No. 4

BASIC DESIGN STUDY REPORT
ON
THE PROJECT
FOR
IMPROVING THE VIENTIANE RIVER PORT (PORT OF LAKSI)
IN
THE LAO PEOPLE'S DEMOCRATIC REPUBLIC

FEBRUARY 1988

JAPAN INTERNATIONAL COOPERATION AGENCY

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PREFACE

In response to the request of the Government of the Lao People's Democratic Republic (LAO PDR), the Government of Japan has decided to conduct a basic design study on the Project for Improving the Vientiane River Port (Port of Laksi) and entrusted the study to the Japan International Cooperation Agency (JICA). JICA sent to the LAO PDR a study team headed by Dr. Hiroaki Ozasa, Director, Design Department, 5th District Port Construction Bureau, Ministry of Transport from September 30 to November 3, 1987.

The team had discussions on the Project with the officials concerned of the Government of the LAO PDR and conducted a field survey in the Laksi area. After the team returned to Japan, further studies were made, a draft report was prepared and a mission to explain and discuss it was dispatched to the LAO PDR. As a result, the present report has been prepared.

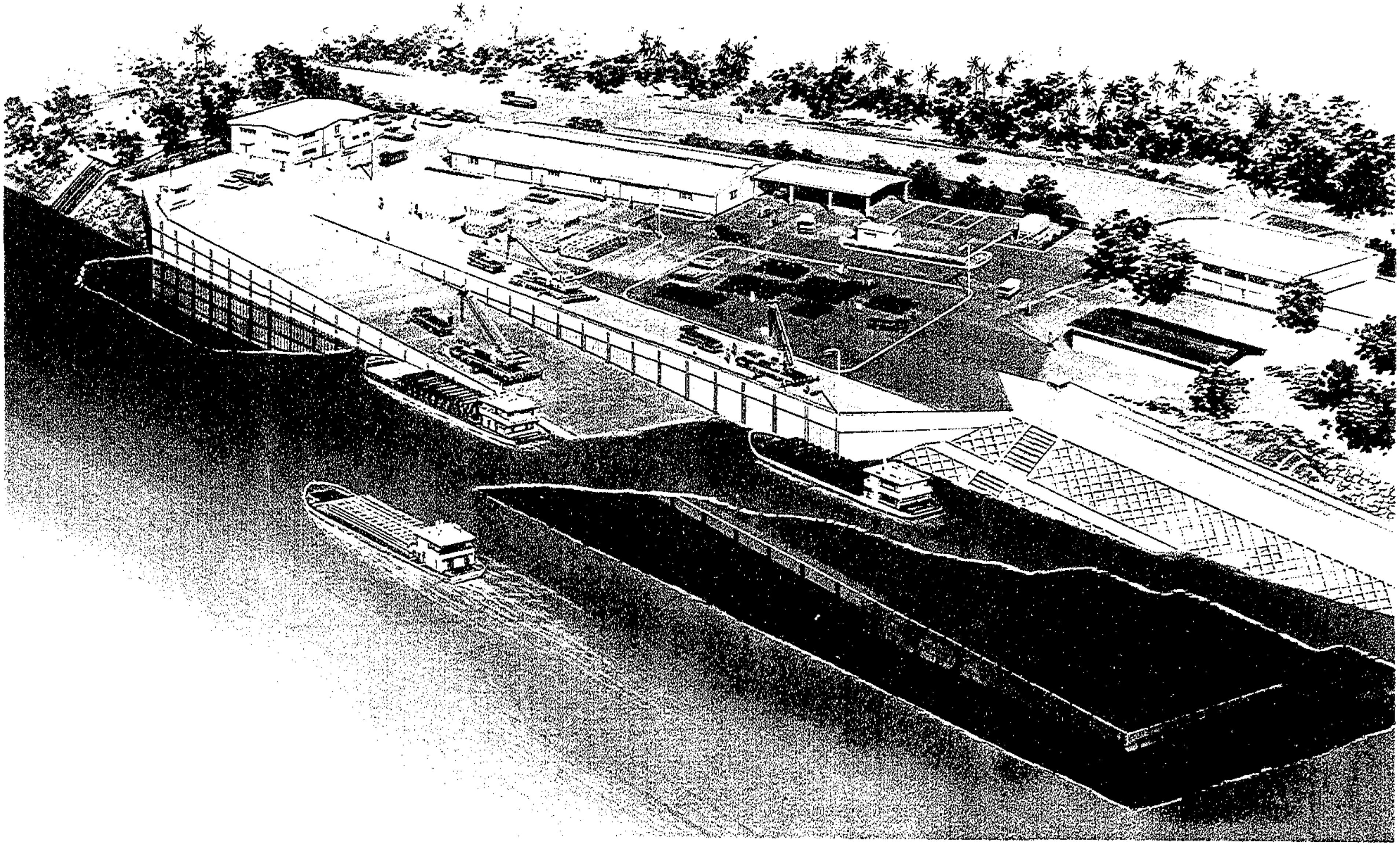
I hope that this report will serve for the development of the project and contribute to the promotion of friendly relations between our two countries.

I wish to express my deep appreciation to the officials concerned of the Government of the Lao People's Democratic Republic for their close cooperation extended to the team.

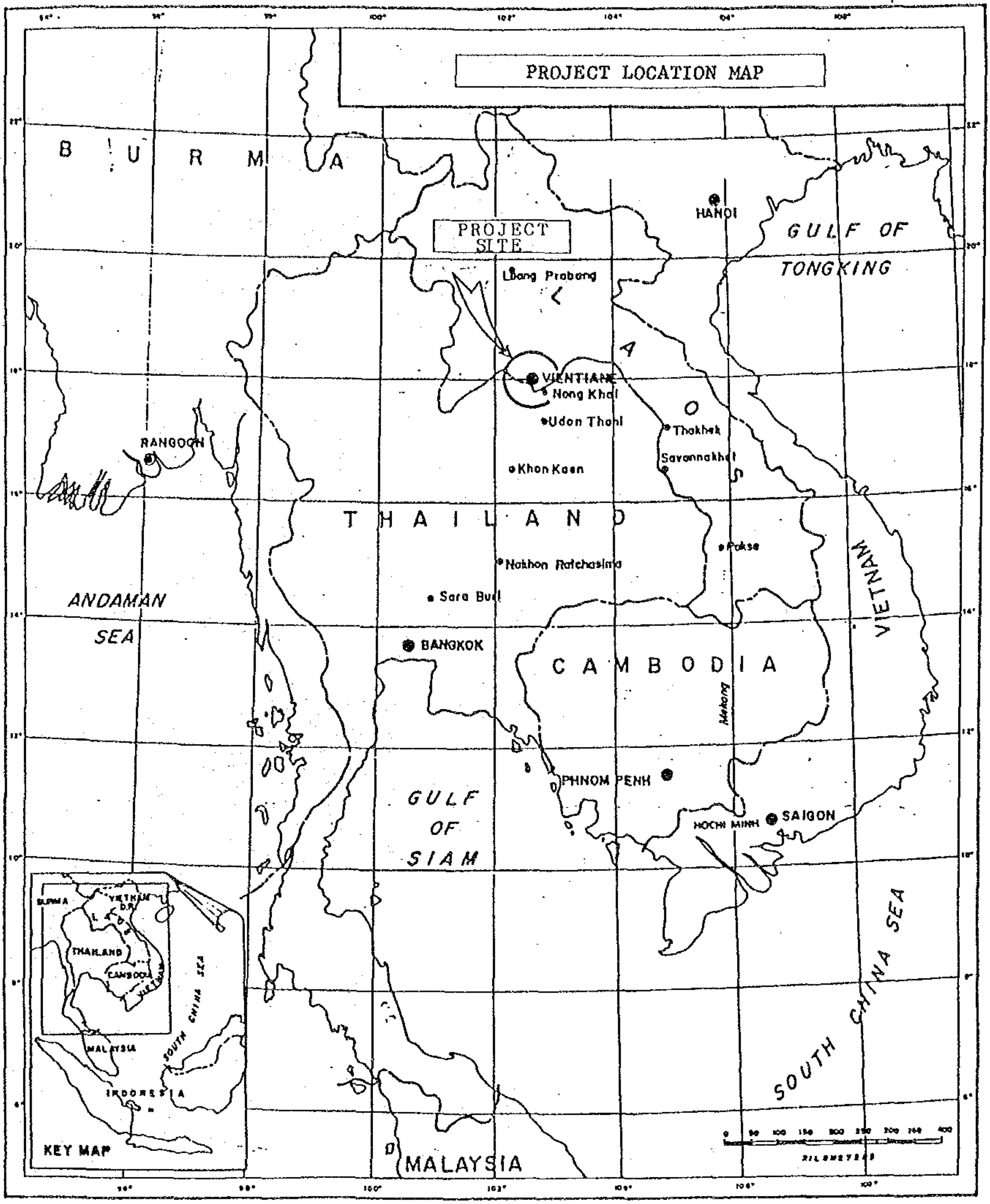
February, 1988

Kensuke Yanagiya

Kensuke Yanagiya
President
Japan International Cooperation Agency



JAPANESE GRANT AID :
VIENTIANE RIVER PORT (PORT OF LAKSI) IMPROVEMENT PROJECT
FEBRUARY 1988


PROJECT LOCATION MAP
PROJECT SITE
B U R M A
L A O
THAILAND
CAMBODIA
VIETNAM
MALAYSIA
HANOI
GULF OF TONGKING
Luang Prabang
VIENTIANE
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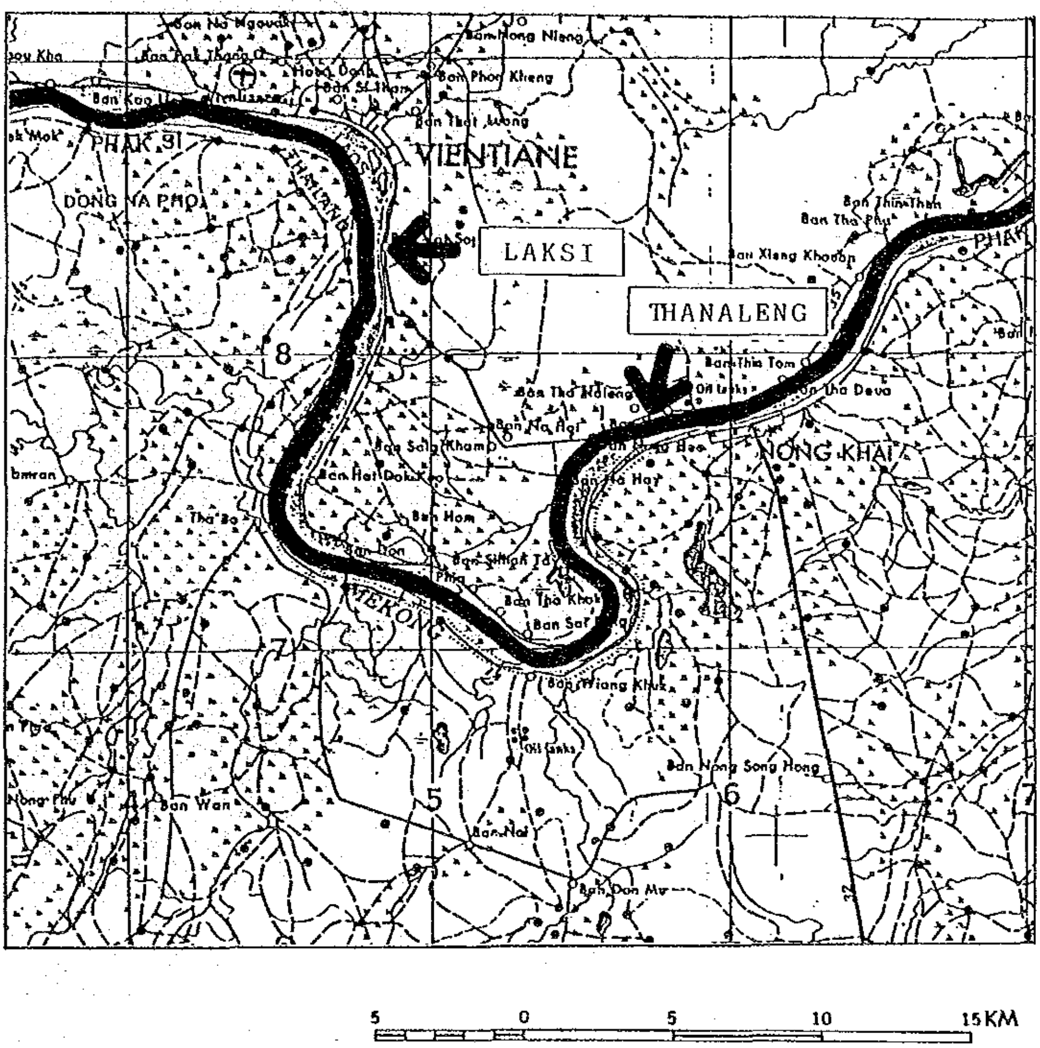

THE PORT OF LAKSI AREA

SUMMARY

SUMMARY

In the Lao People's Democratic Republic (hereinafter referred to as "LAO PDR"), cities have developed along the Mekong River that flows in a north-south direction. For transporting cargo and passengers between cities, transportation on the Mekong River, as well as on the north-south road trunk line (Route 13), holds a most important position. During the rainy seasons when roads are disrupted by flooding, river transportation becomes extremely important.

In the southern part of the country, the Keng Kabao Port, constructed upstream of Savannakhet in 1986 with grant aid from the Netherlands, has modern facilities. Consequently, it is expected that cargo flow from the Keng Kabao Port to the north will increase.

In the Vientiane metropolis there are two ports: the Thanaleng Port which performs as the trading port with Thailand across the Mekong River; and the Port of Laksi which handles domestic transportation.

The Port of Laksi, by pairing up with the Keng Kabao Port, should become the primary point for north-south transportation; however, its facilities are deteriorated and the port area is small. Presently, the Port of Laksi does not have the capabilities to handle the increasing amounts of cargo.
Therefore, early port improvement is highly desirable.

In view of the above background, the Government of LAO PDR planned the Project for Improving the Vientiane River Port (Port of Laksi) and requested grant aid cooperation from the Government of Japan. In response to the Government of LAO PDR's request, the Government of Japan dispatched a Preliminary Study Team in June 1987. Then, after deciding to conduct a basic design study on the Project, they entrusted the study to the Japan International Cooperation Agency (JICA). JICA formed the Basic Design Study Team headed by Dr. Hiroaki Ozasa, Director, Design Department, 5th District Port Construction Bureau, Ministry of

Transport, and dispatched the team to LAO PDR from September 30 to November 3, 1987. The Study Team held a series of discussions related to the Project with Government officials, conducted field surveys, and collected and analyzed necessary data.

The Study Team carefully re-examined the contents of the request and concluded that the following components were appropriate receiving the grant aid cooperation:

(1) Mooring facility

(2) Cargo handling equipment (including mobile cranes)

(3) Warehouse and open storage yard

(4) Roads within the port area

(5) Others:

- Port Administration Office
- Passenger Terminal
- Water, fuel, and electric supply facilities

For the mooring facility, the main Project facility, the ramp type which is very common in the country was adopted by taking into consideration the natural conditions in the Project area, the cargo handling, and the present port operation, maintenance, and management system. For the ramp type structure, a vertical wall with anchored steel sheet-piles was selected.

The Ministry of Transport and Post (MOTP) will be the executive organization for the Project implementation. The following State Companies that are under the jurisdiction of MOTP will participate in the Project implementation;

• Communication Design and Research Institute	:	Research and investigation
• River Work Construction Company	:	Construction
• State River Transport Company	:	Operation, maintenance, and management

MOTP is currently managing the Port of Laksi and the Keng Kabao Port (opened in 1986), and will manage the Tha Deua/Pak Khone Port that is presently under construction. After the Project's completion, MOTP will be responsible for the management, operation and maintenance of the Port of Laksi. In order to fully utilize the improved port, effective port operation, maintenance, and management are absolutely essential. For effective port utilization the following measures should be taken: (1) improve the transportation network; (2) strengthen the facilities' repair and maintenance system; (3) maintain accurate port statistics; (4) establish cargo handling safety measures; (5) provide training to staff personnel.

The implementation of the Project will result in such benefits as increased cargo handling volume and shortened boat waiting time for berthing. Thus, the enhancement of passenger and cargo transportation to and from the Vientiane Metropolis will be achieved. Further, industries related to the port activities will be stimulated and expanded. As a result, the increase of employment opportunities and the stable supply of daily necessities will be realized, and the standard of living will be upgraded.

Therefore, from this point of view, the implementation of the project under Japan's Grant Aid Program is extremely meaningful and the early completion of the project is highly anticipated.

The Study Team would like to take this opportunity to express its great appreciation to the Interim Mekong Committee for their cooperation in the Basic Design Study.

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CHAPTER 1 INTRODUCTION

(1) Objectives of the Study

In LAO PDR, cities are developed along the Mekong River that flows entirely through the country from the north to the south.

For transporting cargo and passengers between cities, transportation on the Mekong River, as well as on the north-south road trunk line (Route 13), holds a most important position.

Near the southern city Savannakhet (in the downstream region of the Mekong River), the Keng Kabao Port, having modern facilities, was constructed in 1986 with grant aid from the Netherlands. It is expected that the amount of cargo transported from the south to the north will increase and that the Keng Kabao Port will be a primary shipping point.

In the Vientiane Metropolis there are two ports: the Port of Thanaleng, having the role as a trading port with Thailand; and the Port of Laksi, used for domestic transportation. The location of the Port of Laksi puts it in a position to become the largest south-north transportation terminal in the country. However, the port's present facilities are small in scale and show signs of severe deterioration. Its cargo handling capability will not be able to handle increased volumes of cargo.

In this connection, the Government of LAO PDR requested grant aid cooperation from the Government of Japan for improving the Vientiane River Port (Port of Laksi).

In response to the request, a preliminary study team was dispatched in June 1987. The team confirmed the background of the request, the content and propriety of the plan, and the scope of the basic design study.

The objectives of the Basic Design Study were to gain an understanding of the background of the plan and the contents of the Government of LAO PDR's request to the Government of Japan for grant aid cooperation to improve the Port of Laksi.

Further, based on the results of the preliminary study, the study team studied the effects and propriety of the Project under grant aid cooperation and prepared a basic design having the most suitable contents and Project scale.

