.

2.4 Development Plans

The Project is a key element of the strategy for development of the economically depressed eastern region of the country as identified in the National Development Plan issued in 1998.

The Project is also identified as an important transportation link in the Puebla-Panama Plan (2001) in addition to the construction of new highway systems for the operation of the dry canal between the La Union Port and the Cortes Port in Honduras on the Atlantic Ocean.

2.5 Present Port Activities in El Salvador

The volume of cargo passing through the Acajutla Port has grown steadily for the last ten years (1991-2000) at an average annual growth rate of 7.9%.

The total cargo volume handled by the port in the year 2000 was 2.46 million MT consisting of 2.02 million MT of imports and 0.44 million MT of exports.

Since the closure of the Cutuco Port in 1996, the Punta Gorda wharf has served commercial vessels under the administration of CORSAIN (Salvadorean Investment Corporation), a corporation under the Ministry of Economy.

The volume of cargo passing through the Cutuco Port in 1995 before its closure was 63,000 MT all comprising imports of diesel oil, fertilizer and other dry bulks.

The volume of cargo passing through Punta Gorda Port in the year 2000 was 128,435 MT consisting only of imports which 70% are liquid bulk cargo such as LPG and butane gas, and the remainder is dry bulk comprising fertilizer, cement in bag, and salt.

CHAPTER 3 TERMINAL PLANNING

3.1 Traffic Demand Forecast

3.1.1 General Approach

The cargo and passenger traffic through the La Union Port was forecast for the target years 2005, 2010 and 2015 based on the social and economic indices up to the year 2000.

The population growth rates applied for the forecast are 1.84% for the period between 2001 and 2005 and 1.50% for the period between 2005 and 2015.

The growth rate of Gross Product applied for the forecast is 3.5% for the target years.

The final cargo and passenger volume were determined after comparison of both micro and macro forecasts.

3.1.2 Microeconomic and Macroeconomic Traffic Forecast

(1) Microeconomic Traffic Forecast

Conventional Cargo

The allocation of conventional cargo was carried out by a three step process. In the first step the entire Salvadorean overseas trade cargo was estimated. In the second step the cargo was allocated to the La Unión and Acajutla Ports based on transport cost analysis that determines reasonable hinterlands for each Port. In the third step the volume of potential transit cargo to be attracted from neighboring countries to the La Unión Port was estimated also using statistical and transport cost analysis methods.

Container Cargo

The Salvadorean container traffic through the Pacific Coast region now using Quetzal Port is expected to shift to the La Unión Port. The additional volume was then calculated by a two step process: In the first step the volume of containerizable cargo was estimated based on past trend in Acajutla; in the second step the number of transit containers from neighboring countries added to La Unión Port based on transport cost analysis were calculated and added to the Salvadorean local containers.

(2) Macroeconomic Traffic Forecast

A macro economic analysis was carried out to obtain the total volume of Salvadorean trade by all transport modes for the target years for imports and exports. For imports, the analysis was based on the economic indices and statistical correlation between the Salvadorean GDP and the total volume of imports. For exports, the analysis was made based on statistical correlation between the major trade partners' GDP namely Central American countries, the USA, and Germany.

Additionally, historical transport cargo trends were then used to allocate the share of cargo to be handled by Salvadorean ports. Many assumptions were made with a high degree of

reasonableness: The Salvadorean trade cargo made up mostly of containers currently via Caribbean ports, mainly via Santo Tomas, will also shift to the La Unión Port, since the transport cost will be lower; lastly, the Panamax container ships currently allocated in pendulum service between East Asia and the USA East Coast or between the USA West Coast and Europe via the Panama Canal will also call at the La Unión Port in the future.

From the foreign cargo transport cost analysis, it was determined that the La Unión Port will attract 25%, 50% and 25% of the container cargo from the ports of Corinto in Nicaragua, San Lorenzo in Honduras, and Quetzal in Guatemala respectively.

(3) Comparison of Two Forecasts

The results of cargo forecast for Salvadorean local cargo (container and bulk cargo) by the microeconomic approach and macroeconomic approach are shown in Table 3.1 it shows tolerable differences or less than 10% for the target year 2015. The result of microeconomic forecast was used as a basis of further discussion.

Table 3.1 Comparison of results of Microeconomic and Macroeconomic Approaches

Unit:1,000 MT

Forecast Volume of Local Cargo		2005	2010	2015
Microeconomic Approach	Imports	3,079	3,941	5.013
	Exports	604	678	791
	Total	3,683	4,619	5,804
Macroeconomic Approach	Imports	2,923	3,849	4,967
	Exports	801	1,082	1,435
	Total	3,724	4,931	6,402

3.1.3 Allocation of Cargo to La Unión

In the microeconomic cargo forecast, each commodity was examined to determine what cargoes have a potential to be handled at the La Unión Port mainly from the viewpoint of transportation cost. The share of cargoes between the Acajutla Port and the La Unión Port is forecast as shown in Table 3.2.

The total volume of container and bulk cargo by import/export, package style, commodity and port to be allocated to the La Union Port in the target years was estimated as shown in the table below.

Table 3.2 Summary of Cargo Forecast for Acajutla and La Union Ports in the Target Years by Commodity Type.

(Unit : MT)

Import/ Export	Package Style	Commodity	Acajutla Port			La Union Port		
			2005	2010	2015	2005	2010	2015
Imports	General Cargo	Miscellaneous	15,000	15,000	18,000	-	-	-
		Chemical products	32,000	52,000	78,000	-	-	-
		Iron and steel, and its products	334,800	499,500	710,100	37,200	55,500	78,900
		Fertilizer in bag	39,000	39,000	39,000	-	-	-
		Vehicles	10,500	15,400	23,100	4,500	6,600	9,900
		Nonferrous metal products	17,000	29,000	45,000	-	-	-
		Cement in bag	-	-	-	60,000	70,000	80,000
		Sub-total for General Cargo	448,300	646,900	913,200	101,700	132,100	168,800
	Dry Bulk	Cereals including maize flour	675,500	833,000	1,002,400	289,500	357,000	429,600
		Fertilizer	245,700	245,700	245,700	105,300	105,300	105,300
		Soybean flour	135,8000	146,300	157,500	58,200	62,700	67,500
		Others	9,000	9,000	9,000	-	-	-
		Sub-total for Dry Bulk	1,066,000	1,234,000	1,414,600	453,000	525,000	602,400
	Liquid Bulk	Diesel oil	276,000	375,000	494,000	-	-	-
		Gasoline	166,000	225,000	276,000	-	-	-
		Animal and vegetable fats	77,000	90,000	107,000	-	-	-
		Soybean oil	19,000	19,000	19,000	-	-	-
		Alcohol	18,000	18,000	18,000	-	-	-
		Butane gas	15,000	15,000	15,000	-	-	-
		Caustic soda	28,000	43,000	63,000	-	-	-
		Alkane	5,000	5,000	5,000	-	-	-
		Others	30,000	30,000	30,000	-	-	-
		Sub-total for Liquid Bulk	634,000	820,000	1,027,000	0	0	0
		Total for Imports	2,148,300	2,703,900	3,354,800	554,700	657,100	771,200
Exports	General Cargo	Miscellaneous	4,000	2,000	2,000	-	-	-
		Sub-total for General Cargo	4,000	2,000	2,000	-	-	-
	Dry Bulk	Sugar	190,000	190,000	190,000	60,000	60,000	60,000
		Sub-total for Dry Bulk	190,000	190,000	190,000	60,000	60,000	60,000
	Liquid Bulk	Molasses	150,000	150,000	150,000	10,000	10,000	10,000
		Ethyl Alcohol	19,000	19,000	19,000	-	-	-
		Sub-total for Liquid Bulk	169,000	169,000	169,000	10,000	10,000	10,000
		Total for Exports	363,000	361,000	361,000	70,000	70,000	70,000
Grand Total of General Cargo in MT			2,511,300	3,064,900	3,715,800	624,700	727,100	841,200

The Salvadorean local containers that are destined to or originate from the Pacific Coast regions including the USA West Coast and Asia are currently passing through the Acajutla

Port (via-Acajutla-Port Pattern) and the Quetzal Port (via-Quetzal-Port Pattern). It is assumed that the latter traffic flow, viz "via-Quetzal-Port pattern", will shift to the La Union Port after its development.

The forecast volumes of the Salvadorean trade cargo currently passing via Acajutla and via Quetzal were finally summed up to obtain the forecast potential cargo to be attracted to the Salvadorean ports, once the La Union Port project is implemented. The forecast volumes are shown in Table 3.3 mostly allocated to the La Union Port.