(2) Dispatching the Study Team

In response to the request previously mentioned, the Basic Design Study Team, headed by Dr. Hiroaki Ozasa, Director, Design Department, 5th District Port Construction Bureau, the Ministry of Transport, was formed. The Study Team conducted a site investigation from September 30 to November 3, 1987.

During the site investigation period the Study Team and the officials concerned from the Government of LAO PDR signed the Minutes of Discussions on the Project for Improving the Vientiane River Port (see Appendix 3).

(3) The Contents of the Study

The Study Team conducted the following investigations, studies, and surveys to examine the feasibility of implementing the Project with grant aid from the Government of Japan:

1) A study was made to gain an understanding of the background of the plan and the contents of the request.

2) Confirmation of the Project's components.

3) Field surveys and examination of the Project Site.

4) Examination of natural conditions.

5) Study of port use situations.

6) Study of Project plan.

7) Study of present operation and maintenance conditions.

8) Examination of the scope of work to be undertaken by the Government of LAO PDR.

9) Survey of present construction work situation.

10) Investigation of other related and similar ports.

Based on the results of the above investigation, The Basic Design Study Team made further studies in Japan concerning the contents and scope of the Project, the arrangement of facilities and their structures, construction costs, and the propriety of the Project. As a result, this report, the Basic Design Study Report on the Project for Improving the Vientiane River Port (Port of Laksi), has been prepared.

The Japan International Cooperation Agency dispatched the Team headed by Dr. Hiroaki Ozasa, Director, Design Department, 5th District Port Construction Bureau, Ministry of Transport, to LAO PDR from January 31 to February 10, 1988.

The Team presented and explained the Basic Design Study Report draft to the staff concerned of the Government of the LAO PDR.

Both parties held a series of discussions concerning the report, afterwhich they confirmed its contents.

As a result, they reached agreement on the major points of the report and, on February 5, 1988, they signed the Minutes of Discussions (see Appendix 4).

CHAPTER 2 BACKGROUND OF THE PROJECT

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2.1 General Description of the LAO PDR

(1) Transportation

The transportation network in LAO PDR consists of roads, waterways, and airlines.

Major cities in LAO PDR have developed along the Mekong River, which flows through a strip of the country in a north-south direction. Because of this, the south-north roadways and waterways play a most important role in the country's transportation system.

During dry seasons, the main means of transportation is via roadways. During rainy seasons, when the roads become inundated, the waterways play a vital transportation role.

The total volume of cargo transported in 1985 was 1,013,000 tons: 954,000 tons by road (94.2%), 50,000 tons via waterways (4.9%), 800 tons by air (0.0%), and 8,600 tons by pipeline (0.9%).

In terms of ton-kilometers, the total transport volume was 132 million ton-kilometers: 86.5% by road, 11.7% by waterways, 0.1% by air, and 1.7% by pipeline. The transportation volume by means of waterways and pipelines was larger in terms of ton-kilometers than in terms of tonnage volume.

In 1985, 9.88 million passengers were transported: 9.44 million (95.9%) travelled by road, 320,000 (3.2%) by waterways, and 90,000 (0.9%) by air.

In terms of passenger-kilometers, passenger transport quantity totalled 339 million passenger-kilometers: 84.3% by road, 6.6% by waterways, and 9.1% by air. Quantity of passengers transported by waterways and air was higher in terms of passenger-kilometers than in terms of numbers of passengers.

As for transportation enterprises, there are state, cooperative, and private transportation companies.

State transportation companies carry a greater number of passengers and a larger volume of freight than cooperative and private transportation companies. In 1985 state transportation hauled 56% of the freight tonnage (65.4% in terms of ton-kilometers), and 61.5% of the passengers (70.9% in terms of passenger-kilometers).

LAO PDR's main trading partners are Vietnam, Thailand, and Kampuchea. Ties with Vietnam and Thailand are especially strong.

In 1985, the import flow of commodity (including intermediate flows) was 90,000 tons from Vietnam and 91,000 tons from Thailand. On the other hand, the export flow of commodities (including intermediate flows) during the same year was 120,000 tons to Vietnam, 30,000 tons to Thailand, and 5,000 tons to Kampuchea. Percentage wise, exports to Vietnam were substantially high.

Trade between LAO PDR and Vietnam is by National Roads No. 7, 8, and 9, while trade between LAO PDR and Thailand is by ferryboat across the Mekong River (between Thanaleng and Nong Khai, and between Savannakhet and Mukdahan).

1) Road Transportation

The road network (total length: 13,000 km) in LAO PDR consists of national and provincial roads. 17% (2,200 km) of the total network are now paved.

1,000 km out of 2,500 km of the national roads connecting main cities with neighbouring countries are paved.

Route 13, which runs 1,230 km approximately parallel to the Mekong River from Luang Prabang in the north to Khong in the south, is the most important national road. East-west trunk lines are Route 1 in the north, Route 8 in the middle, and Route 9 in the south.

Road transportation is conducted by state, provincial, and private companies. The three state companies are mainly engaged in long-distance transportation of merchandise and oil products between provinces and with neighbouring countries.

2) Air Transportation

Of the country's domestic transportation means, air transportation carries the least number of passengers and the least amount of cargo. For passenger transportation, the airlines, in terms of passenger-kilometers, accounts for 9%. For long distance passenger travel, air transportation is particularly important.

In LAO PDR there are five airports (Vientiane, Luang Prabang, Savannakhet, Pakse, and Phone Savann) and thirteen airstrips.

Regularly scheduled flights take place at the Vientiane Airport. Domestic flights by Antonov AN24 aircraft are scheduled a few times a week between Vientiane and Luang Prabang, Savannakhet, and Pakse. Helicopter flights are available between Vientiane and Sayabouri and Phone Savann. International airlines fly between Vientiane and Bangkok, Moscow, Hanoi, and Phnom Penh.

3) Pipeline

A 250 km-long pipeline transporting gasoline is installed from Vinh Port in Vietnam to Phou Ngou along Route 8. In 1985, 8,600 tons of gasoline, about one-third of the total amount imported, was transported through the pipeline.

(2) Waterway Transportation and River Ports

1) General

The waterway transportation's share of the total domestic transportation is about 12%, in terms of ton-kilometers, as previously described.

The waterway transportation is mainly carried out on the Mekong River which flows 1,820 km within the LAO PDR. The Mekong River is used for water transportation from

Ban Houayxai, which is located in the northern part of the country, to, except for certain parts, the country's southern borderline with Kampuchea. The river from Ban Houayxai to Savannakhet (approximately 1,200 km) is highly used for waterway transportation. Between Savannakhet and Pakse at Khemmarat rapid, there is a rapid flow section in the river that is difficult to navigate. Downstream, from Pakse to Kampuchea (except for Khong Falls), the river is again used for transportation.

2) River Ports

In LAO PDR there are eighteen ports along the Mekong River. Eleven of them have ramp type port facilities while the remaining seven use the river banks for loading and unloading commodities.

The Port of Laksi in the country's capital, Vientiane, the Thanaleng port and the Keng Kabao port in the suburbs of Savannakhet are under the control of the Ministry of Transport and Post (MOTP). Other ports are under the control of the provincial government.

3) Number of Boats

In 1985, there were 532 cargo boats and 329 passenger boats in LAO PDR. Among them, 31 boats are owned by the State River Transport Company at present (1987).

The largest cargo boat in service is 140 DWT. The largest passenger boat carries 300 passengers. Both of these boats are owned by SRTC.

The average size of a cargo boat is 60 DWT. The dimensions of the largest cargo boat are 33.8 m (length) x 6.8 m (breadth) x 1.2 m (draft).

The largest passenger boat is 41.5 m in length, 6.2 m in breadth, and has a draft of 1.5 m. Boat draft is limited by the water depth of the Mekong River during the dry season.

Cargo boats generally have living quarters on their sterns. The maximum length of the loading space for commodities on the largest cargo boat is 25 m. Trucks and construction equipment are transported by self-propelled barges or ferries.

4) Cargo Volume

In 1985, the volume of cargo transported by waterways was 50,000 tons (100,000 tons of handled cargo volume). Since 1976, waterborne cargo volume has been steadily increasing 5.0% annually, and, in terms of ton-kilometers, it has been increasing 6.0% annually. However, cargo volume at each port is not recorded, except at the MOTP controlled ports of Laksi, Thanaleng, and Keng Kabao.

In accordance with 1986 statistics, cargo volumes were 38,000 tons at the Port of Laksi, and 121,000 tons (17,000 of exports and 104,000 tons of imports) at Thanaleng Port. During the period from January to September 1987, Keng Kabao Port handled 9,000 tons of cargo.

2.2 General Description of Relative Plan

(1) The Second Five-year National Development Plan

Since 1975 LAO PDR has aimed at improving its social and economic foundations. The Three-year National Development Plan (1978-1980) and the First Five-year National Development (1981-1985) were steps undertaken to achieve its goal. Accordingly, agricultural production increased favourably, and, in 1984, the country attained self-sufficiency in the supply of rice. However, rice planting and harvesting rates for state farms continues to be low. Accomplishments in the areas of industrial production and transportation network improvement have been less than planned on.

In 1986, LAO PDR set up the Second Five-year National Development Plan (1986-1990) and it is presently striving to achieve the objectives of the plan. In the Second Five-year Plan, special emphasis is being placed on agriculture development and transportation and communication system improvement.

2.3 Background and Major Contents of the Request

In January of 1987, the Government of LAO PDR requested grant aid cooperation from the Government of Japan for the purpose of improving the Vientiane River Port (Port of Laksi).

In response to the request, the Government of Japan decided to conduct a preliminary study on the Project, and sent a preliminary study team headed by Dr. Hiroaki Ozasa, Director, Design Department, 5th District Port Construction Bureau, Ministry of Transport to LAO PDR for thirteen days from June 8, 1987.

The preliminary study team briefly studied and confirmed the background and contents of the request, the Project implementing organization, propriety of the Project, and the scope of the basic design study, and agreed with the Government of LAO PDR to study further the adequacy of the scope of works, type, and layout of the Port of Laksi at the basic design stage.

Subsequently, JICA sent to LAO PDR the Basic Design Study Team headed by Dr. Hiroaki Ozasa from September 30 to November 3, 1987. The contents confirmed by the Basic Design Study Team were basically the same as that confirmed by the preliminary study team.

The contents requested by the Government of LAO PDR to the Government of Japan for the improvement project of the Vientiane River Port (Port of Laksi) under grant aid cooperation are as follows:

1) Mooring facilities
2) Cargo handling equipment (including mobile cranes)
3) Warehouse and open storage yard
4) Road within the port area
5) Other facilities:
   - Port administration office
   - Passenger terminal
   - Water, fuel and electric supply facilities

CHAPTER 3 NATURAL CONDITIONS

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LAO PDR is a landlocked country; its elongated shape is oriented in a north-south direction. Geographically, it locates at 14° to 22° N latitude, and 100° to 108° E longitude. The country is an area of approximately 240,000 km^2.

The country is in the tropical climate zone, having a hot and humid rainy season (from May to October) and a dry season (from November to April).

About 80% of the country is at an altitude of from 200 to 3,000 m above sea level. Lowlands along the Mekong River and its tributaries are used for rice paddies.

Natural conditions in Vientiane are described as follows:

3.1 Weather Conditions

(1) Temperature

December and January is the cool season. The hot season is March and April. The coolest month is December with temperatures ranging from 12°C to 32°C. April is the hottest month with temperatures varying from 20°C to 38°C.

Temperatures do not vary much throughout the year.

Table 3-1 Monthly Temperatures in Vientiane

(°C)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Maximum	33.7	33.6	36.7	38.4	35.8	34.8	34.3	33.4	33.6	33.6	32.2	31.8
Minimum	14.5	15.1	18.8	20.0	21.2	23.4	22.8	23.0	22.7	15.3	15.9	11.8
Average	23.5	24.2	28.2	29.0	28.5	28.7	27.4	27.8	27.3	27.0	25.3	23.1

(2) Humidity

The humidity in Vientiane is relatively high, varying from 52% to 91% with an average of 72%.

(3) Rainfall

90% of the average annual rainfall, which is approximately 1,700 mm, occurs during the rainy season from May to October. The maximum average monthly rainfall (approximately 320 mm) occurs in August. The recorded maximum monthly rainfall was 660 mm. The recorded maximum daily rainfall was 160 mm.

Table 3-2 Average Monthly Rainfall

Month	Rainfall (mm)	Month	Rainfall (mm)
Jan	11.2	Jul	275.4
Feb	15.5	Aug	317.4
Mar	30.3	Sep	314.3
Apr	96.6	Oct	87.7
May	252.3	Nov	16.0
Jun	276.3	Dec	2.5

Observation Period: Feb 1914 to 1986

Average Annual Rainfall: 1,648.8 mm
Maximum Annual Rainfall: 2,290.3 mm
Maximum Monthly Rainfall: 656.7 mm
Minimum Monthly Rainfall: 0.0 mm

(4) Wind Velocity

Wind directions and velocities have been recorded at Wat Tay Airport in Vientiane. The maximum wind velocity during the past six years was recorded as 37 m/sec.

3.2 Features of the Mekong River

(1) Plane Profile

The Vientiane River Port is located on the left bank of the Mekong River approximately 4 km downstream of the central part of Vientiane.

Approximately 20 km of the Mekong River, from Vientiane City to the Thanaleng Port, has the most tortuous channel alignment with small radii throughout its entire journey in LAO PDR.

As shown in Fig. 3-1, the Vientiane Port is in the straight river channel section that is downstream of the section that curves 90° to the right. Judging from historical records of the river, it can be said that the river's channel alignment in this section is quite stable.

In the section that curves 90°, a shoal that is 800 m wide and 3.5 km long has developed in the left side of the river. In the straight section where the Vientiane Port is located, a shoal that is 300 m wide and 3.0 km long exists in the Thailand side. The highest point of the upstream shoal is higher than MSL 170m; this part of the shoal is cultivated.

Comparing the present river channel to a topographic map made in the 1920's, no noticeable changes to its plane profile have occurred.

(2) Longitudinal and Cross Sectional Profiles:

In an approximately 4 km section (about five times the width of the river), upstream and downstream of the Vientiane Port, the river is about 700 m wide and relatively straight. The river has a stable flow in this section. Thus, from the viewpoint of river conditions, this section is most favourable as a river port site.

The width of the river at the Vientiane Port is approximately 700 m, and there is a 300 m wide shoal in the Thailand side of the river; therefore, during the dry season the river flow becomes very narrow due to the decreased discharge. In this area the riverbed elevation is MSL 150 to 154 m (average), and the riverbed slope is approximately 1/10,000.

(3) Recorded Flood and Drought Water Levels:

The maximum flood discharge of 26,000 m^3/sec (an occurrence probability of 40 years) was recorded in September 1966. The water level of that flood was MSL 170.75 m at the Wat Sop Gauging Station in Vientiane (located approximately 1,580 km upstream from the mouth of the Mekong River). About 15,000 ha of land, including Vientiane and part of Thailand, were inundated during that flood.

Each year the highest water levels occur in August or September. Even in low water years, the highest water level is more than MSL 168.0 m.

The drought discharges recorded in 1956 and 1958 were 701 m^3/sec. The lowest water level of MSL 157.76 m (an occurrence probability of 80 years) was recorded in April 8, 1960.

The river stage in Vientiane is generally high during the rainy season (May to October), especially in August and September. During the dry season (November to April), particularly in March and April, the water stage is generally low.

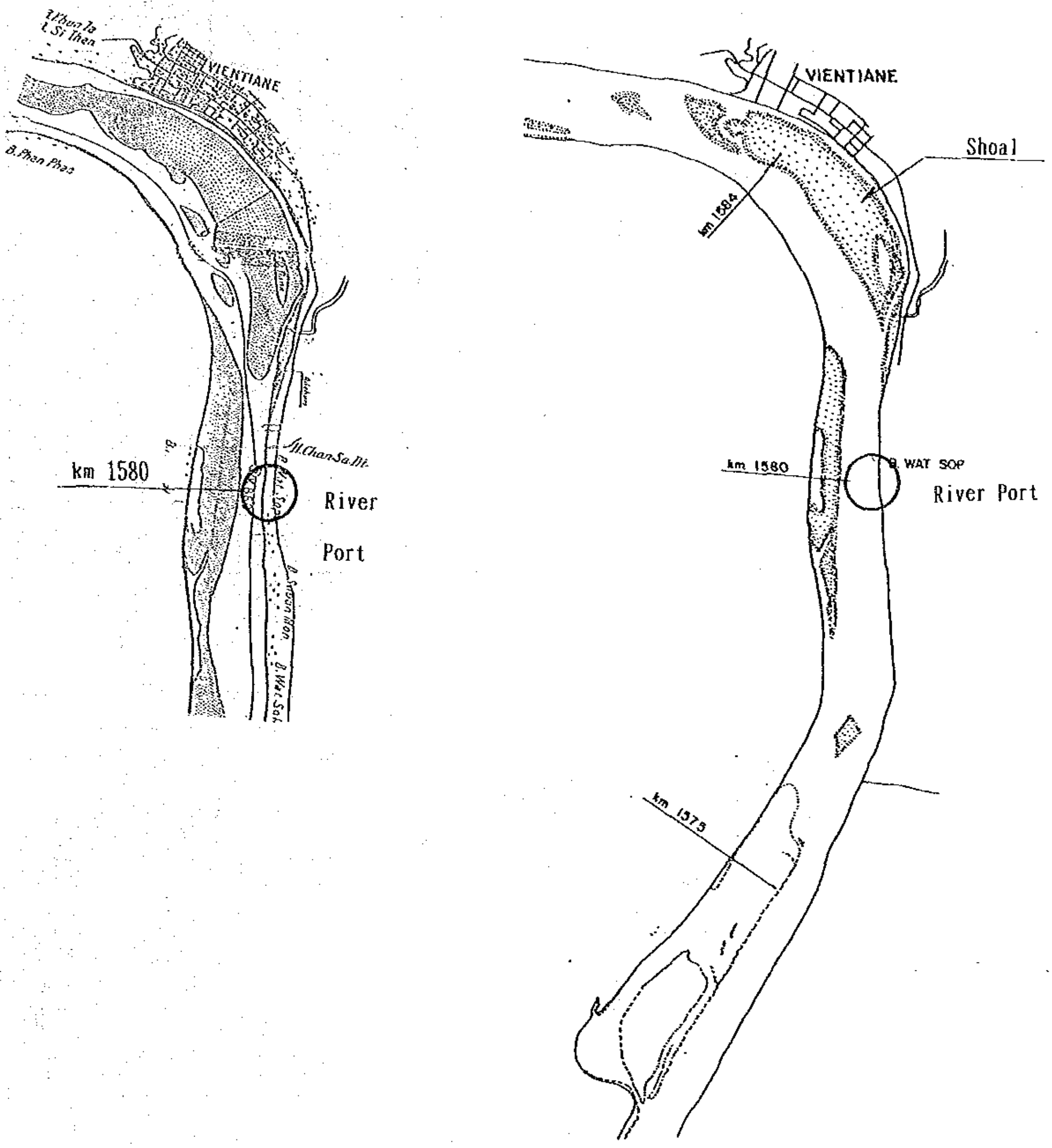
According to past data, navigation during the dry season becomes difficult.