Table 3.3 Forecast Volumes of Local Containers to be Attracted to Salvadorean Ports due to Traffic Pattern Change

(Currently via-Acajutla Port Pattern)

Local Containers		2000	2005	2010	2015
Volume of Containerized Cargo in 1000 MT	Imports	68	112	179	278
	Exports	24	28	30	30
	Total	112	140	209	308
Number of Containers in 1000 TEUs		15	24	39	60

(Currently via-Quetzal Port Pattern)

Local Containers		2000	2005	2010	2015
Volume of Containerized Cargo in 1000 MT	Imports	173	263	401	609
	Exports	94	143	217	330
	Total	267	406	618	940
Number of Containers in 1000 TEUs		22	57	87	132

(Total Volume to Salvadorean Ports in the Future)

Local Containers		2000	2005	2010	2015
Volume of Containerized Cargo in 1000 MT	Imports	241	376	580	887
	Exports	118	171	247	360
	Total	359	547	827	1,248
Number of Containers in 1000 TEUs		37	81	125	192

The percentage of container traffic in overseas trade with Asia represents approximately 25% of the total traffic via the ports on the pacific Coast, while that with the USA West Coast is said to account for over 50% of the total, assuming that the former percentage will remain unchanged in the future. Such containers to/from the neighboring countries are called transit containers potentially attracted to the La Union Port and summarized in Table 3.4.

Table 3.4 Number of Containers Potentially Attracted to La Union Port as Transit Containers from Neighboring Countries in C.A.

(Unit: 1000 TEUs)

Volume of Transit Containers		2005	2010	2015
Corinto Port in Nicaragua	25%	4	6	8
San Lorenzo Port in Honduras	50%	3	4	6
Quetzal Port in Guatemala	25%	34	50	70
Total		40	60	84

The total volume of containers allocated to the La Union Port was estimated by summing up the Salvadorean local container cargo and transit cargo to/from the neighboring countries. The resulting container volumes in the target years are shown in Table 3.5.

Table 3.5 Total Volume of Containers Allocated to La Unión Port

	2005	2010	2015
Containers (TEUs/Years)	121,000	185,000	275,000

3.2 Major Port Facilities Requirements

3.2.1 Berth Facility

The berth facilities required for the Container, Multi-purpose and Passenger Terminals for efficient operation in the target years were determined based on the number of containers and average container movement per ship, the average number of port calls by bulk carriers, and the average number of port calls by car carries and passenger ships.

The total number of shipcalls was estimated as shown in Table 3.6.

Table 3.6 Total Number of Shipcalls at La Union Port

	2005	2010	2015
Container vessel	208	208	208
Bulk carrier	38	46	53
Car carrier (Ro-Ro)	15	22	33
Passenger ship	1	1	1
Total	262	277	295

Judging from the number of shipcalls, it was determined to provide three berths: 1) Container Berth, 2) Multi-purpose Berth, and 3) Passenger/RoRo Berth.

The berth dimensions were assumed based on the characteristics of ships expected to call at the La Unión Port and are shown in Table 3.7.

Table 3.7 Dimensions of Berths

	Ship Size	Berth Length (m)	Berth Depth (m)
Container Berth	55,000 DWT	340 m	-14.0 m
Multi-purpose Berth	50,000 DWT	220 m	* -14.0 m
Passenger Berth	25,000 DWT	240 m	-9.5 m

Note : To allow container ships to use the Multi-purpose Berth in special cases, the required depth of the berth was adjusted to –14.0 m

3.2.2 Major Onshore Facilities

(1) Yards and Buildings

The dimensions of the major onshore facilities were determined as indicated in Table 3.8.

Table 3.8 Dimensions of Major Onshore Facilities

	Area	Description
Yard for Multi-purpose Terminal	34,000 m^2	
Yard for Ro-Ro Terminal	18,000 m^2	
Administration Building	2,540 m^2	6 levels (3 main levels and three tower levels)
Container Freight Station	2,420 m^2	(30 m x 75 m) 222 m^2 mezzanine
Maintenance and Repair Shop	1,440 m^2	(54 m x 24 m) small mezzanine

(2) Gates

Separate gates will be provided for the Container Terminal and the Multi-purpose Terminal. The number of lanes of each gate was determined within a range of occupancy rate of 45% in the year 2010. Based on the aforesaid requirements the container gate was determined to have 6 lanes (3 gates IN and 3 gate OUT), and the Multi-purpose Terminal to have 3 lanes (1 gate IN and 2 gates OUT).