The difference between the recorded maximum flood level and the recorded minimum drought level is 13.0 m.

(4) River Stage Record:

The Mekong River's monthly stages at Vientiane are shown in Fig. 3-2 and 3-3.

Stages of the Mekong River change greatly. Generally the river stage difference between the rainy season and the dry season reaches about 10 m.



(1) Configuration in 1920s.

(2) Configuration in 1970s.

Fig. 3-1 Vicissitude of the Mekong River Alignment & Shoal in the Vicinity of the Port of Laksi

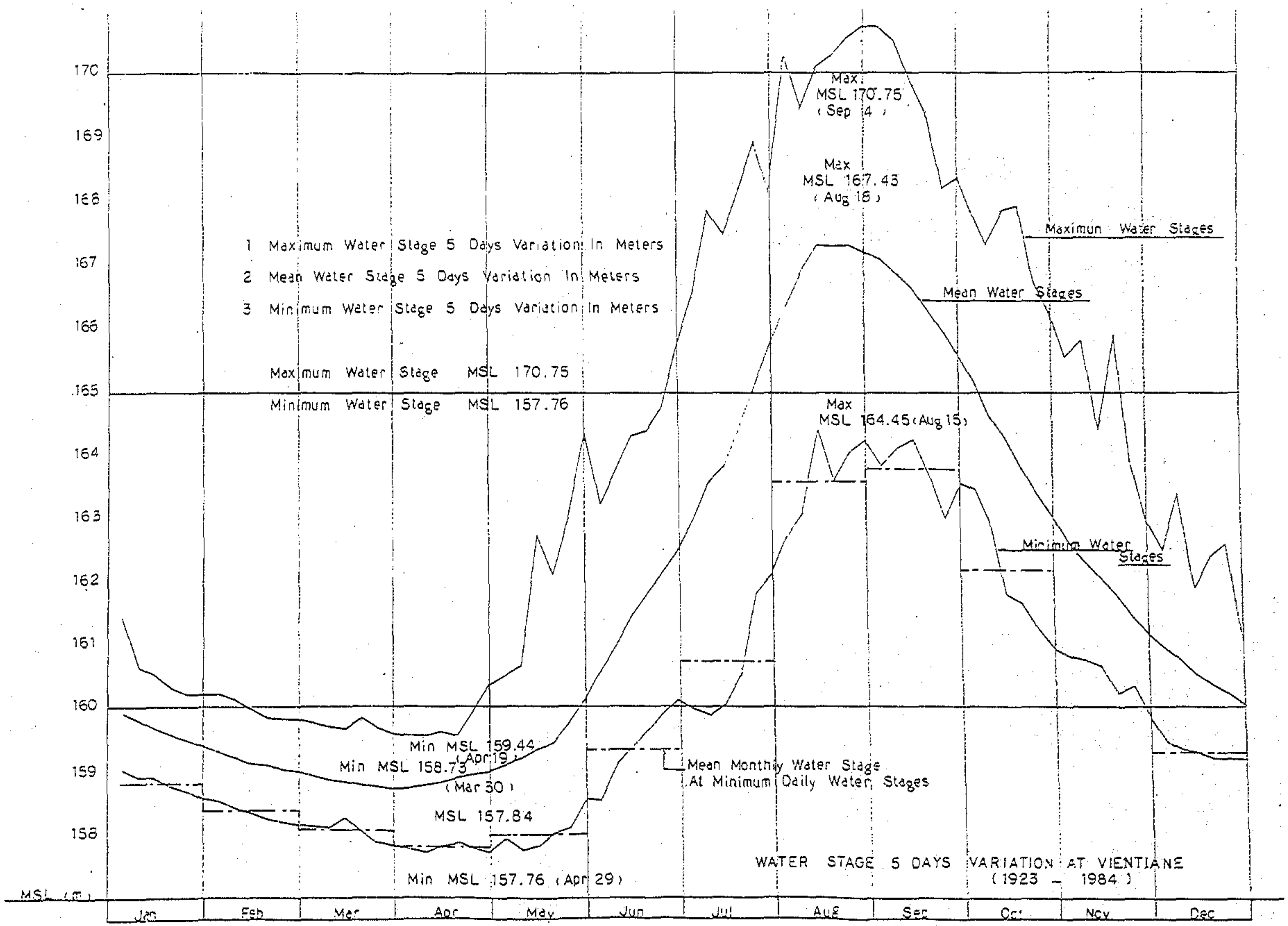


Fig. 3-2 Mekong River's Monthly Stage Variation at Vientiane (1923 - 1984)

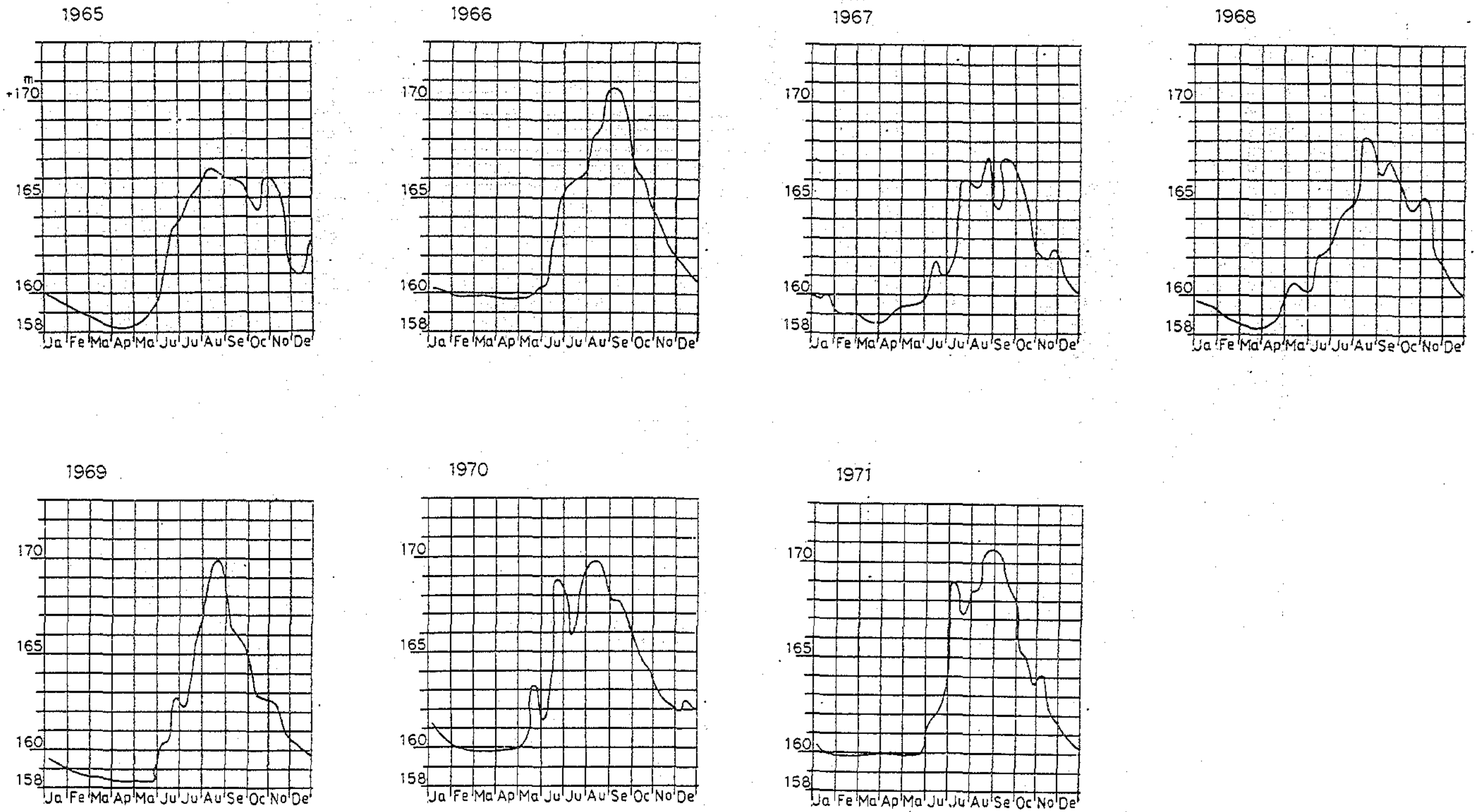


Fig. 3-3 Mekong River's Monthly Stage Variation in Different Years (at Vientiane)

(5) Discharge:

The Mekong River has a catchment area of approximately 300,000 km^2 at Vientiane. The river's recorded discharge data from 1913 to 1985 are shown in Fig. 3-4 and Table 3-3.

Catchment area:	299,000 km^2
Average discharge for 72 years:	4,605 m^3/sec (from 1913 to 1984)
Maximum discharge:	26,000 m^3/sec (Sep.4, 1966)
Minimum discharge:	701 m^3/sec (Apr. 28, 1956)

Table 3-3 Average Monthly Discharge from January 1913 to March 1985 in Vientiane

Month	Discharge	Month	Discharge
Jan	1,770. m^3/s	Jul	7,100. m^3/s
Feb	1,410.	Aug	12,300.
Mar	1,200.	Sep	11,300.
Apr	1,210.	Oct	6,950.
May	1,680.	Nov	4,020.
Jun	3,580.	Dec	2,500.

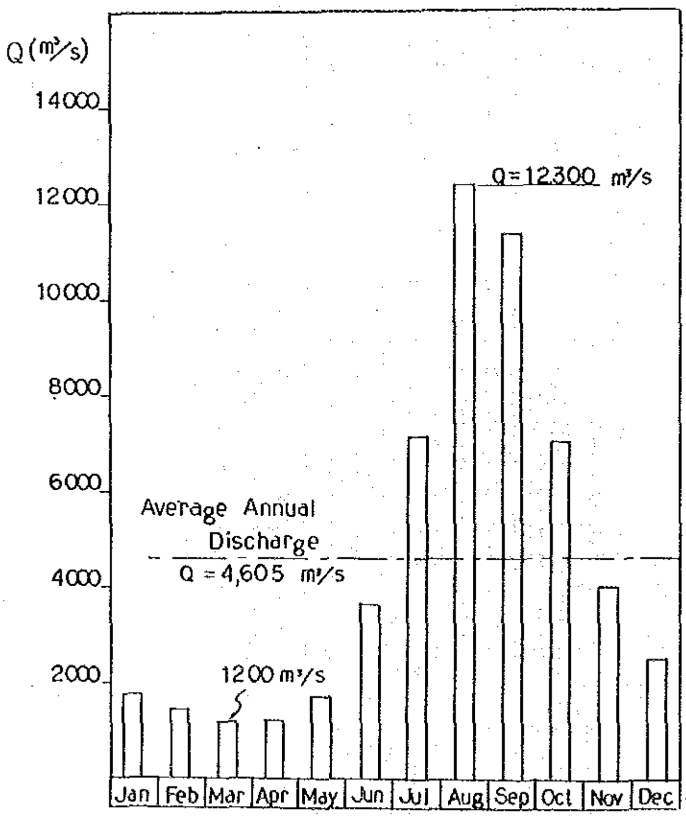


Fig. 3-4 Monthly Average Discharge at Vientiane (Jan. 1913 - Mar. 1985)

(6) Velocity

As the measured Mekong River's velocity data in front of the Port of Laksi was nonexistent, the Study Team made the measurements by using a CM-1 electric current meter and a float during the field survey period.

Results:

The velocity is comparatively low (0.2 to 0.8 m/sec) at locations 10 to 20 m away from the shore, and become 1.6 to 2.0 m/sec at locations 100 to 150 m away from the shore. From these figures, it is assumed that the maximum velocity during flood periods reaches from 2.0 to 2.5 m/sec at locations about 100 m away from the shore. The above data was obtained from 16 to 23 October 1987, i.e., the turning period from the rainy season to the dry season.

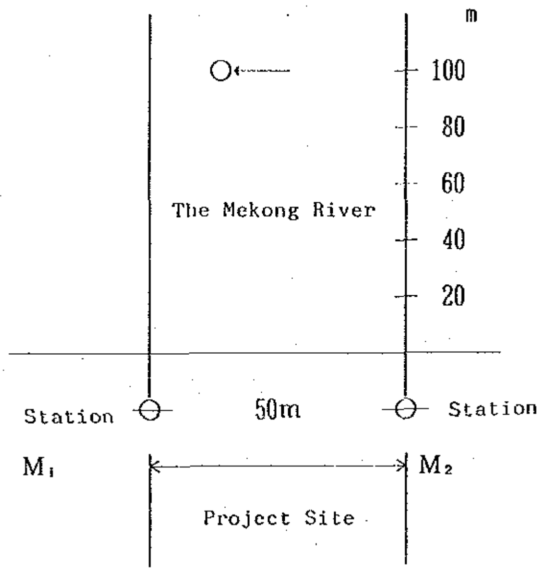


Fig. 3-5 Velocity Measurement Sketch

Table 3-4 Measured Velocity

Distance From Shore (m)	0~20m	30	40	50~100
Flow Velocity(m/s)	0.2~0.8	0.8	1.0	1.5~2.0

3.3 Geological Conditions

(1) Soil Survey:

Because past soil surveys were conducted with relatively shallow borings and the laboratory testing was inadequate, two new boring tests were made during the Basic Design Study Survey period in order to obtain the information necessary for the Project's Basic Design, i.e., obtain soil coefficients and confirm the thicknesses of soil layers and the depth of the bearing layer.

A summary of the conducted soil surveys follows:

1) Organization Conducting the Survey:

The Communication Design and Research Insitute (CDRI) of the Ministry of Transport and Post.

2) Locations and Number of Borings:

Locations: As shown in Fig. 3-6
Number of borings: 2

3) Depth of Borings:

No. 1 hole: 23.80 m (MSL 146.30)
No. 2 hole: 24.00 m (MSL 146.40)

4) Type of Boring Machine Used:

UGB 50 M (made in U.S.S.R.)

5) Undisturbed Sampling:

Undisturbed samples were obtained at 2.0 m deep intervals. No. 1 hole: 11 samples; No. 2 hole: 11 samples; total samples: 22.

6) Laboratory Tests:

- Physical Tests (with 19 samples):
  Liquid limit, plastic limit, measurement of soil particles specific gravity, mechanical analysis, moisture content.

• Unconfined Compression Test: 13 samples.

7) Soil Survey Results:

Two boring tests revealed that relatively compact clayey and silty soil layers (qu = 0.5 to 1.5 kg/cm^2, C = 2.5 t/m^2 to 8 t/m^2) exist up to the depth of 14 to 17 m from the ground surface (MSL 170 m). Below these layers, a 2 to 4 m thick silty layer mixed with cobblestones exists. Further below the layer (MSL 153 to 151 m), there is a hard clay layer which has enough strength for a bearing layer.

Detailed soil survey results are presented in Appendices 9.

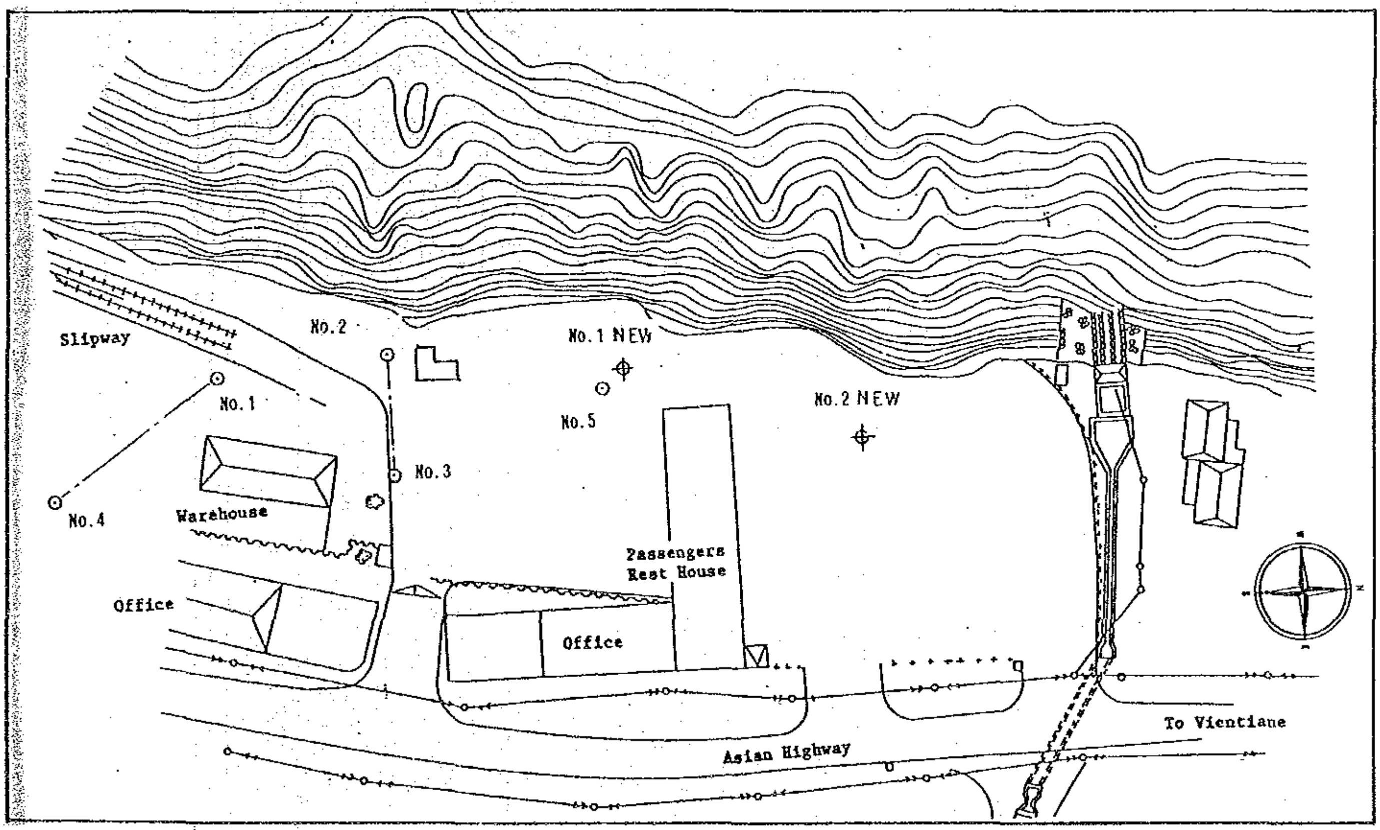


Fig. 3-6 Boring Location Map

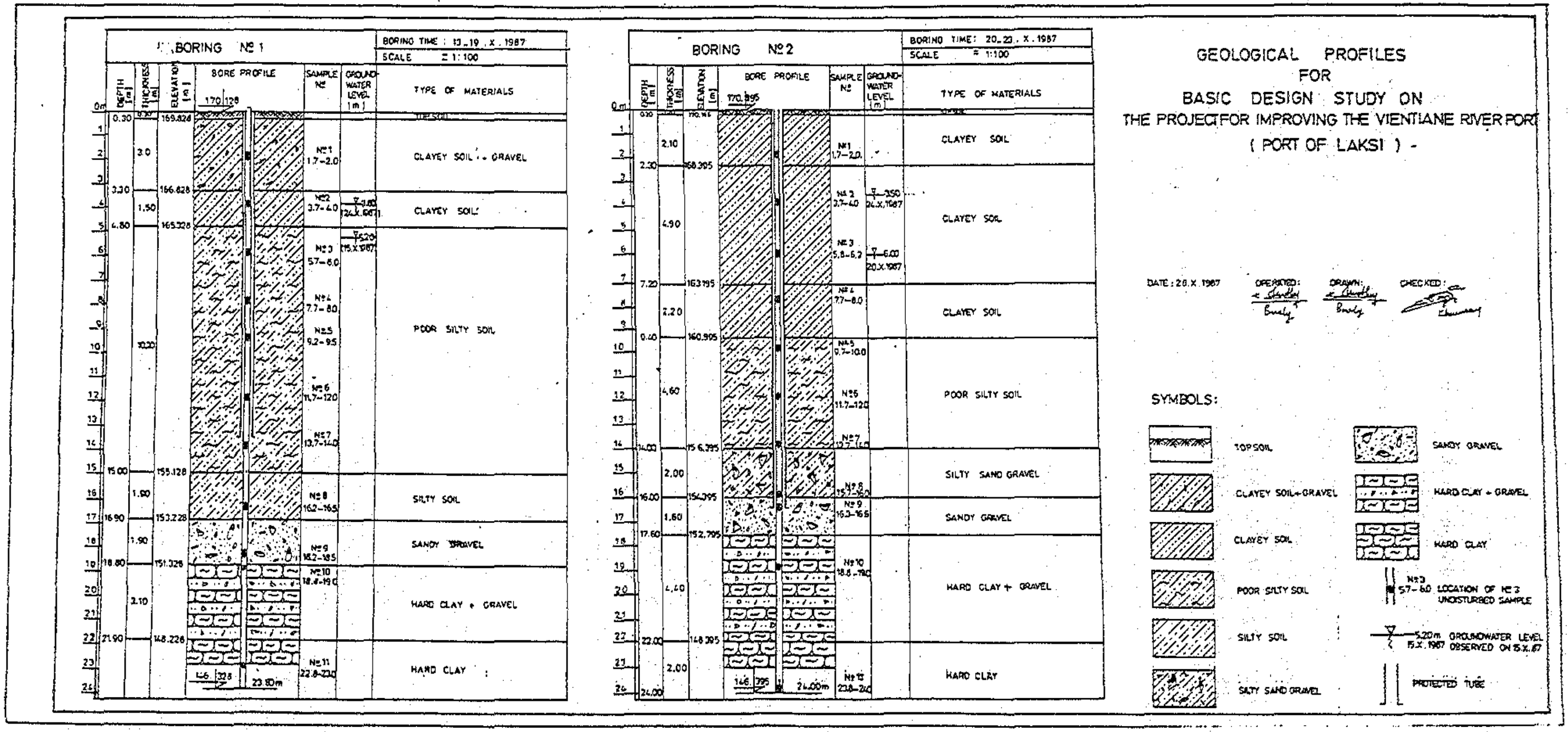


Fig. 3-7 Columnar Section Boring Log

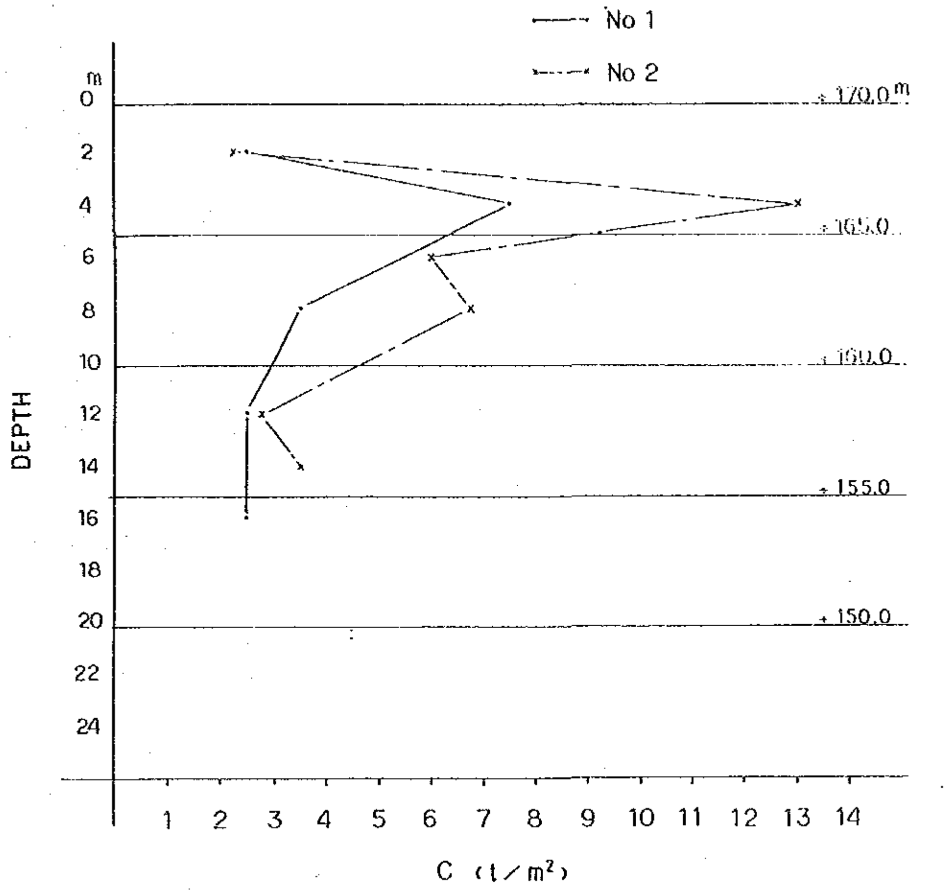


Fig. 3-8 Relationship between Depth and Cohesion

CHAPTER 4 PRESENT CONDITIONS OF THE PORT OF LAKSI

CHAPTER 4 PRESENT CONDITIONS OF THE PORT OF LAKSI

4.1 Conditions of Facilities

As shown in Fig. 4-1, the Port of Laksi is an approximately 300 m long by 80 m wide site along the Mekong River.

(1) Shipyard:

The southern half of the port site (approximately 150 m long) belongs to the shipyard which is under the jurisdiction of the Ministry of Transport and Post. Presently, two 140 DWT and one 50 DWT boats (steel boats) are under construction in the shipyard. The yard's slipway is 137 m long.

This is a repair shipyard that is capable of handling ten boats per year, and can build about five new boats a year.

(2) Ramp:

In front of the shipyard slipway there is a 4 to 5 m wide paved ramp that is used for a landing. There is a 25 ton mobile crane that is used for handling cargo on the ramp.

(3) Boat Mooring Method:

There is an embankment in front of the ramp that extends upstream. The embankment has a steep slope and its entire length in the port area is eroded. Boats are moored to the embankment even outside the port area. Normally, about fifteen boats are moored waiting either to take on or unload cargo.

(4) Passenger Boat:

Passenger boats as well as cargo vessels operate between the Port of Laksi and the Savannakhet Port in the Mekong River. The passenger boat sails once a week. The boat, even though it has a 300 passenger capacity, sometimes carries as many as 400.

The boarding and disembarking of passengers is conducted by having them walk across a plank that is placed between the boat and the ramp. When the space between the boat and the ramp is too wide, a small pontoon is brought into use.

The plank is only about 40 to 50 cm wide and has no handrails; boarding and disembarking are extremely unsafe operations.

(5) Buildings:

In the port area, along Route 2, there is a management office building, a customs house, and a staff dormitory. Fenced in are two warehouses; one is small and the other is large. Within the confines of the fence there is also a small police box. About two-thirds of the large warehouse (60 m x 15 m) is used for storage, and one-third is used for lodging. The small warehouse that is next to the police box is also used for lodging.

To the north of the large warehouse there is a fenced in area that is about 70 m long wherein six private homes are located. These homes are to be relocated prior to the commencement of Project construction.

In the shipyard there are two buildings: one is used for an office and repair shop; the other is a lodging for workers.

In the west corner of the cargo handling area there is an oil storage tank having a capacity of 13 kilolitres.

All of the above mentioned buildings in the port area suffer from heavy deterioration.

(6) Cargo Handling Area and Roads within the Port Area:

Neither the cargo handling area nor the roads within the port area are paved; during dry seasons they create dust, and during rainy seasons they become muddy.

(7) Cargo Handling Equipment:

The State River Transport Company possesses one 25-ton mobile crane, two 3-ton forklifts, and eight 10-ton trucks.

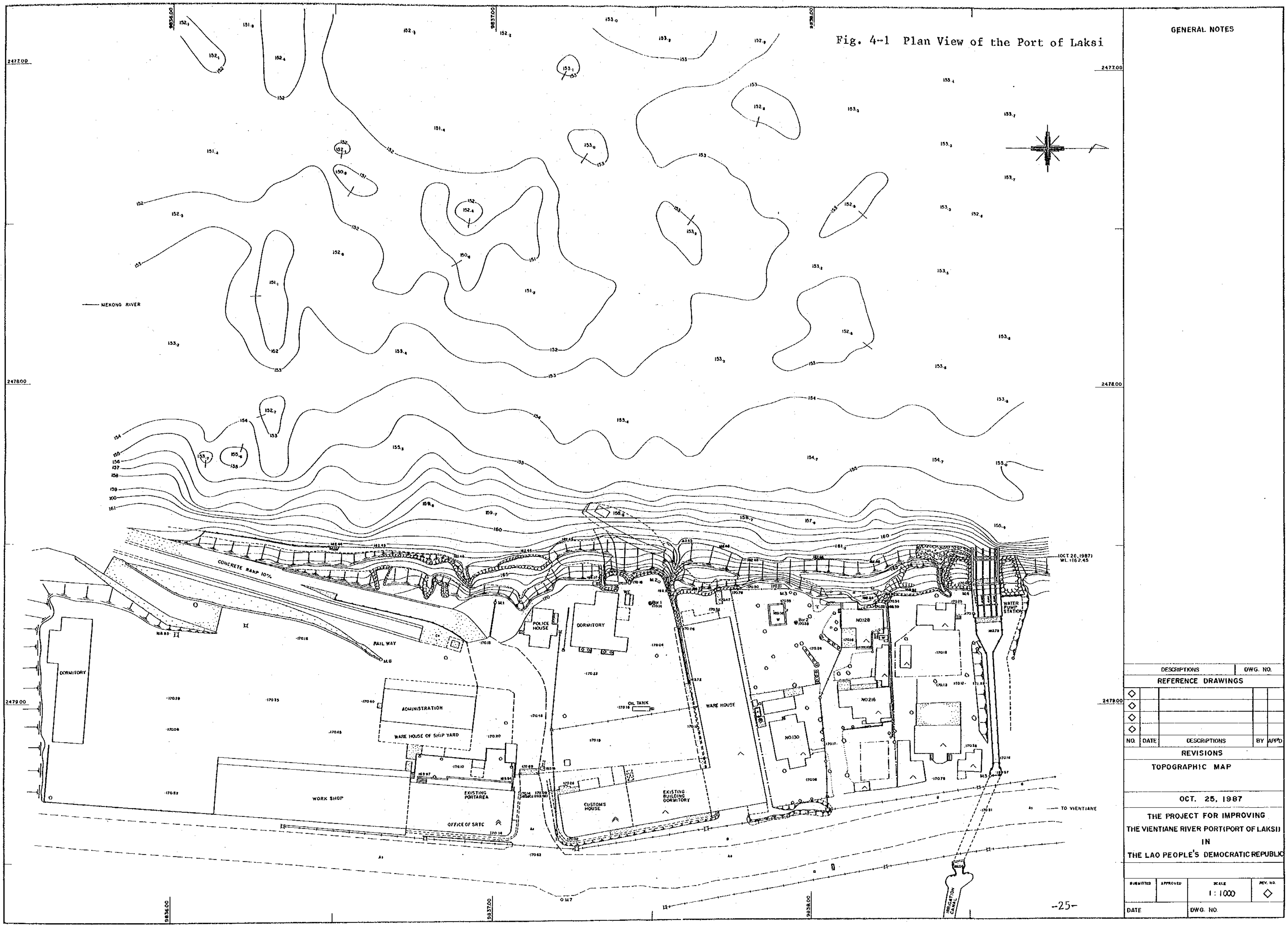


Fig. 4-1 Plan View of the Port of Laksi

4.2 Port Use Conditions

(1) Cargo Handling Volume:

As shown in Table 4-1, the cargo handling volume and the number of passengers at the Port of Laksi increased a great deal since 1985.

Table 4-1 Cargo Handling Volume and Number of Passengers at the Port of Laksi

	1981	1982	1983	1984	1985	1986
Cargo (tons)	11,200	13,700	16,000	17,700	31,000	38,000
Passengers	8,600	9,400	9,700	9,600	12,300	15,000

Of the 38,000 tons of cargo handled in 1986, 9,300 tons were carried by boats owned by the State River Transport Company (STRC); the other 29,000 tons were carried by privately owned boats.

Table 4-2 lists the items of cargo handled, and indicates their place of origin and destination. From this Table the overall movement of cargo can be discerned.

About 60% (5,800 tons) of the total cargo handled at the port was inbound. About 2,000 tons of cement was brought in, making it the largest type of cargo handled. Other major items included rice, daily necessities, and construction materials. All unloaded cargo items, except lumber, were shipped from the southern ports of Keng Kabao, Savannakhet, and Thakhek.

There was a total of about 3,500 tons of outgoing cargo. Almost 75% (2,600 tons) was construction materials and equipment, including cement and steel. Daily necessity items totalled only 470 tons.

(2) Boats:

There are about 100 boats operating out of the Port of Laksi: 26 boats are owned by the State River Transport Company, and about 70 boats are privately owned.

Most of these boats are in the range of 40 to 140 DWT. 70% of the boats are from 40 to 60 DWT, the remaining 30% are from 60 to 140 DWT.

The boats are from 20 to 35 m long, 4 to 6 m wide, and have drafts of 1.2 m.

The largest passenger boat has a 300 passenger capacity. The dimensions of this boat are 42 m in length, 5.8 m in breadth, and has a 1.5 m draft.

(3) Boat Operating Conditions:

As the water in the Mekong River is deep during the rainy season (June to December), boats can be operated under full load conditions between the Port of Laksi and other ports, such as Keng Kabao and Savannakhet to the south, and to Luang Prabang in the north.

However, during the dry season (February to May) the river's water level becomes low, and rocky shoals appear. Thus, the draft of boats must be regulated. During the dry season, boats operate with 70 to 80% of their total capacities between the Port of Laksi and the Keng Kabao Port; boats larger than 100 DWT cannot operate between the Port of Laksi and the Luang Prabang Port.

Table 4-2 Cargo Handled by SRTC at the Port of Laksi in 1986

(Unit: in metric tons)

	Origin/Destination	Cement	Rice	House Hold Goods	Construction Materials	Other Steel	Engines and Machinery	Wood	Others	Total	Remarks
1. Incoming	Keng Kabao	1,958	771	181	189	410	178		237	3,924	
	Savannakhet	20	469	700	18	169	71		65	1,512	
	Thakhek				120			172		292	
	Luang Prabang							87		87	
Subtotal		1,978	1,240	881	327	579	249	259	302	5,815	
2. Outgoing	Keng Kabao	120			348	619	2	10	12	1,111	
	Savannakhet	30		402	296	288	72		65	1,153	
	Thakhek			49	162		41		129	381	
	Pak Sane				163				5	168	
	Luang Prabang	67			19	137	23		2	248	
	Sayaboury		160				17		1	178	
	Others	50		19	94		77		7	247	
Subtotal		267	160	470	1,082	1,044	232	10	221	3,486	
Total		2,245	1,400	1,351	1,409	1,623	481	269	523	9,301	

CHAPTER 5 TRANSPORTATION DEMAND FORECAST

CHAPTER 5 TRANSPORTATION DEMAND FORECAST

5.1 Cargo Movement

Summarizing the cargo movement in LAO PDR, the foreign trade cargo volume (including transit cargo to and from third countries) in 1985 was 120,000 tons (77.4%) exported to Vietnam, 30,000 tons (19.4%) exported to Thailand, and 93,500 tons (50.7%) imported from Vietnam and 91,000 tons (49.3%) imported from Thailand. About 80% of the total exports was to Vietnam, and an almost equal amount was imported from Vietnam and Thailand (see Table 5-1).

Concerning trade items, exports, except for electricity to Thailand (a primary item for acquiring foreign currency), were limited to such products as lumber, timber, plywood, resins, coffee, gypsum, and tin (see Table 5-2). On the other hand, there was a great variety of imported items, such as vehicles, fuel, cement, paper, fabrics, food items, medicines, construction equipment, daily necessities, etc. (see Table 5-3).

The trade route from Vietnam starts at Da Nang and goes to either the Savannakhet Port or the Keng Kabao Port via Route 9. The cargo is then transported to Vientiane either by vehicles over Route 13, which runs parallel to the Mekong River, or by boats on the Mekong River.

Trade with Thailand is carried out by ferryboats crossing the Mekong River either by the Thanaleng-Nong Khai route or the Savannakhet-Mukdahan route.