(3) Other Onshore Facilities

In addition to the above facilities, the following onshore facilities will also be necessary for adequate port operation:

- Storm water drainage system
- Wastewater treatment facilities
- Water supply facilities (domestic water supply and water purification)
- Oil separator for the Maintenance and Repair Shop and Fuel Station
- Power substation and distribution system
- Stand by power generator
- Oil fence

3.3 Terminal Layout Plan

3.3.1 Container Terminal

A study was carried out of the handling system for the Container Terminal operation and it

was determined that the Rubber Tyred Granty (RTG) system is the most appropriate system in consideration of its long service life, low maintenance cost, and easy adaptability of computer management system.

3.3.2 Multi-purpose Terminal

The layout plan of the Multi-purpose Terminal was prepared on a preliminary basis as it is expected that the final yard arrangement and layout plan will be decided by the concessionaire, who will also decide the handling equipment based on the characteristics and volumes of cargoes to be handled, through market research and promotion.

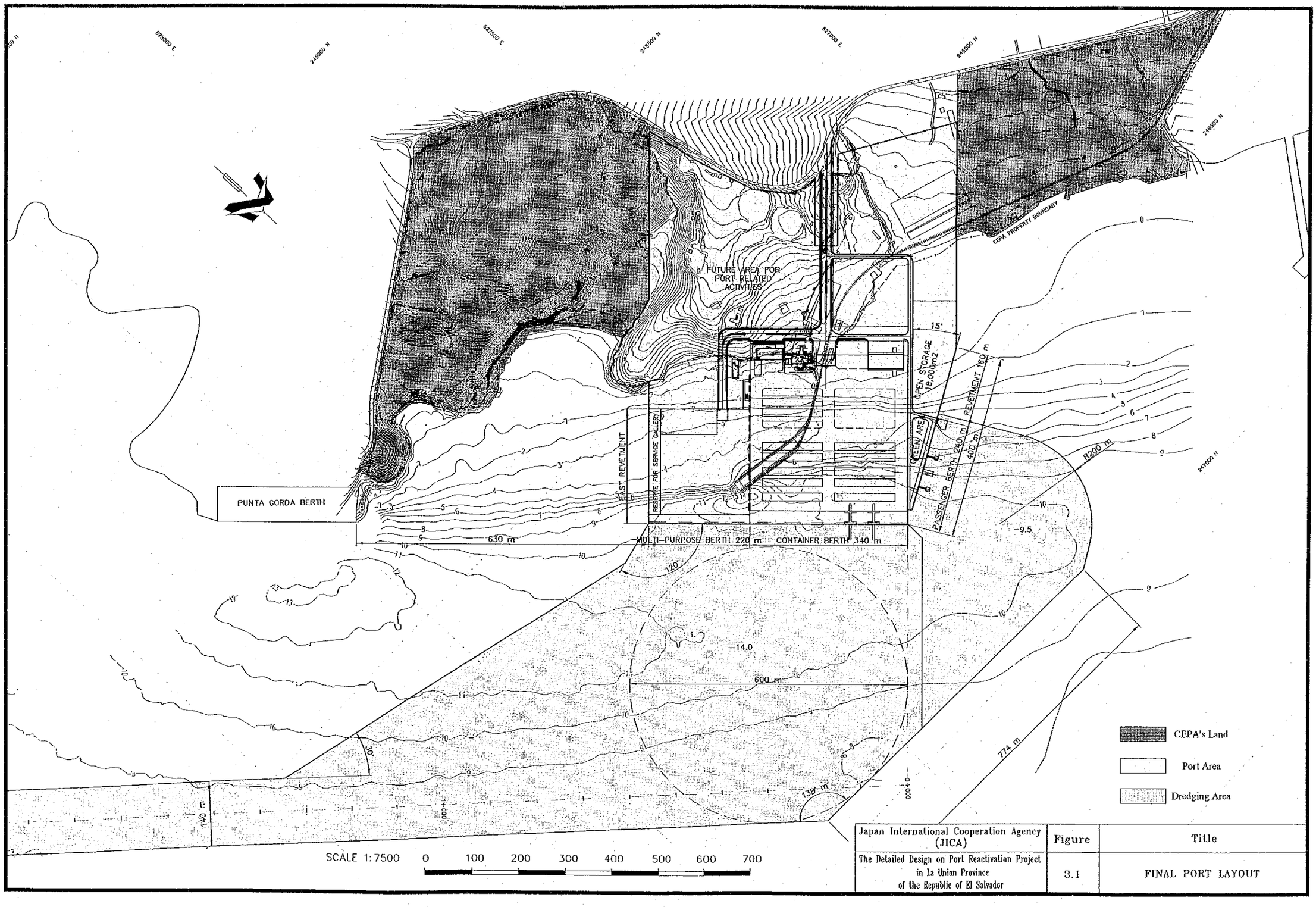
Nevertheless, the port basic infrastructure such as berth, apron paving, gate, tunnel under the quaywall to accommodate future pipelines will be provided.