Trade with third countries through Thailand is carried out by vehicles or trains via the Bangkok-Nong Khai route, and by boats crossing the Mekong River via the Nong Khai-Thanaleng route.

The Second Five-year Socioeconomic Development Plan (1986-1990), plans call for increasing exports to Thailand by 1990 to 96,000 tons (24.6% of total exports), and increasing the import, amount from Vietnam to 207,000 tons (71.1% of total imports). On the other hand, the plan calls for reducing imports amount from

Thailand to 80,000 tons (27.5% of total imports), which is less than the amount actually imported from Thailand in 1985.

According to a report*, trade amount at Thanaleng Port in 1986 totaled 16,616 tons of exports and 104,583 tons of imports.

Table 5-1 Present and Future Cargo Movement

(Unit: 1,000 tons)

		1985	1986–90	'86	'87	'88	'89	'90	90/85
1	Total Import	184.5	1,132.0	170.0	194.0	223.0	254.0	291.0	1.58
	Vietnam	93.5	723.5	90.0	113.0	141.5	172.0	207.0	2.21
	Campuchea		8.5		1.0	1.5	2.0	4.0	
	Thailand	91.0	400.0	80.0	80.0	80.0	80.0	80.0	0.88
2	Total Export	155.0	1,338.1	155.5	202.5	259.1	330.0	391.0	2.52
	Vietnam	120.0	970.6	125.5	151.0	185.1	234.0	275.0	2.29
	Campuchea	5.0	61.0	5.0	8.0	12.0	16.0	20.0	4.00
	Thailand	30.0	306.5	25.0	43.5	62.0	80.0	96.0	3.20
3	Foreign Trade	339.5	2,470.1	325.5	396.5	482.1	584.0	682.0	2.01
4	Domestic Cargo	345.5	2,891.9	460.5	523.5	567.9	617.0	693.0	2.01
	3 + 4	685.0	5,362.0	786.0	920.0	1,050.0	1,201.0	1,375.0	2.01

* The 1986 Thanaleng Port Business Report submitted by the State River Transport Company to the Ministry of Transport and Post.

Table 5-2 Major Export Items

Item	Unit	1976	1980	1982	1983	1984	1985
Elec. power	Million KWH	157	766.5	750	694	658	666
Timber	Thou.m^3	1	16	20	4	9	50
Lumber	Thou.m^3	29	10.5	2	3	3	15
Plywood	Thou.sheets	41	...	34	98	108.5	170
Rotary veneer	Tons	1,048	591	17	98	200	250
Chipped wood	Thou.m^3	...	...	73	...	30	50
Coffee	Tons	2,732	890	3,600	3,080	4,040	4,351
Gardamono	Tons	92	2	...	2	58	310
Benzoin	Tons	...	10	26	19	18	148
Gypsum	Thou.tons	...	3	32.5	51	70	80
Tin	Thou.tons	1,101	9	304	361.5	400	...

Source: Ten years of Socioeconomic Development in LAO PDR, State Planning Committee.

Table 5-3 Major Import Items

Items	Unit	1976	1980	1982	1983	1984	1985
- Electric power	Million Kw/h	7	8	11	13.5	15	18
- Trucks	unit	...	491	290	290	178	358
- Sedan cars	unit	...	41	70	89	60	90
- Specialized cars	unit	...	42	5	8	49	8
- Buses	unit	...	18	8	11	11	18
- Tractors	unit	...	310	65	1		50
- Fuel	Thou.Tons	0.5	56	60	80	65	50
- Cement	Thou.Tons	-	16	5.5	22	23	65
- Iron	Thou.Tons	-	9	4	8	5	20
- Fertilizer	Thou.Tons	-	...	1	1	2	2
- Papers	Tons	-	...	2,950	680	1,000	1,000
- Cotton Thread	Tons	-	49.5	1,188	374.5	350	250
- Fabrics	Tons.m	161.5	106	8,741	10,546.5	8,782	8,125
- Medicines	Tons.us$	-	1,086.5	2,517.5	5,359	2,596.5	9,208.5
- Sugar	Tons	3,132	362	2,120	920	3,210	4,000
- Condensed milk	Thou.Tons	1,686	453	2,572	1,944.5	700	700
- Bicycles	Thou.unit	-	...	13	10.5	5	10.5
- Sewing machines	Ea(unit)	-	200	2,701	5,100	2,560	7,000
- Rice	Thou.Tons	44.5	1	18	26.5	38	...
- Salt	Thou.Tons	1	...	3.5	2	0.5	0.5

Source: Ten years of Socioeconomic Development in LAO PDR, State Planning Committee.

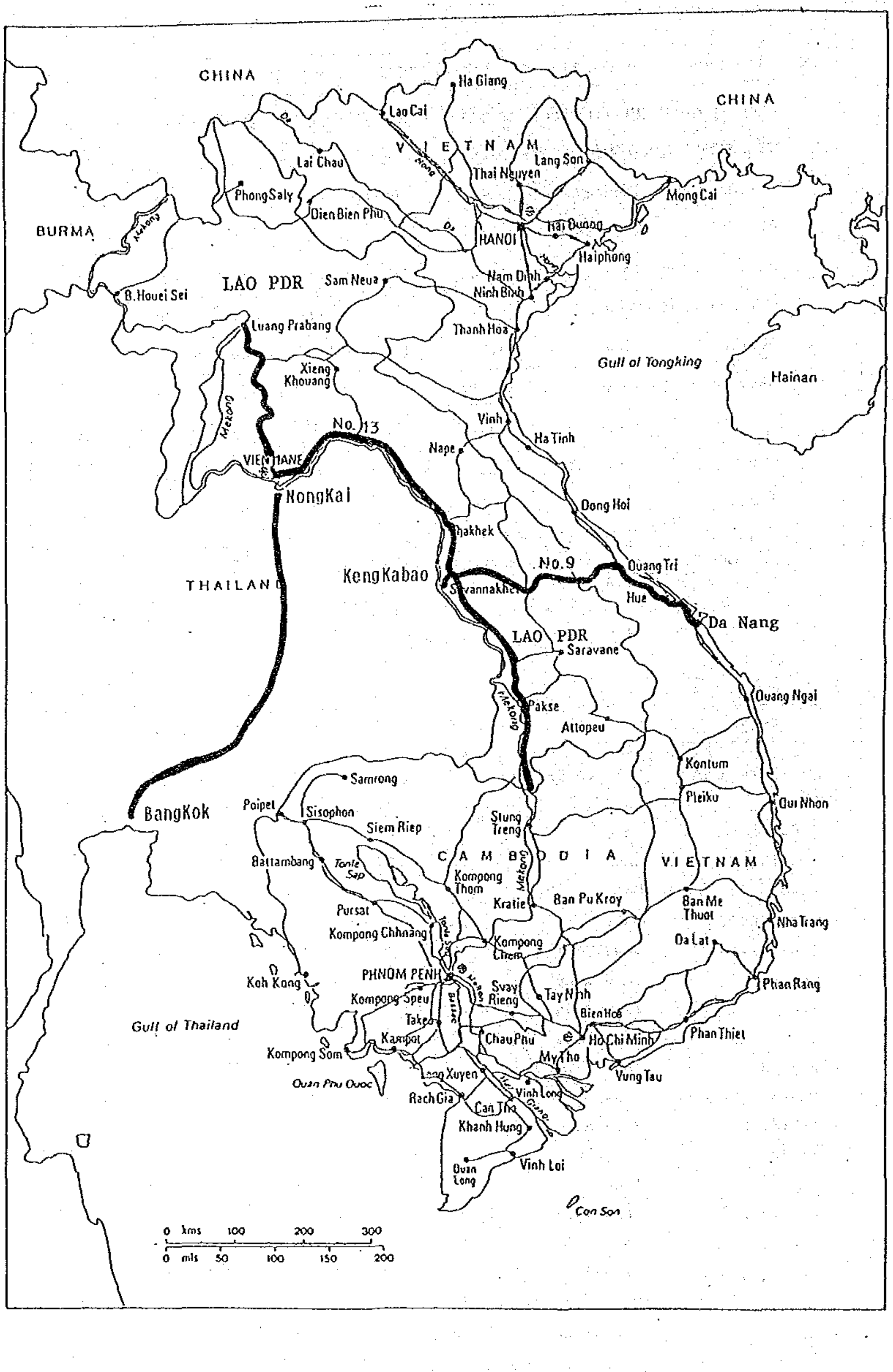


Fig. 5-1 Cargo Transportation Routes

5.2 Cargo Handled at the Port of Laksi

Cargo volumes handled at the Port of Laksi from 1981 to 1986 were as shown in Table 5-4.

Table 5-4 Cargo Volume Handled at the Port of Laksi

(Unit: 1,000 tons)

YEAR	1981	1982	1983	1984	1985	1986
CARGO VOLUME	11.2	13.7	16.0	17.7	31.0	38.0

Source: The Ministry of Transport and Post, LAO PDR.

The cargo handled at the port was not classified by unloaded volume, cargo item, origin, or destination. However, a rough idea concerning cargo movement at the port in 1986 is known; about 4,000 tons of domestic rice came from the ports of Savannakhet and Keng Kabao to Vientiane, and about 28,000 tons of imports from Vietnam (including transit cargo), making the total inbound cargo volume about 32,000 tons. About 3,000 tons of construction materials, agricultural machines, and daily necessities were shipped out for domestic use from Vientiane to the ports of Savannakhet and Keng Kabao.

In LAO PDR, the organizations that are engaged in river transportation can be classified into three categories: The State River Transport Company (SRTC) which is controlled by MOTP; cooperative organizations (those controlled by provincial governments or by district offices) which are called "associations" and conduct local transportation services; and private enterprises.

MOTP prepares cargo movement data based on reports from the above mentioned organizations. However, the classified cargo data desired by the Study Team was not prepared. For this reason, the Study Team prepared cargo movement data for the period covering January 1986 to August 1987 using the records of SRTC, and classified the cargo by item, origin and destination.

The figures in Table 4-2 show the amount of cargo handled by SRTC, one of the transportation organizations previously mentioned. From these figures, the movement of 9,300 tons (24.5%) of the 38,000 tons handled at the Port of Laksi in 1986 can clearly be seen.

Table 5-5 Inbound Cargo Volume Handled at the Port of Laksi in 1987 (Jan to Aug) by SRTC

(Unit: Tons)

ORIGIN	RICE	HOUSE HOLD GOODS	ENGINE & MACHINERY	CEMENT	CONSTRUCTION MATERIALS	OTHER STEEL	CHEMICAL FERTILIZER	LUMBER	ROLLED PAPER	FUEL	OTHERS	TOTAL
KENG KABAO		453.637	91.106	120.000	1,100.144	413.856						2,178.743
SAVANNAKHET	2621.146	127.545	99.420		37.736	60.656			1.077		3.975	2,951.549
LUANG PRABANG											52.542	52.542
SAYABOURI								57.604				57.604
TOTAL	2621.146	581.182	190.526	120.000	1,137.880	474.506	—	57.604	1.077	—	56.517	5,240.438

Notes: 1. Figures are tabulated from SRTC's data book.

2. Cargo volumes shown in the table are the only for cargo handled by SRTC.

Table 5-6 Outbound Cargo Volume Handled at the Port of Laksi in 1987 (Jan to Aug) by SRTC

(Unit: Tons)

DESTINATION	RICE	HOUSE HOLD GOODS	ENGINE & MACHINERY	CEMENT	CONSTRUCTION MATERIALS	OTHER STEEL	CHEMICAL FERTILIZER	LUMBER	ROLLED PAPER	FUEL	OTHERS	TOTAL
KENG KABAO					4.400							4.400
SAVANNAKHET		386.320	5.445		60.000			0.800			116.431	568.996
LUANG PRABANG				3.000	36.000						1.660	40.660
THAKHEK			16.000		430.692						0.335	447.027
PAK SANE		77.000									0.498	77.498
HOUEI SAI					60.000						27.770	87.77
SAYABOURI	160.000				31.040							191.04
TOTAL	160.000	463.320	21.445	3.000	622.132			0.800			146.694	1,417.391

Notes: 1. Figures are tabulated from SRTC's data book.

2. Cargo volumes shown in the table are the only for cargo handled by SRTC.

As SRTC, in comparison with the other transportation organizations, carries the largest volume of cargo, the overall cargo movement (including foreign trade items) between the northern and southern parts of the country can be recognized from the figures shown in Table 4-2.

Breaking down the 9,301 tons of cargo handled at the Port of Laksi in 1986 by SRTC, 5,815 tons (62.5%) was inbound cargo and 3,486 tons (37.5%) was outbound cargo. These figures reveal that most of the cargo comes to Vientiane where the country's population and industry is concentrated.

The 1,240 tons (21.3%) of rice that was sent from the southern granary to Vientiane via the ports of Savannakhet and Keng Kabao representeds that largest share of handled cargo.

According to explanations of LAO PDR officials, most of the domestic cargo shipped from the ports of Savannakhet and Keng Kabao is rice. In 1986, about 4,000 tons of rice was shipped from these two ports. From the aforementioned figures it can be understood that about 70% of the rice transported -- in numerous small shipments -- was handled by organizations other than SRTC; a tendency that will continue even in the future.

Other major domestic inbound cargo items that were handled by SRTC included lumber from Luang Prabang Port, and lumber and construction materials (mainly building stone) from Thakhek Port.

Other inbound cargo consists mainly of imported items of these, 2,304 tons of cement used in road construction, was the largest single item (39.6%). The Study Team, during the field survey period, confirmed that canned tar imported from Singapore through the Da Nang Port in Vietnam and then transported by boats from the Keng Kabao Port to the Port of Laksi was being used for the construction of Route 13. Road construction is presently the most important infrastructural work in LAO PDR and this policy is likely to continue in the future.

Inbound cargo mainly originated at the Keng Kabao Port (3,924 tons, i.e., 67.5%), and at the Savannakhet Port (1,512 tons, i.e., 26%); therefore, 93.5% of all inbound cargo originated at these two ports.

As for outbound cargo, the major items included 1,349 tons (38.7%) of construction materials, including cement, and 1,045 tons (30%) of steel.

The main destinations of outbound cargo were the ports of Savannakhet and Keng Kabao; a total of 2,264 tons (64.9%) of cargo was shipped to these ports. Unlike inbound cargo, however, outbound cargo was also shipped to such northern ports as Houei Sai, Luang Prabang, and Sayabouri as well as to ports in the central area of the country.

During the field survey the Study Team noted that imported electrical appliances were being brought to Thanaleng Port from Bangkok and were then being shipped from the Port of Laksi to the Savannakhet Port. Although the exact amounts were not confirmed, the Study Team verified that some of the imported goods coming from Thailand are being distributed from the Port of Laksi to various parts of the country.

From the findings discussed above, it seems that the Port of Laksi is the center of the river transportation system, and ties Vientiane to the southern ports of Savannakhet and Keng Kabao. Major inbound cargo items are rice from the southern granary destined for the metropolis of Vientiane, and imported construction materials which are mainly used for road construction. Major inbound cargo items are medicines and construction materials that are manufactured in the metropolitan area, and some of the imported goods that enter the country from Thailand.

The Port of Laksi is of prime importance to the economy of LAO PDR
.

5.3 Forecast of Cargo Volume

The target year set for the forecast is 1995. 1995 was chosen as the target year by taking into account the following facts. In general, the port improvement plan's target year will be 5 years after the completion of construction. Further, LAO PDR's Third Five-year National Development Plan ends in 1995.

Since 1976, LAO PDR's population has increased steadily without any abrupt changes. The production of unhusked rice -- the foundation of the country's economy -- has been increasing steadily, except for the 1982-83 period.

LAO PDR's National Planning Committee has estimated that by 1990 the population will be 4.17 million, and, by the year 2000, it will be 5.5 million. They estimate that the unhusked rice production will be 1.8 million tons in 1990 and 2.2 million tons in 2000.

The estimated population increase rate is 2.9% a year. On the other hand, the estimated rice production increase rate is slightly lower than the estimated population increase rate, but it reflects the past rice production increase rate.

In LAO PDR, because of the insufficient infrastructure, rapid economic development and agricultural production increases are not expected. As the country must slowly shift its excess labor force into the manufacturing sector, the country's future economic and agricultural development will continue at their present rates for some time to come.

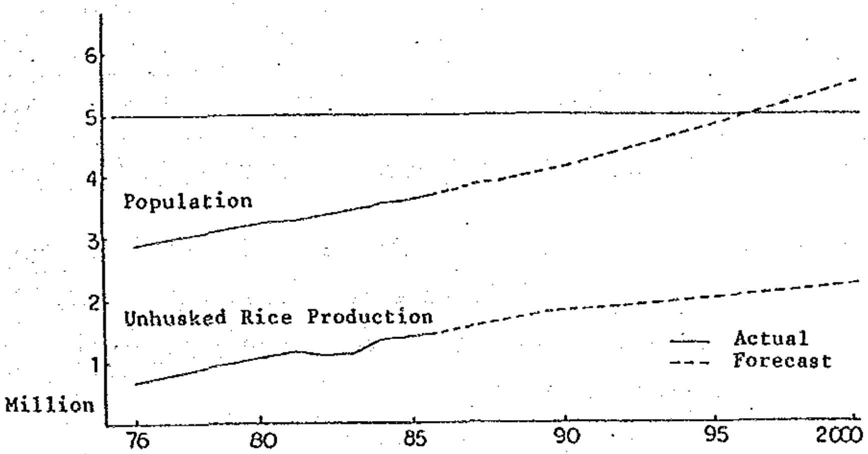


Fig. 5-2 Population and Unhusked Rice Production Forecast

SOURCE: " 10 years of Socio-Economic Development in LAO PDR "
" Scientific Forecast of the Socio-Economic Expansion of LAO PDR During This Period to 2000 "

By setting Vientiane City and Vientiane District as the hinterland of the Port of Laksi, the correlation between the cargo volume at the Port of Laksi from 1981 through 1985 and the hinterland's population increase during the same period was calculated using the following equation:

$$V = 0.261 \times P - 142.497 \quad (\sigma = 0.8929)$$

where, V: Cargo volume
P: Population in the hinterland

Based on the National Planning Committee's estimated future population increase rate of 2.9% a year, the 1995 population will be 862,000. By introducing the 1995 population into the above equation, the cargo handling volume in 1995 at the Port of Laksi is calculated as 82,000 tons/year.

Construction material, one of the major cargo items handled at the Port of Laksi, consists mainly of material used in the building of roads. Therefore, it may not be rational to estimate the cargo handling volume in correlation to the population increase rate. However, this estimate of the cargo volume provides one reference for the possible future cargo volume at the Port of Laksi.

Table 5-7 Past Population Trend in the Hinterland of the Port of Laksi

Unit: 1,000

	1981	1982	1983	1984	1985
Vientiane City	-	-	360	372	381
Vientiane District	584	595	252	261	267
TOTAL	584	595	612	633	648

Source: 10 years of Socio-Economic Development in Lao PDR

Annual cargo volumes handled at the Port of Laksi during the five year period, except for 1984, show an increasing trend. Thus, the cargo volume forecast for the target year 1995 was calculated using the following equation.

$$V = a + b \cdot t$$

where, V: Cargo handling volume (in 1,000 tons)
a and b: Coefficients
t: Time in years

The coefficients a and b were calculated by the least square method. Based on the assumption that the same cargo handling volume increase rate from 1981 through 1986 will continue in the future, the 1995 cargo handling volume was estimated as 83,000 tons.

$$V = 5.36\ t - 1{,}061.29 \quad (\gamma = 0.9361)$$

A time factor analysis is used for forecasting future trends based on actual past records. The method is very effective for forecasting a country's future economic activities, especially in the case of LAO PDR.

A decision was made to use 83,000 tons/year cargo handling volume as the forecast volume for the target year 1995 because of the extremely high correlation factor in the above equation. Further, this figure is very close to that obtained using the correlation equation of cargo volume handled in the past and the population in the hinterland of the Port of Laksi.

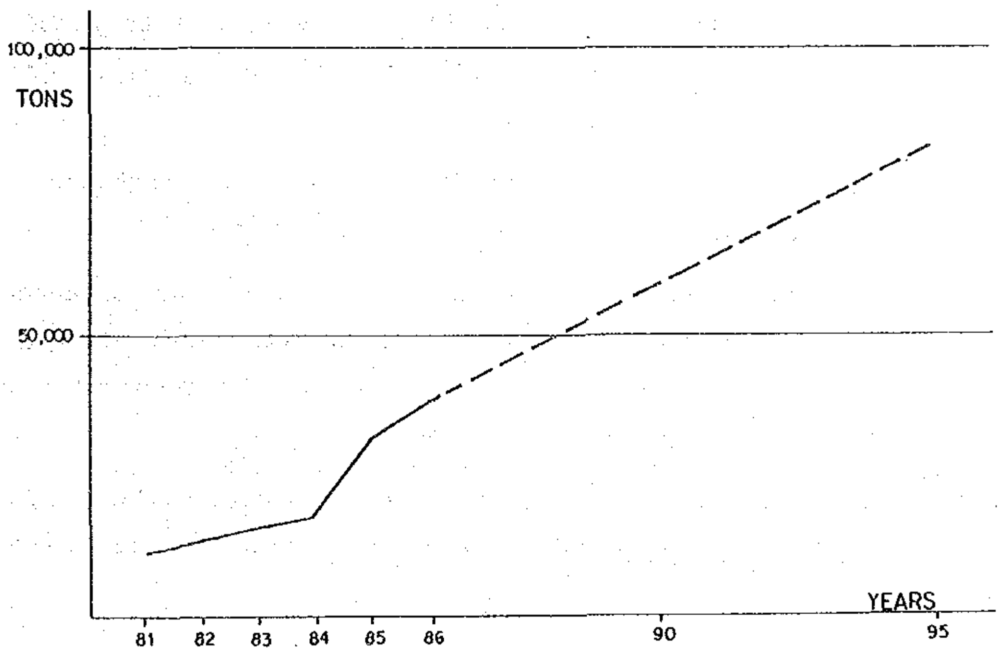


Fig. 5-3 Forecast of Cargo Handling Volume at the Port of Laksi

5.4 Passenger Demand Forecast

The total number of passengers boarding and disembarking boats at the Port of Laksi in 1986 was 15,000. During the period from January to September 1987, 16,380 passengers used the port. Of them, 15,230 (93%) were carried by SRTC boats. It is certain that the number of passengers in 1987 will surpass 20,000.

Table 5-8 Number of Passengers at the Port of Laksi

(Unit: 1,000 persons)

YEAR	1981	1982	1983	1984	1985	1986	1987
Number of Passengers	8.6	9.4	9.7	9.6	12.3	15	20*

* Estimated figure.
Source: The Ministry of Transport and Post.

SRTC has three passenger boats with a total seating capacity of 560. Two of the boats, each having 220 seats, are operating alternately once a week between Vientiane and Savannakhet.

Annually from 1982 to 1984 the number of passengers was in the range of 9,000. In 1985, another 220 seater was placed in commission, making the total number of seats available on SRTC boats 460. As a result, the number of passengers in 1985 increased to 12,300. Presently, SRTC boats have a total of 560 seats. Further, a boat having 120 seats is being built and is expected to be in service by 1988.

Therefore, passenger boat service between Vientiane and Savannakhet is scheduled to increase to twice a week.

The population densities in Vientiane Province and Savannakhet Province are 27 persons/km^2 and 25 persons/km^2 respectively; the national average is 15 persons/km^2. 33% of the country's total population live in these two provinces.

According to the explanation of officials concerned, the breakdown of passengers is 45% boarding passengers and 55% disembarking passengers.

Based on the assumption that the same rate of capital investment in passenger boats since 1984 will continue in the future and the passenger increase rate from 1984 to 1987, will also remain constant, the number of passengers in 1995 in forecast using the following equation.

$$P = a + b \times t$$

where, P: Number of passengers (x 1,000)
a and b: Coefficients
t: Time in years

Coefficients a and b were determined by using the least square method.

The estimated number of passengers in 1995 is 46,000.

$P=3.39\ t - 6,716.62 \quad (\gamma = 0.9865)$

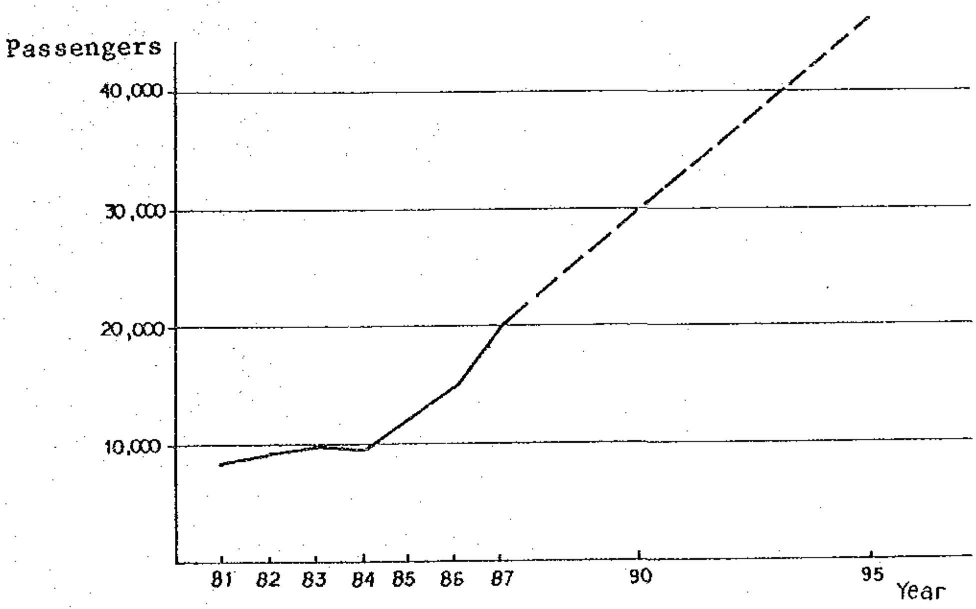


Fig. 5-4 Number of Passengers at the Port of Laksi

CHAPTER 6 PORT PLANNING

CHAPTER 6 PORT PLANNING

6.1 Port Planning Objectives

The hinterland of Laksi Port is Veintiane and its suburbs, the capital region of LAO PDR. Port Laksi links together the northern and southern parts of the country. During rainy seasons, north-south waterborne transportation on the Mekong River is an especially vital means for transporting cargo. Furthermore, for the future development of the country, low-priced large volume waterborne transportation is essential for handling increasing volumes of cargo. For the above reasons, the following objectives were established for the planning of the Port of Laksi.

6.1.1 Improvement of Cargo Handling Efficiency

The forecast cargo handling volume for the target year 1995 is 83,000 tons. This figure is approximately 2.2 times the present cargo handling volume. For this reason, the port facilities must be planned to meet the demands of the future.

The water level difference of the Mekong River between the high water period and the low water period is about 13 m. Waterborne transportation becomes increasingly more active during the high water period. The monthly waterborne cargo volume during the high water period is approximately three times that of the volume during the low water period (see Fig. 6-1).

In order to improve cargo handling efficiency, the facility planning of the Port of Laksi must be carried out by taking into account the aforementioned waterborne transportation characteristics. Furthermore, facility planning must take into consideration the fact that the Keng Kabao Port, which is the only non-ramp type port in the country, is not functioning properly due to siltation and difficulty in performing maintenance.

6.1.2 Measures Needed to Improve Passenger Boat Service

Presently, there is one ferry trip a week. The annual number of passengers in 1995 is forecast to reach 46,000. This is 2.3 times the present number of annual passengers.

The only existing ferry service facility at the Port of Laksi is a ticket counter. There is no passenger waiting facility at the port.

The transporting of passengers by passenger boats is expected to become more important in the future because the need for passenger boat service will increase in proportion to the inter-regional activities of the people.

6.1.3 Integration of Port Control Functions

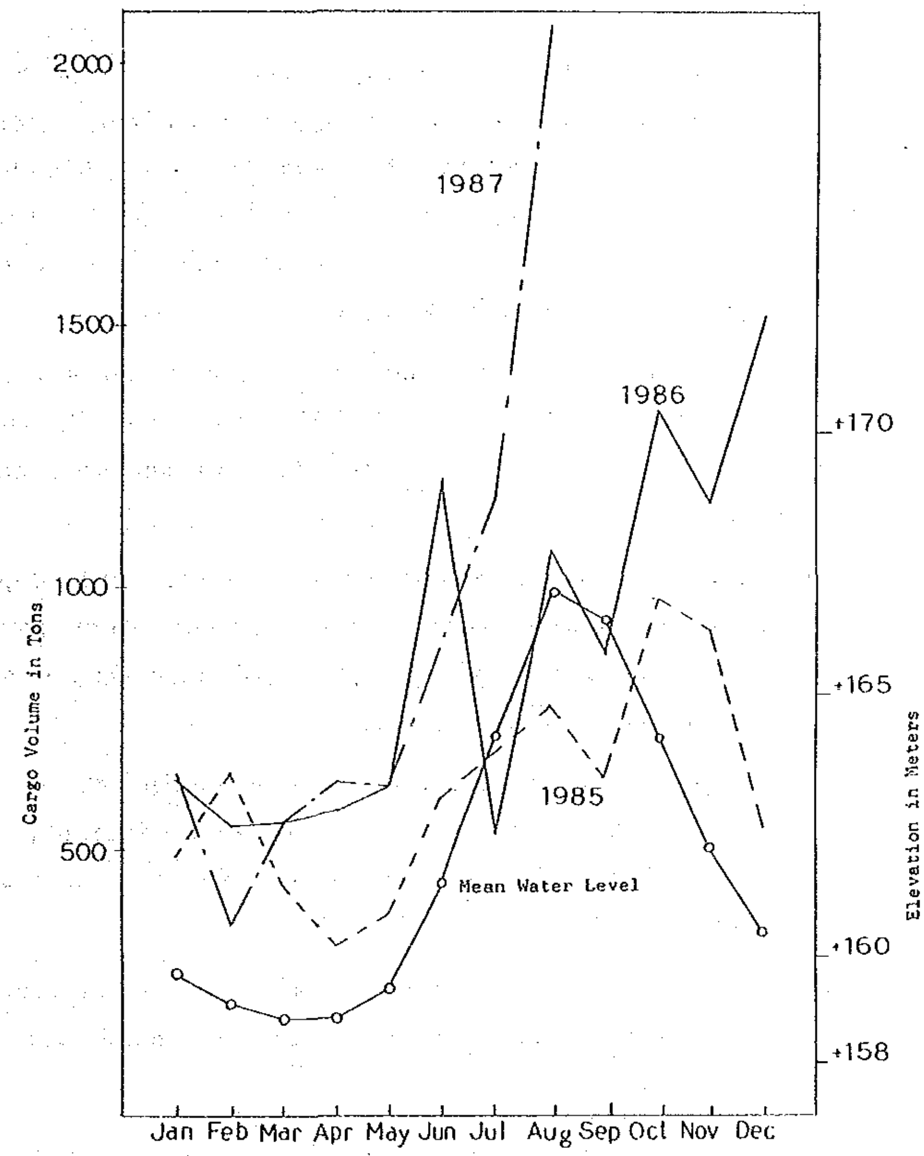
Administrative organizations controlling the port are SRTC, the customs office, and the police department. Presently, these three organizations are working at separate facilities. Judging from the size of the Port of Laksi, it is necessary for these three organizations to function together in order to improve the convenience of the port service.

6.1.4 Improvement of Safety Measures

Presently, loading and unloading cargo between boats and trucks is executed using a truck crane. Due to insufficient port facilities, the current cargo handling method is considered to be unsafe. The existing open storage yard and warehouse were not built and arranged to handle cargo efficiently and safely. Further, together with inadequate passenger facilities, both cargo and passengers use the same space. Therefore, safety measures must be improved upon to meet the increasing volume of cargo, and the increasing number of passengers.

6.1.5 Improvement of Port Service

As the port use is expected to increase steadily, port services, such as the supply of fuel, water and electricity to boats must be improved.



Remarks

- - - - - - Cargo handled volume in 1985
———— " " " in 1986
— - — " " " in 1987
o—o—o Mekong River's Mean Water Level

Fig. 6-1 Relationship between the Mean Water Level and SRTC's Monthly Cargo Handling Volume

6.2 Facility Plan

6.2.1 Boat to be Accommodated

Boats to be accommodated at the port are as follows:

(1) Cargo Boat

The largest cargo boat presently calling at the port is 140 DWT (33.8 m length, 6.8 m breadth, 1.4 m draft). During the low water period, however, the maximum navigable boat is limited by the Mekong River's channel depth, width and alignment to 100 DWT. The present average cargo boat is 60 DWT (30 m length, 6.0 m breadth, 1.2 m draft).

In order to take care of the increasing cargo volume, LAO PDR has a plan to build a 350 DWT cargo boat by the year 1995. As of this time, the dimensions of the boat have not been decided upon.

Taking into consideration the Mekong River's water depth and the conditions of the facilities at various other ports, it is assumed that there will be no rapid enlargement of boat sizes in the near future.

As the serviceability of cargo handling equipment is limited to ten years because of part supply conditions, it is assumed that future boats will not differ much in size from those presently in use.

For the above reasons, a decision was made to use dimensions equivalent to those of existing boats for the design of the port facilities.

	DWT	Length (m)	Draft (m)	Breadth (m)
Maximum Boat:	140	34	1.4	7
Average Boat:	60	30	1.2	6

(2) Passenger Boat

The largest passenger boat presently calling at the port has a 300 passenger capacity. It is 41.8 m in length, 5.8 m in breadth, 1.5 m in draft, and has 220 seats. However, only smaller boats are in service during low water periods.

A boat which has a 120 passenger has just completed.

For these reasons, the dimensions of the existing passenger boats were used for the design of the Project facility.

6.2.2 Scale of Facilities

(1) Mooring Facility

1) Handling Capacity

(a) Existing Conditions

The existing truck crane takes an average of five minutes per cycle to handle cargo. The maximum and average cargo handling volumes are from 4 to 5 tons and from 1 to 1.5 tons per cycle respectively.

The present cargo handling method is inefficient. Not only is there a wide space between the truck crane and the moored boat, but the width of the ramp is also too narrow.

Cargo handling is performed only during daylight hours because of insufficient lighting facilities.

(b) Design Cargo Handling Capacity

For the Project design, the daily cargo handling capacity per gang* was determined as follows:

a) Boat: Wharf mooring

b) Cargo handling:
Truck crane handling, 4 min/cycle, 1.2 tons/cycle.

c) Cargo handling hours:
7:00 to 22:00 (handling is done in shifts).

d) Cargo handling efficiency during handling hours:
0.8 (high-water period), 0.7 (low-water period)

e) Annual number of cargo handling days: 270.

Based on the above conditions, the daily cargo handling capacity per one gang was determined as 216 tons.

---

* gang: A team of cargo handling workers.

2) Wharf Scale

Port usage varies from the rainy season to the dry season due to water level changes.

Waterborne transportation becomes the main means of transportation during the rainy season, while, during the dry season, road transportation becomes the main means. This characteristic of the transportation system will not change even in the future.

In view of the above, the required wharf length can be determined based on port use conditions during the high-water period.

The cargo handling ratio in terms of tonnage during the high-water period and the low-water period is about 3 to 1. Thus, the cargo handling ratio must be taken into account for determining the length of the wharf.

The forecast annual cargo handling volume is 83,000 tons (62,000 tons during the rainy season and 21,000 tons during the dry season). By assuming that the cargo on one boat will be handled by one gang, the required wharf length is calculated as follows:

During high-water period:

$$\frac{62{,}000 \text{ tons}}{216 \text{ tons/day} \times 135 \text{ days} \times 0.8} = 2.7, \text{ say 3 berths}$$

During low-water period:

$$\frac{21{,}000 \text{ tons}}{216 \text{ tons/day} \times 135 \text{ days} \times 0.7} = 1.03, \text{ say 1 berth}$$

3) Structural Type of for Mooring Facility

Structural type the mooring facility was determined after taking into consideration the following:

- The annual river water level at the Project site varies by about 13 m.
- The new mooring facility should not cause siltation or scouring near existing facilities.

- The new mooring facility should be able to withstand collision with driftwood.
- The mooring facility should be a simple structure that is easy to operate and maintain.
- The mooring facility should be of a type that allows cargo handling work to be performed either manually or mechanically.
- Locally available construction materials should be used in the construction of the mooring facility.

The following three types of mooring facilities were studied:

(a) Ramp Type
(b) Pier Type
(c) Floating Type

In LAO PDR, the floating type is presently used only at the Keng Kabao Port, but it does not function as originally planned and it has operation and maintenance problems. Thus, the floating type was not selected.