3.3.3 Passenger Terminal Plan

The Passenger Terminal will be of dolphin type and located in the western part of the port. This terminal will serve passenger ships and Ro-Ro ships and will be used also for mooring tugboats. This berth could also accommodate the planned ferry boats to Nicaragua.

3.3.4 General Terminal Plan

Two port layouts were studied prior to the determination of the definitive terminal plan. The main considerations for the final location were drawn from results of field investigations, but most importantly the chosen terminal plan should allow the port to secure a larger port hinterland for expansion. Figure 3.1 show the final port layout plan.



Japan International Cooperation Agency (JICA)	Figure	Title
The Detailed Design on Port Reactivation Project in La Union Province of the Republic of El Salvador	3.1	FINAL PORT LAYOUT

CHAPTER 4 DESIGN OF CIVIL WORKS

4.1 Design Criteria

4.1.1 Design Codes and Standards

The design standards, codes and manuals for offshore civil works adopted and referred to in the design of the project structure are:

1) Technical Standards for Port and Harbor Facilities in Japan;
2) Shore Protection Manual: U.S. Army Coastal Engineering Research Center; and
3) Regulation for Structural Safety of Constructions, by ASIA "Asociación Salvadoreña de Ingenieros y Arquitectos".

4.1.2 Natural Conditions

(1) Meteorological and Oceanographic Conditions

Meteorological and oceanographic conditions applied for the design are summarized in Table 4.1.

Table 4.1 Design Natural Conditions

Meteorological Conditions	Temperature	Highest Maximum		37.2℃
		Lowest Minimum		18.1℃
	Rainfall	Probable Rainfall Intensity (10yr. return)		70 mm/hr
	Wind	Stormy condition (75 year return) Maximum wind velocity		31 m/sec
Oceanographic Conditions	Tide	H.W.L		+3.37 m
		L.W.L		-0.13 m
	Current	Maximum velocity (upper layer)		1.79 m/sec
		Direction		SE
	Wave	Operational condition	(H1/3)	1.0 m
			(T1/3)	3.4 sec
		Stormy condition	(H1/3)	2.2 m
			(T1/3)	4.5 sec

(2) Geological and Geotechnical Conditions

Geological and geotechnical conditions of the project site were investigated by means of soil and core drilling, standard penetration tests (SPT), and laboratory tests.

General characteristics of subsoil from the upper layer are summarized below.

Layer 1: Silty clay (CH), 5.0 to 10.0 m thick

$\gamma' =$ 4 kN/m^3
$\gamma =$ 14 kN/m^3
cu = 5.0 kN/m^2

Layer 2: Gravelly Sand (SG), 5.0 to 10.0 m thick

$\gamma' =$ 10.0 kN/m^3
$\gamma =$ 18.0 kN/m^3

ϕ = 35 degree

Layer 3: Gravelly/sandy Clay (CL), 2.0 to 5.0 m thick

γ' = 10.0 kN/m^3
γ = 18.0 kN/m^3
ϕ = 35 degrees

The design seismic coefficient of 0.2 was adapted which is equivalent of a return period of 75 years.

4.2 Berth Structure

4.2.1 Berth Dimensions

Berth dimensions were determined as shown in Table 4.2 to accommodate the design vessels.