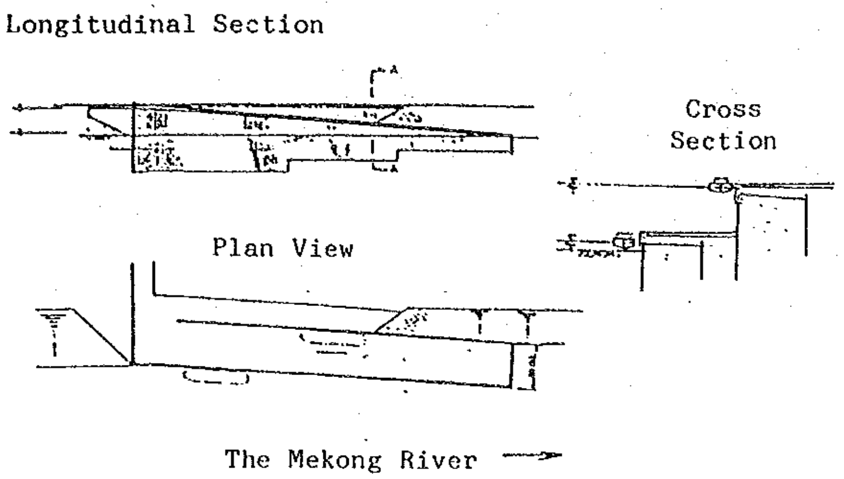
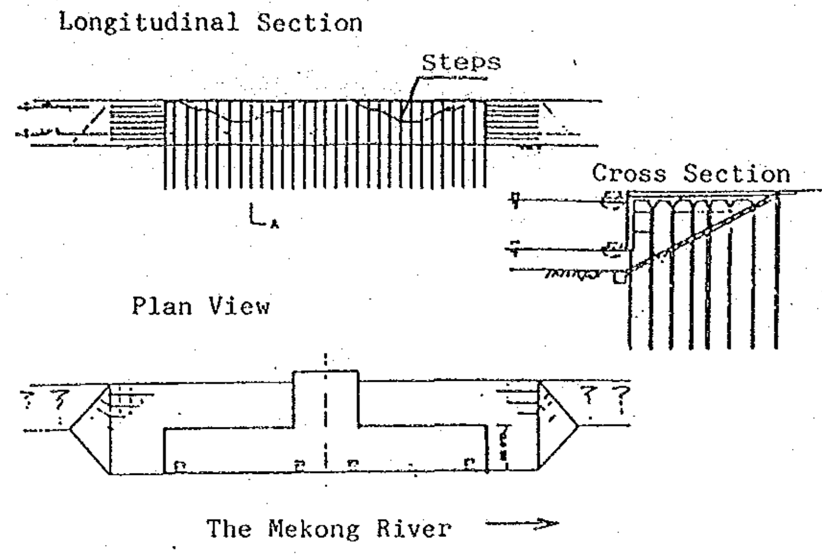
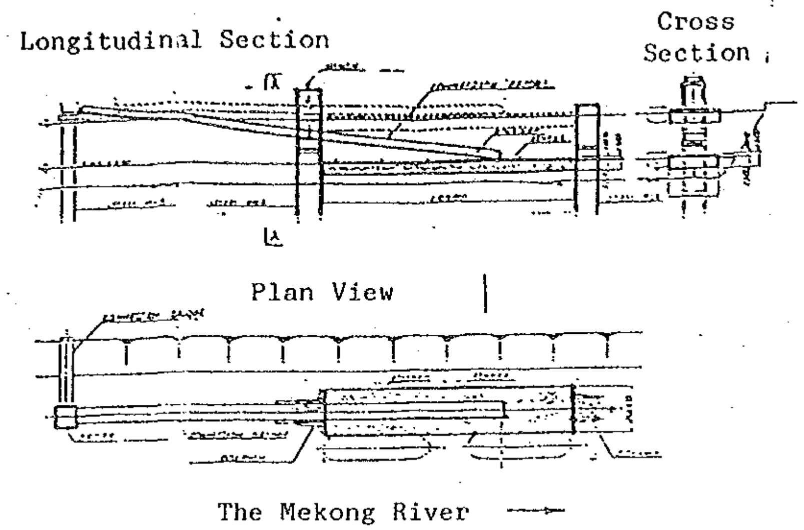
There are no pier type mooring facilities in LAO PDR. However, it is believed that this type would experience operational and management problems, as well as cargo handling problems during low water stage periods. Thus, this type was not selected.

The ramp type, which meets the requirements, was selected for the mooring facility at the Port of Laksi. The ramp type mooring facility has been adopted at all ports in the country other than at Keng Kabao Port.

4) Apron

By taking into account the truck crane space and the temporary storage space, the apron width was set as 10 m where there is an open storage area behind it and 20 m where there is no open storage area behind it.

Table 6-1 List of Mooring Facility Comparisons

	Type A: Ramp Type	Type B: Pier Type	Type C: Floating Type
General Plan			
Characteristics	It is possible to change boats' mooring positions depending upon the water level of the Mekong River. Most ports in LAO PDR are of this type.	The crown height of the wharf is constant.	As the floating mooring facility changes its elevation depending upon the water level, it is possible to maintain a certain wharf height and length.
Merits	This type is most commonly adopted in LAO PDR and is the most familiar type to port operators and management. This type allows boats to change their mooring positions depending upon the water level, and it is suitable to the Mekong River whose water level varies greatly. This type is capable of accommodations roll-on/roll-off boat. Both mechanized and manual cargo handling are possible.	As the piles on the supporting ground carry the loads, it is possible to make a reliable structure. This type is strong against scouring and settlement.	As the floating mooring facility changes its elevation depending upon the water level, it is possible to maintain a certain wharf height and length.
Demerits	As this is a ramp type structure, it is necessary to build a long wharf to provide adequate usable space. It is also necessary to handle cargo on a slope.	The elevation difference between the wharf top and the mooring boat's deck becomes greater during the low water level period, and it is inconvenient for cargo handling. This type of wharf has not been built in LAO PDR yet, and has operation and maintenance problems. Manual cargo handling is very difficult.	The structure is intricate and has various operation and maintenance problems. It is required to build a long access road in order to drive a vehicle onto the floater.
Evaluation	Recommended type.		

(2) Cargo Handling and Storage Facilities

At the Port of Laksi, cargo handling to and from boats is mainly carried out by use of a truck crane. Boats that are moored and await loading or unloading are used for cargo storage. The warehouse accommodates only about 200 tons of cargo.

As the present cargo handling method is expected to be used even in the future, the required warehouse and open storage spaces were determined as follows (Japanese Standard Cargo rotation rate, and warehouse and open storage space occupancy and usage rates were used):

1) Cargo Classification:

Cargo not requiring handling and storage facilities:
42,000 tons.

Cargo requiring handling and storage facilities:
41,000 tons.
Warehouse use: 20,000 tons
Open storage use: 21,000 tons

2) Required Warehouse Space

$$A = \frac{N}{R \cdot \alpha \cdot w}$$

where, A: Warehouse space (m^2)

N: Annual cargo handling volume, 20,000 tons/year

α: Warehouse storage rate, 0.5

w: Warehouse's unit storage capacity, 2 tons/m^2

As the warehouse building is flat, a storage rotation rate of 20 times/year was adopted for the calculation.

Thus, the required warehouse space was determined as $A = 1,000\ m^2$.

3) Required Open Storage Area

$$A = \frac{N}{R \cdot \alpha \cdot w}$$

where, A: Open storage area (m^2)

N: Annual cargo handling volume, 21,000 tons/year

R: Rotation rate, 10 times/year

α: Space use rate, 0.7

w: Unit storage capacity, 1.0 to 1.5 tons/m^2

Therefore, the required open storage area is:

A = 2,000 to 3,000 m^2.

(3) Port Administration Office and Passenger Station

1) Port Administration Office

(a) Staff and Office Space:

SRTC staff:	10 to 15
Customs house staff:	2
Police:	4
Total:	16 to 21

Including future increases, a total of 25 personnel was used in determining the office space.

Considering the present situation in LAO PDR, an unit floor space of 6 m^2/person was used.

Thus, the office space is:

A = 25 persons x 6 m^2/person = 150 m^2.

(b) Conference Room:

Large meeting room:	60 m^2 x 1 = 60 m^2
Small meeting rooms:	20 m^2 x 2 = 40 m^2
Total:	100 m^2

(c) Other space: 50 m^2.

(d) Total office space: 300 m^2.

2) Passenger Terminal

The present ferry service is provided once a week, but it is expected to increase to twice weekly in the future. LAO PDR requested that a waiting space, office, and rest area be provided in the passenger terminal.

(a) Waiting space:

The required waiting space per person in LAO PDR is 0.4 m^2. The capacity of the passenger boat is 300 persons. During the rainy season, however, the number of passengers increase to more than 350. Thus, the required waiting space is:

$$0.4\ m^2 \times 300 \times 1.2 = 150\ m^2.$$

(b) Rest area: 100 m^2

(c) Office space: 50 m^2

Thus, the total space becomes 300m^2. The required passenger terminal space is determined by the following equation:

$$A = a \cdot n$$

where, A: Area of the passenger terminal (m^2)

a: Space per person (1.2 m^2/person)

n: Number of passengers (300 persons)

In accordance with the above equation, the required space becomes 360 m^2. However, as passenger boat service at the port will be provided only once or twice weekly, some of the passengers are expected to wait outside the building. For this reason, the area of the passenger terminal was determined as 300 m^2.

3) Rest Area for Port Workers and Boat Crews

As the passenger terminal will only be used in the early morning by boarding passengers and in the evening by arriving passengers (due to ferryboat scheduling), the passengers' waiting room can also be utilized as a rest area for port workers and ferryboat crews.

The existing SRTC office is to be used for the lodging of port workers.

(4) Control Tower

A control tower that will have a floor area of approximately 15 m^2 is to be installed. The tower will be the center for directing and guding boats in docking and undocking, and for ensuring that cargo handling work is carried out safely.

A decision was made to locate the control tower near the starting point of the new ramp by taking into consideratin the visual confirmation of boat docking and undocking operations, and cargo and passenger movement.

(5) Fuel, Water, and Electric Supply Facilities

1) Fuel Facility (Diesel Oil)

(a) Present Conditions:

a) Capacity: 13,000 litres

b) Fueled Boat:

As the storage capacity of the present fuel facility is limited, only SRTC owned boats are fueled at the stations. Private boats use canned fuel purchased by their individual owners.

c) Amount of Fuel Used:

SRTC boats:	60,000 litres/month
Private boats:	60,000 litres/month
Total:	120,000 litres/month

d) Fuel Consumption for Different Types of Boats:

Passenger boats:

4,800 litres/trip x 4 trips = 19,200, say 20,000 litres/month.

Cargo boats:

SRTC boats:	40,000 litres/month
Private boats:	60,000 litres/month
Total:	100,000 litres/month

e) Fuel Supply to Storage Tank:

A tanker truck belonging to the State Oil Company supplys fuel 3 or 4 times weekly.

(b) Future Perspective

a) Passenger Boats:

Passenger boat operations are planned to increase from the present once-a-week service to twice-a-week service in the future. It is expected that the number of annual passengers in 1995 will increase to 2.3 times the present number. Thus, the monthly fuel supply to passenger boats will be 46,000 litres a month.

b) Cargo Boats:

The present fueling station provides fuel only to SRTC cargo boats due to its capacity limitations. However, SRTC has a plan to supply fuel even to private boats if the planned fueling station has sufficient capacity to meet the demand. Therefore, fuel supply in 1995 will increase in proportion to the cargo volume increase (2.2 times the present supply quantity; i.e., 220,000 litres a month).

c) Total Fuel Supply Amount: 266,000 litres /month.

(c) Required Tank Capacity:

As for portside fuel tank capacity, it is preferable to secure a half-month's supply (133,000 litres/month) if the State Oil Company is able to provide it. However, this capacity (133,000 litres/month) is more than the present monthly supply amount during the peak demand period. For this reason, the fuel tank capacity was set at a half-month supply of the current level during peak demand periods.

From the viewpoint of tank maintenance and repair, it is preferable to have more than one tank. Therefore, it was determined to install two 30 kilolitre tanks.

(d) Other Facilities:

In the vicinity of the fuel tanks, a 15 m^2 shed is to be installed for storing materials and equipment necessary for fuel supply work.

The tank site must be large enough to allow for future expansion in order to meet demand increases.

2) Water Supply Facility

Although a 600 to 700 mm water supply main runs beneath the state road outside of the port area, a water supply tank is to be installed to secure the necessary pressure and amount of water even during supply cutoff periods. The tank capacity was determined as 6.0 m^3 based on the following conditions:

(a) Drinking Water Supply:

a) Number of office personnel and workers:

Office personnel:	25
Workers:	40
Total:	65

b) Ferryboat passengers:

The ferryboat capacity is 300 passengers. However, as the ferryboat departs from the port very early in the morning, the number of passengers used for the estimation is 10% of the total, i.e., 30 persons.

Thus, based on a water use rate of 100 liters/person (standard office water use rate), the necessary water supply amount is:

95 persons x 0.1 m^3/persons/day = 9.5 m^3/day.

(b) Water Supply to Boats:

Passenger and cargo boats are to be supplied. Passenger boat service is provided once or twice weekly. 2.0 m^3 of water is required water for use by the boat. However, 3.0 m^3 of water is planned on for the ferryboat passengers. Thus, it is not necessary to allocate additional water for the passenger boat. Presently, practically no water is supplied to cargo boats. However, the demand for water supply may arise due to the improvement of the water supply facility.

During the high-water period, an average of six cargo boats are expected to enter the port daily. Including those boats only requiring fuel or water supply, it is assumed that ten cargo boats will require water supplies daily; each boat will need 200 litres of water.

Thus, the water demand will be:

10 boats/day x 0.2 m^3/boat = 2.0 m^3/day

(c) Tank Capacity:

The tank capacity is to be one half of the daily supply amount based on the Japanese standard (9.5 m^3 of drinking water and 2 m^3 of boat supply water, total 12.5 m^3/day). Thus, the capacity is calculated as 6.0 m^3.

3) Electric Supply Facility

For illuminating the passenger boat and for charging cargo boat batteries, an electric supply facility is to be installed.

(6) Fire Fighting Equipment

Fire fighting equipment is to be located throughout the port area for use in containing fires that might possibly break out in buildings, cargo areas, or onboard moored ships. The equipment to be provided will be fireplugs and fire extinguishers.

Boxes containing fire fighting equipment will be installed at strategic locations in buildings and in the yard area. Each box will contain a fireplug, a hose, a nozzle, and hose hanger.

Water pressurized by a pump will be sprayed on fires. Additionally, fire extinguishers will be located throughout buildings to be used in fighting newly started fires.

(7) Cargo Handling Equipment

As for cargo handling equipment, a study was made of the wharf crane and of necessary additional equipment for the open storage yard.

1) Loading and Unloading Equipment:

(a) Maximum Load to be lifted:

By taking into account the following conditions, the maximum load to lifted was determined to be 5 tons:

a) The maximum load of one lot of cargo that can be lifted at Keng Kabao Port is 10 tons, but the loading frequency is very low. At the Port of Laksi, the cargo is handled by dividing it into small lots.

b) At the Port of Laksi, the maximum load of one cargo lot to be lilfted is normally 5 tons.

c) The lifting capacity of the crane at Keng Kabao Port is 5 tons under boat cargo handling conditions (with the radius of the load being 28 m).

(b) Radius of Loads:

The radius of the load was studied based on the operating conditions shown in Fig. 6-2.

Radius of load: 11 m

The capacity of the cargo handling equipment was determined by assuming this radius of load condition.

(c) Required Equipment Capacity:

Simultaneous cargo handling of three average-size boats was planned. A truck crane should be provided for each boat.

Taking into account the radius of the load and the compatability of required spare parts, it was decided upon that three truck cranes, each having the maximum lifting capacity of 25 tons, were necessary.

(d) Cargo Handling Method:

A truck crane's capacity and its instruments are based on the crane being mounted horizontally. Therefore, from the standpoint of safety, it is absolutely essential that truck cranes always be horizontally mounted. For this reason, sleeper-type timber must be used to keep the truck crane in a horizontal position while it is being used on the port ramp.

Under normal cargo handling conditions:

Boat size: 34 m (length) and 7 m (breadth).

Lifting load: 5 tons

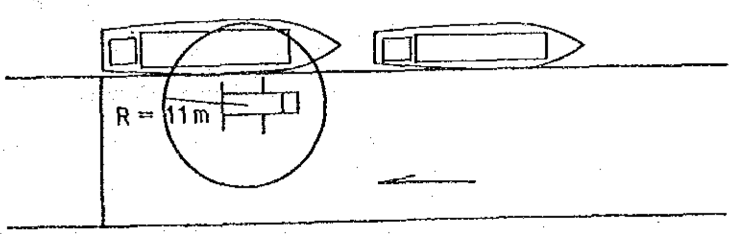


Fig. 6-2 Truck Crane's Capacity and Cargo Handling Conditions

2) Apron, Open Storage Area, and Warehouse

It is planned to use forklift trucks and trucks for cargo handling on the apron, in the open storage area, and in the warehouse.

The number of forklift trucks and their capacities were determined as follows:

(a) Forklift Trucks

a) Cargo handling between boats, and the warehouse and the open storage area:

i) Cargo to be handled by forklift trucks;

The cargo is handled in the warehouse and in the open storage area. As the required number of forklift trucks is determined considering the cargo volume during the high water period.

The daily cargo handling volume per one gang on one berth is 216 tons. It was determined that 50% of the cargo (108 tons) is to be handled by forklift.

ii) Criteria for the Calculation;

- o Average speed:
  12.5 km/hr (10 km/hr with load and 15 km/hr without load)
- o Average load: 1.2 tons
- o Operating hours: 15 hrs/day
- o Operating efficiency: 0.7
- o Operating distance:
  90 m (between wharf, and the warehouse and open storage area).
- o Time required for loading/unloading:
  2 min/cycle (based on interviews with manufacturers).

Based on the above criteria, one cargo handling trip takes 5 minutes. The daily cargo handling volume of one forklift is 150 tons.

iii) Necessary Number of Forklifts;

From the above discussion, one forklift is required for each berth; therefore, a total of three forklifts are necessary.

b) Loading and Unloading of Trucks:

Using the same calculation procedure as for cargo handling between boats and the warehouse and open storage area, it was determined that two forklifts will be necessary for loading and unloading trucks.

c) Necessary Number of Forklifts

Including the two existing units, a total of five (5) forklifts are required.

d) Capacity of Forklifts:

As the heaviest piece of cargo is 5.0 tons, and the existing forklifts' capacities are 3 tons each, one 6-ton and two 3-ton forklifts will be required.