Table 4.2 Berth Dimensions

	Length (m)	Water Depth (m)	Crown Height (m)
Container Berth	340.0	-14.0	+5.0
Multi-purpose Berth	220.0	-14.0	+5.0
Passenger / Car Carrier Berth	240.0	-9.5	+5.0

4.2.2 Load Conditions

The design load for the berth structure applied in the design are summarized in Table 4.3. Besides, the design container crane load and loads imposed by ships were also considered.

Table 4.3 Load Conditions

(1) Design Loads		
1) Dead load (Self weight)	Reinforced concrete unit weight : 24.0 kN / m^3	
	Concrete unit weight : 22.6 kN / m^3	
2) Live load	Normal Condition	Seismic Condition
Container Berth - Apron	20.0 kN/m^2	10.0 kN/m^2
Multi-purpose Berth. - Apron	20.0 kN/m^2	10.0 kN/m^2
Passenger Berth. - Apron	20.0 kN/m^2	10.0 kN/m^2
(2) Seismic load	Horizontal seismic force coefficient : Kh = 0.2	

4.2.3 Study of Alternatives and Proposed Structures

(1) Container and Multi-purpose Berths

The following five alternatives were examined for the Container and Passenger Berth structures.

- Concrete Caisson type
- Vertical Steel Pile Type
- Combined Steel Pile Type
- Steel Sheet Pile Type
- Steel Sheet Pile Cellular Cofferdam Type

The alternatives were compared in terms of cost, durability, and maintenance, and the caisson type structure was retained for the Container and Multi-purpose Berths.

The typical cross section of the Container and Multi-purpose Berth s is shown in Figure 4.1.

(2) Passenger Berth

As to the structure of the Passenger Berth the vertical steel pile type structure was selected after the comparison of alternatives.

(3) Small Craft Basin

Small craft basin is planned to locate at the corner of west revetment and temporary revetment A-north for the purpose to moor two tugboats and some small crafts.

The dimensions of the facilities of the basin are as follows;

Mooring wharf:	Length 50.0m Depth 4.0m Crown height +5.0m
Basin:	Area100m x 90m Depth 4.0m Turning basin Dia. 100m
Breakwater:	Length 95m Crown height +6.0m
	(Rubble mound type breakwater)

4.3 Revetment

The rubble mound type was selected as the most economical and stable structure for the revetment.

Due to the existence of soft subsoil below the seabed, review and study of the soil improvement method were performed and the soil replacement method was selected for the improvement of foundation of the revetment structures.

The typical cross section for the east and west revetments are shown in Figure 4.2.

4.4 Reclamation and Soil Improvement

4.4.1 Location and Earthworks Volume

The proposed reclamation site will be located in the offshore area facing the existing Cutuco Port and will have a land area of approximately 27 ha. The proposed major borrow area for the filling material is situated just behind the reclamation area, and covers an area of approximately 24 ha. The volume of reclamation will be approximately 3.0 million m^3 but only 1.5 million m^3 will be available from the borrow area. Thus, the balance of 1.5 million m^3 shall be obtained by using suitable dredged material or material from an acceptable land borrow in the vicinity of the project site.

4.4.2 Soil Improvement

Same as the subsoil of revetment, improvement of the soft soil layer will be required to minimize the settlement of the terminal area. The replacement method was selected after comparison of various soil improvement methods.

4.4.3 Fill Materials

The fill material for reclamation shall be well-graded sand containing less than 5% in weight of fine particles under 74 μ.

4.5 Road and Paving

4.5.1 Planned Traffic Volume

The total peak daily traffic of trucks was estimated at 1,109 for the year 2015.

4.5.2 Classification of Road

The access roads inside the Port area were classified into main road (4 lanes, 25 m wide) and feeder road (2 lanes, 9 m wide), and their geometric design was carried out accordingly.

4.5.3 Pavement Design

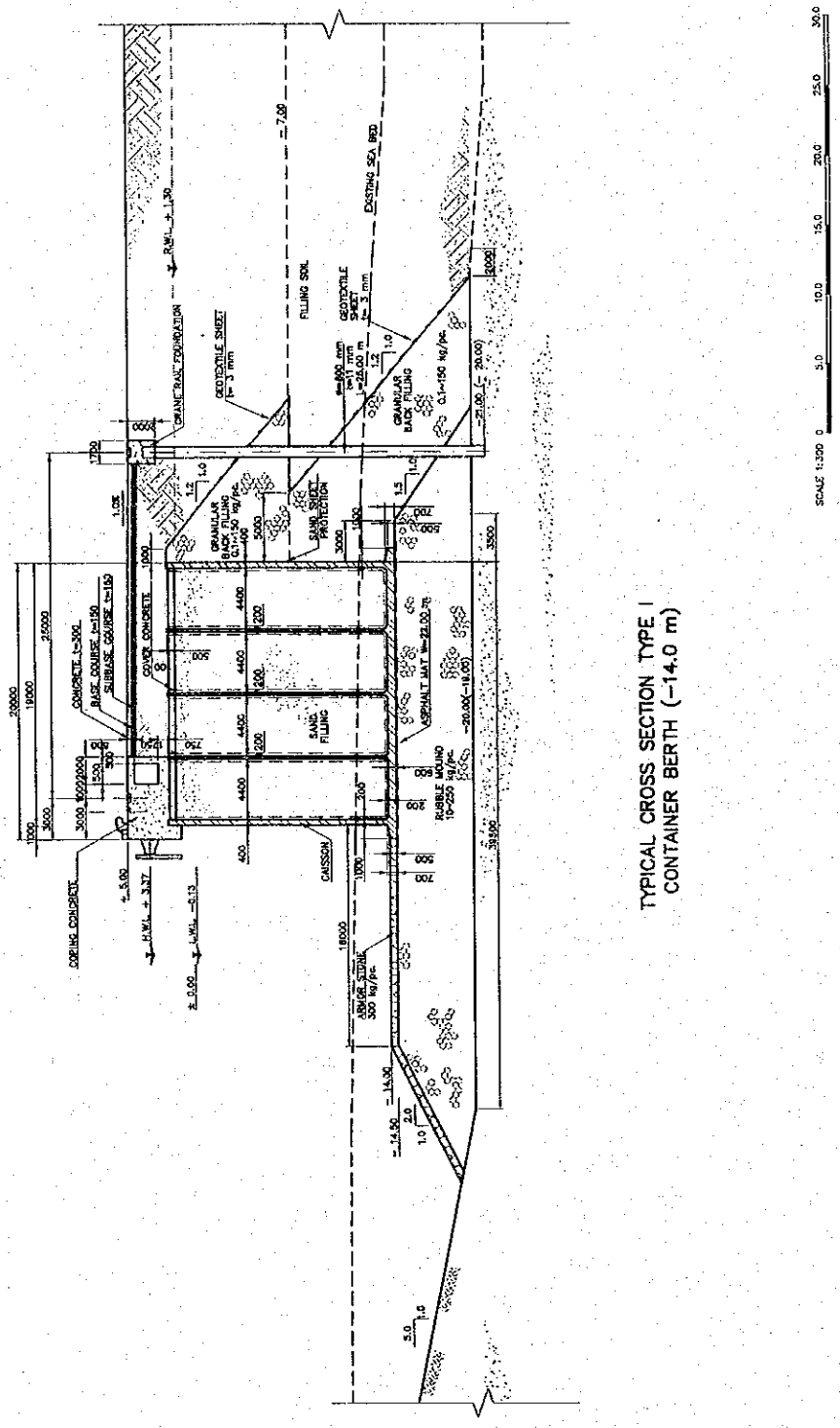
Six (6) types of pavement were considered for the Project:

a) Cement Concrete Pavement (1) [Type 1]: RTG lane
b) Cement Concrete Pavement (2) [Type 2]: Main road, Container yard
c) Asphalt Concrete Pavement [Type 3]: Main road, Feeder road
d) Macadam Pavement (1) [Type 4]: Parking in yard, Empty container yard
e) Macadam Pavement (2) [Type 5]: Multi-purpose yard, Open storage
f) Interlocking Block Pavement [Type 6]: Sidewalks

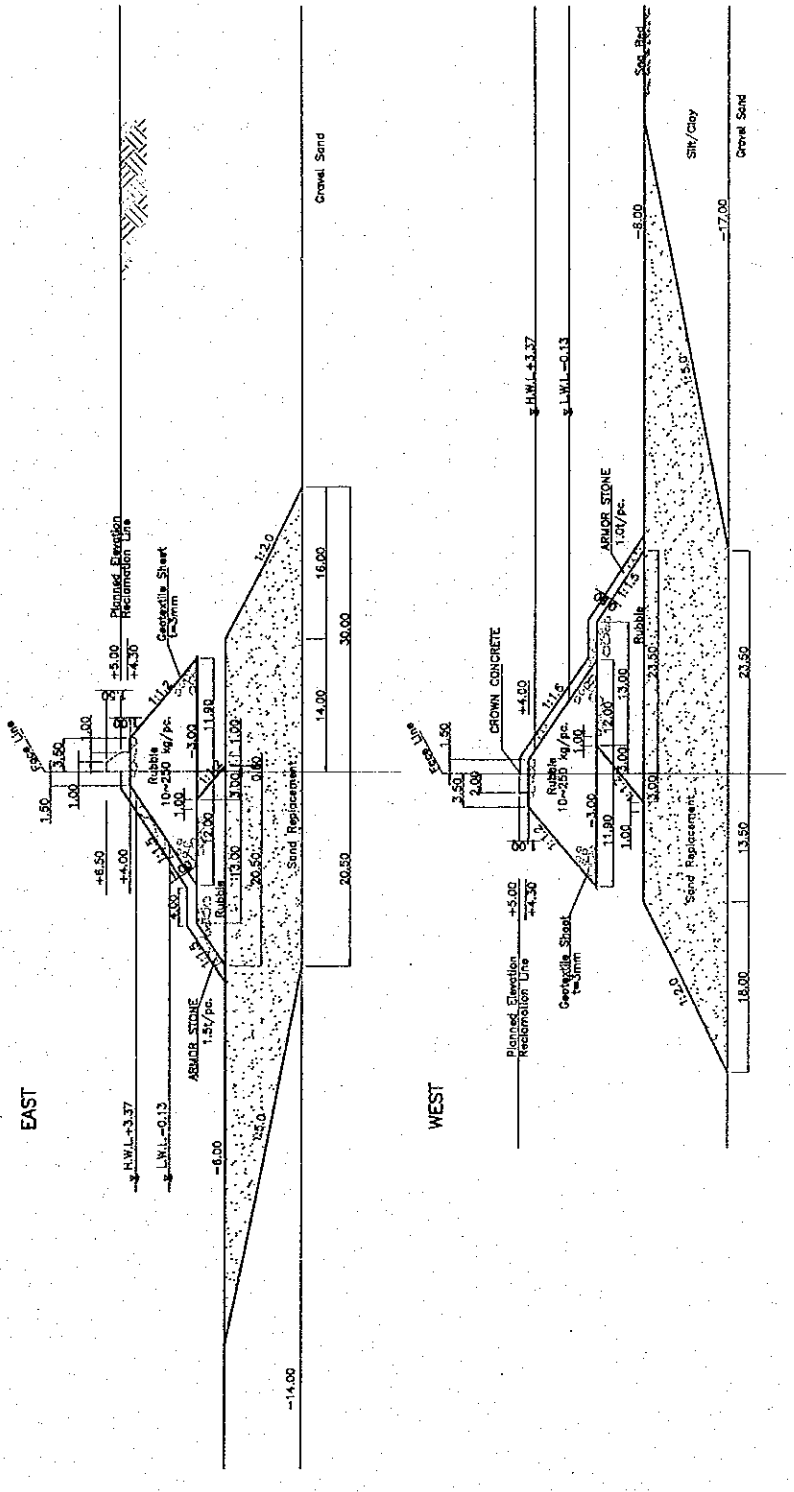
For the container stacking area and reefer container yard, the type of pre-cast concrete plates with gravel pavement was adopted.

4.6 Drainage Design

The design rainfall intensity of 135 mm/hr with a 10-year return period was applied. A storm water drainage consisting of four main lines with outlet pipes of 48" in diameter will be provided .



Japan International Cooperation Agency (JICA)	Figure	Title
The Detailed Design on Port Reactivation Project in La Union Province of the Republic of El Salvador	4.1	TYPICAL CROSS SECTION TYPE I CONTAINER BERTH (−14.0 m)



Japan International Cooperation Agency (JICA)	Figure	Title
The Detailed Design on Port Reactivation Project in La Union Province of the Republic of El Salvador	4.2	TYPICAL CROSS SECTIONS OF REVETMENT EAST-WEST