(b) Trucks

Trucks for port area use will be required to transport drum cans, cement, etc. from the ramp to the open storage area during low-water periods.

As the maximum weight of one unit of cargo is five tons, the capacity of each truck was determined to be six tons. The required number of trucks, three, determined as follows:

a) Assumed Cargo Handling Method:

Only one berth will be used during low-water periods, but, in order tomake effective use of the truck cranes, two will be used thereby improving cargo handling efficiency.

b) Cargo Handling Efficiency:

Cargo handling by Crane:

6 minutes/time and 1.2 tons/time

Cargo handling at open storage area:

2 minuts/time and 1.2 tons/time

Transporting time:

- Transporting distance: 250 m one way
- Average speed: 12.5 km/hr
- Transporting time: 2.4 minutes

c) Cargo Handling Time (per one truck):

Cargo Handling by crane:

$$30 \text{ minutes } \left(\frac{6.0 \text{ tons}}{1.2 \text{ tons}} \times 6 \text{ minutes}\right)$$

Transporting by truck:

$$13 \text{ minutes } \left(\frac{6.0 \text{ tons}}{1.2 \text{ tons}} \times 6 \text{ minutes} + 2.4 \text{ minutes}\right)$$

d) Necessary Number of Trucks:

The necessary number of trucks was determined by using the diagram shown in Fig. 6-3.

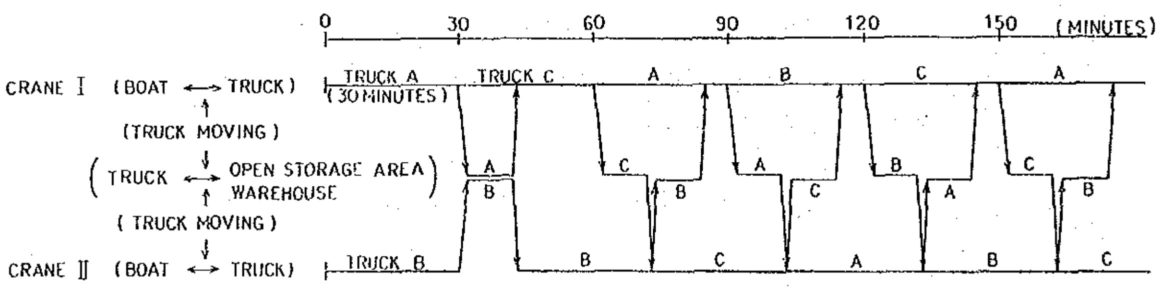


Fig. 6-3 Truck Use Diagram

(8) Equipment Storage Area

A storage area for equipment (forklifts and so forth) and the materials necessary for port control is to be provided. The size of the storage area is to be 20 m x 10 m (200 m^2).

(9) Safety Measures

The following safety measures are required for port operations:

1) Install a portable gangway (either at wharf side or boat side).

2) Provide car stoppers and non-skid protection on the ramp.

3) It is desirable to provide implements, such as pallets or steel nets, for safe and efficient cargo handling.

4) Provide fire fighting equipment.

6.3 Facilities' Layout Plan

6.3.1 Requirements for Facilities' Layout Plan

(1) Physical Limitation and Effects on Existing Facilities:

The port planning area lies between a pump station upstream, and a shipyard and ramp downstream. It is assumed that the construction of a new structure in the Mekong River would cause the scouring or siltation of the surrounding area.

The Port of Laksi area is on the scouring side of the river. However, it is assumed that the construction of a new port structure may cause siltation on surrounding area of the existing ramp and pump station. Thus, the layout of the new port structure must be constructed so that siltation around the existing structures will be minimized.

(2) Water Level Change and Facilities' Elevations

The previous highest river level was MSL 170.75, and the previous lowest river level was MSL 157.76 m. For this reason, the elevations of the port facilities were determined as follows:

1) Floor Elevation of the Warehouse and Office Buildings:
Above the previous highest river level.

2) Open Storage Area:
Above the normal flood level.

(3) Ramp

1) Slope:

The existing ramp has a 10% slope. By taking into consideration easy cargo handling, the new ramp was determined to have a uniform slope of 7%.

2) Length:

The ramp length was determined as 171.8 m (tangent length of 171.4 m) based on level changes within the range of MSL 158 m to MSL 170 m.

3) Width:

The ramp width was determined as 21 m (including a 1.0 m the shoulder), considering smooth cargo handling.

4) Wharf Front Shape:

The wharf front is to have a vertical shape -- as much as possible -- for easy berthing and cargo handling.

5) Depth of Water

In order to maintain the necessary berth length, sufficient water depth, corresponding to water level changes, must be maintained.

6) Measures to be taken for utilizing Roll-on/Roll-off Boat

As a roll-on/roll-off type boat, mainly used for transporting vehicles, places their own ramps directly on the wharf, it is required that adequate water depth be maintained at the end of the wharf in order to put an access pontoon between the boat ramps and the wharf ramp.

(4) Effective Use of the Front of the Open Storage Yard Front

During the high water level period, when cargo handling volume is large, the usable range of the ramp's length becomes shorter, and it becomes possible to use the front of the open storage yard for berthing and cargo handling. Therefore, a wharf apron is to be provided in front of the open storage yard. The width of the apron is to be 10 m.

(5) Unification of the Port Management Office and Passenger Terminal

Because of land area limitations, the port management office and passenger terminal are to be located in the same building. This layout will make effective use of the building and will unify port control and management work. A parking lot is to be provided near the building.

(6) Fuel Oil, Water, and Electric Supply Facilities

Fuel tanks must be arranged a safe distance away from cargo and passengers moving routes and must be an underground type. Fuel oil, water, and electric supply stations are to be installed at the waterfront. The stations must be arranged so that they will not be flooded during high water periods.

(7) Access to Existing Ramp

Access to the existing ramp must be taken into consideration.

(8) Future Expansion

The project site area is limited by both the waterfront line and land boundaries. Further expansion of the port area may be required to meet future cargo volume increases.

The existing shipyard area on the downstream side is the only possible place where expansion can be made. Thus, a means for connecting the shipyard side to the Project Site must be taken into consideration when making the port area layouts.

6.3.2 Facilities' Layout Plan

Based on the above considerations, a port facility layouts was prepared as shown in Fig. 6-3. The relationship between water level changes and the usable wharf are shown in Table 6-2 and in Fig. 6-4.

A portion of the existing riverbed must be either dredged or excavated (see Fig. 6-5).

The relationship between the mean daily water level during each month and the number of usable berths is shown in Fig. 6-6.

The number of usable berths will be three berths at a water level higher than MSL 162 m, two berths at water levels between MSL 162 to 160 m, and one berth at a water level lower than MSL 160 m.

Table 6-2 Relationship between the Water Level Change and the Number of Berths

Water Level MSL (m)	Usable Wharf Length		Number of Berths		
	Inland Wharf (m)	Ramp (m)	Inland Wharf	Ramp	Total
170	96.5	0	3	0	3
168	75.0	30	2	1	3
166	46.5	62	1	2	3
164	18.0	90	0	3	3
162	0	90	0	3	3
160	0	62	0	2	2
158	0	40	0	1	1

Note: The number of berths were calculated assuming a berth length of 30 m. The clearance between berthing boats depends upon the lengths of the boats. A boat also can berth with its bow or stern extending beyond the end of the berth. Thus, the required berth length was calculated as 60 m for two berths and 90 m for three berths.

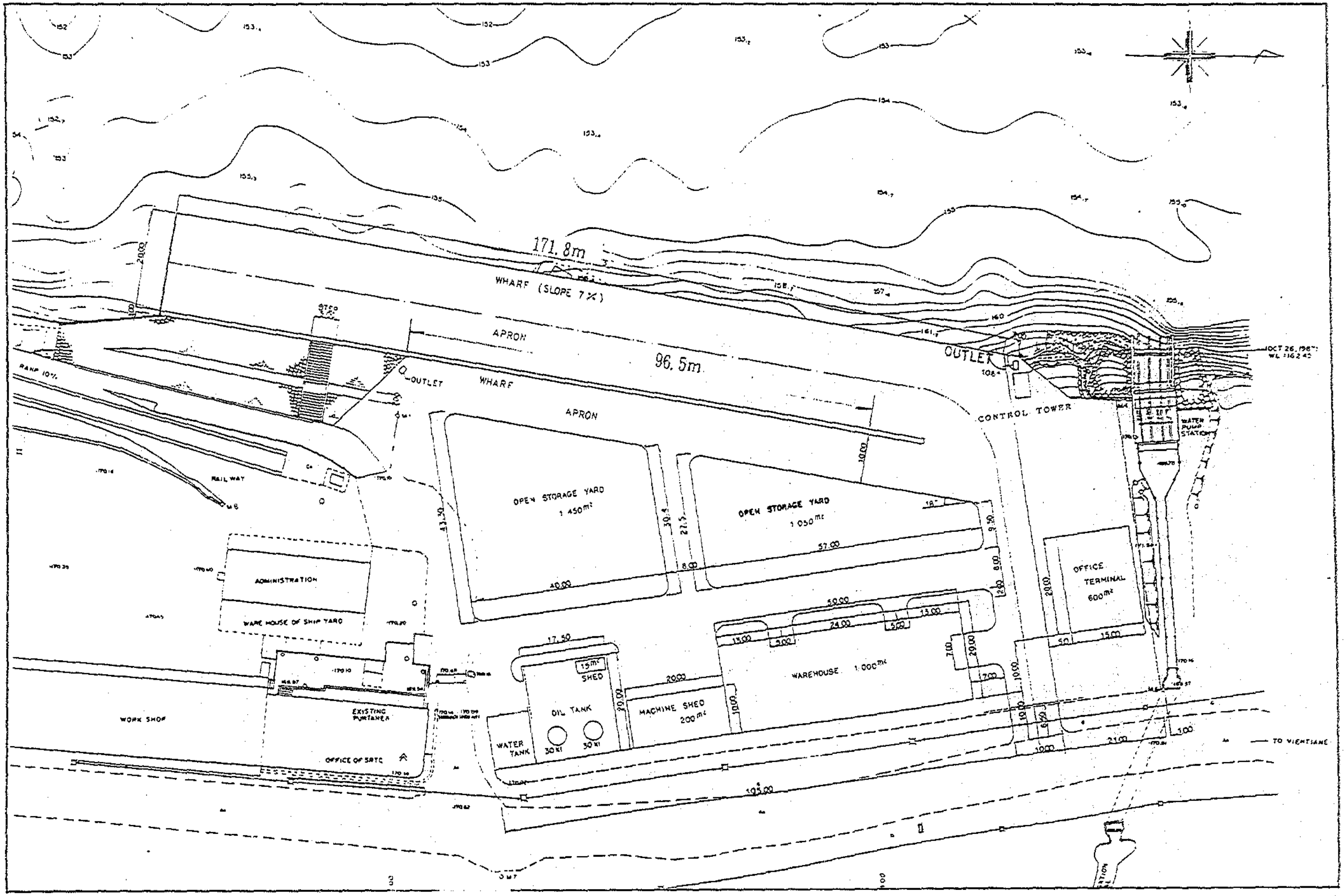
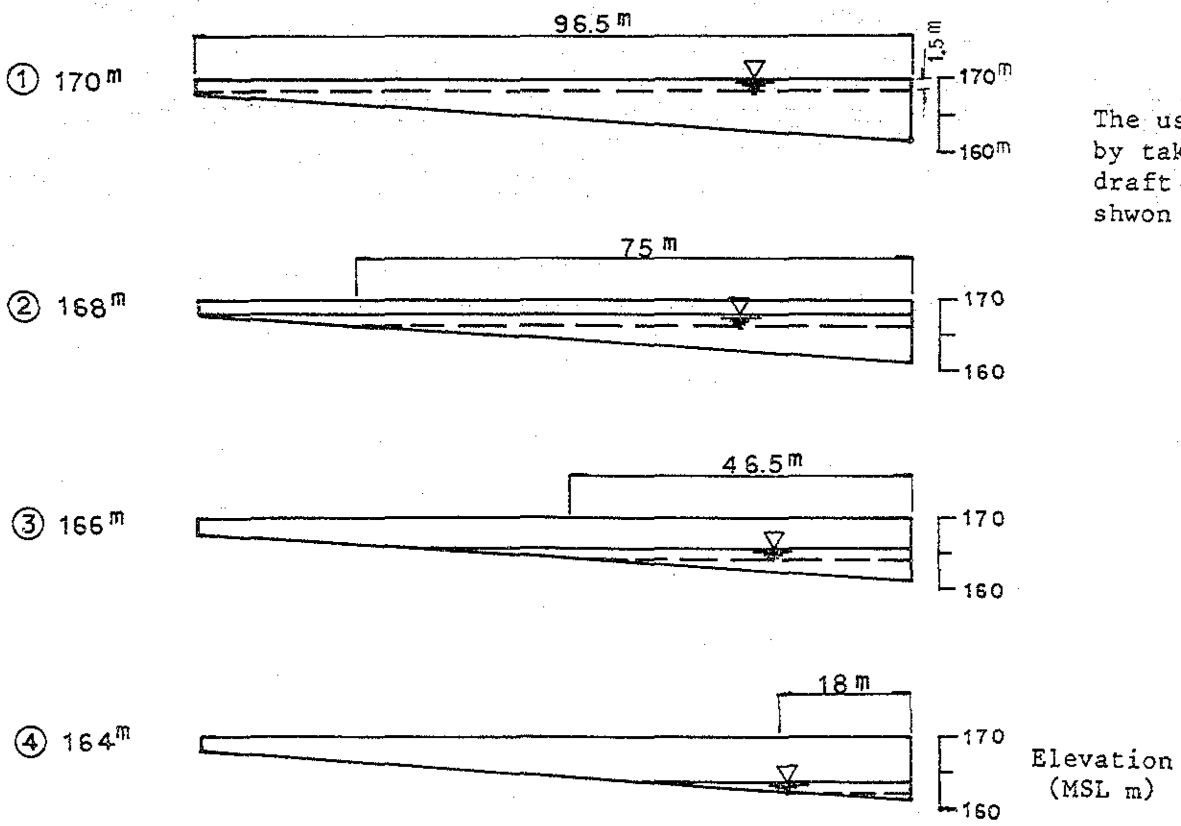


Fig. 6-4 Improvement Plan of Lakxi Port

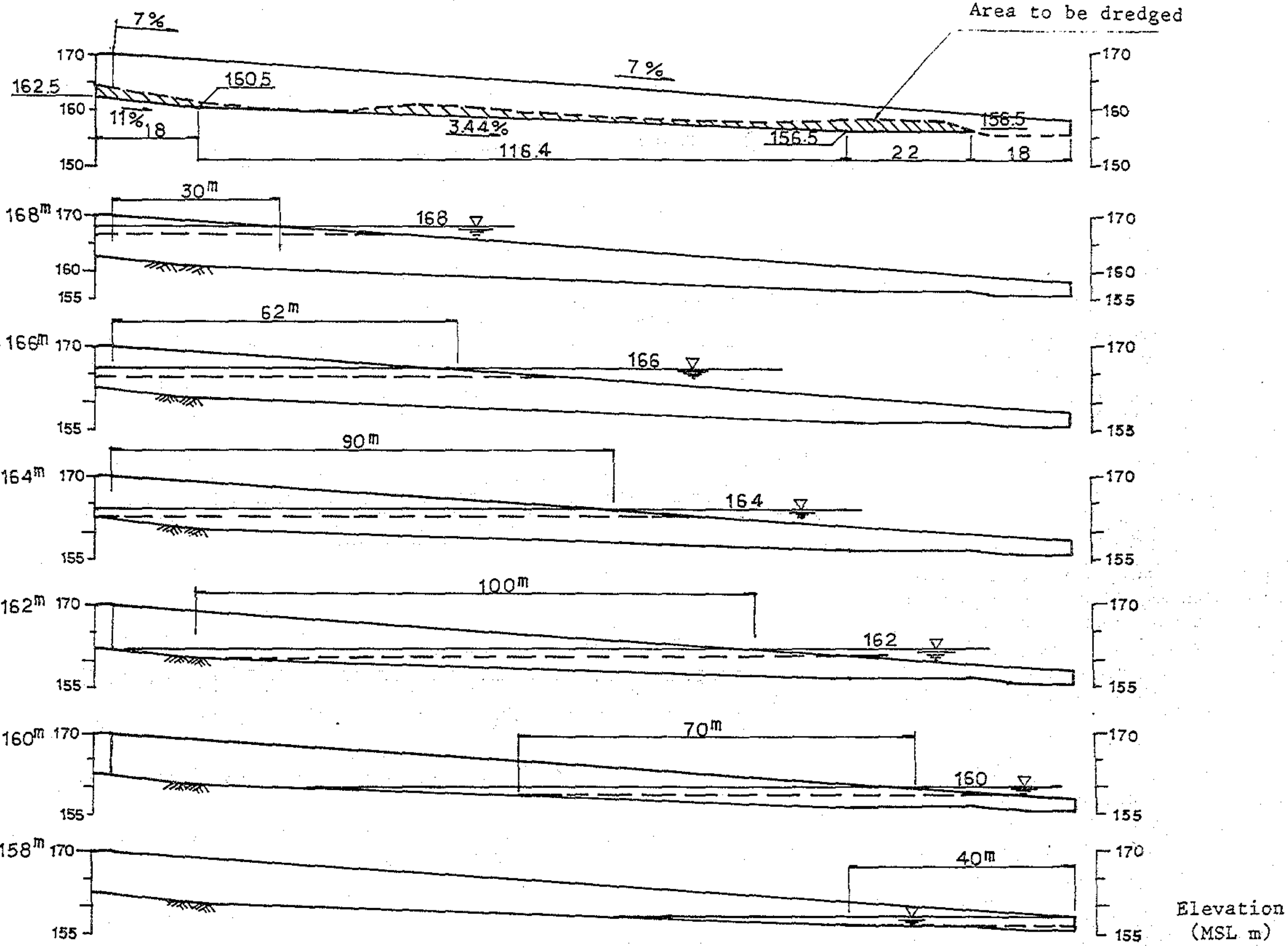
(1) Inland Side Wharf (S=1/1000)



The usable wharf length was determined by taking into consideration the boat's draft (1.2 m) and allowance (0.3 m) as shwon with broken lines in the Figure.

Fig. 6-5 Relationship between Water Level and Usable Wharf Length
(continued on next page)

(2) Ramp (S=1/1000)



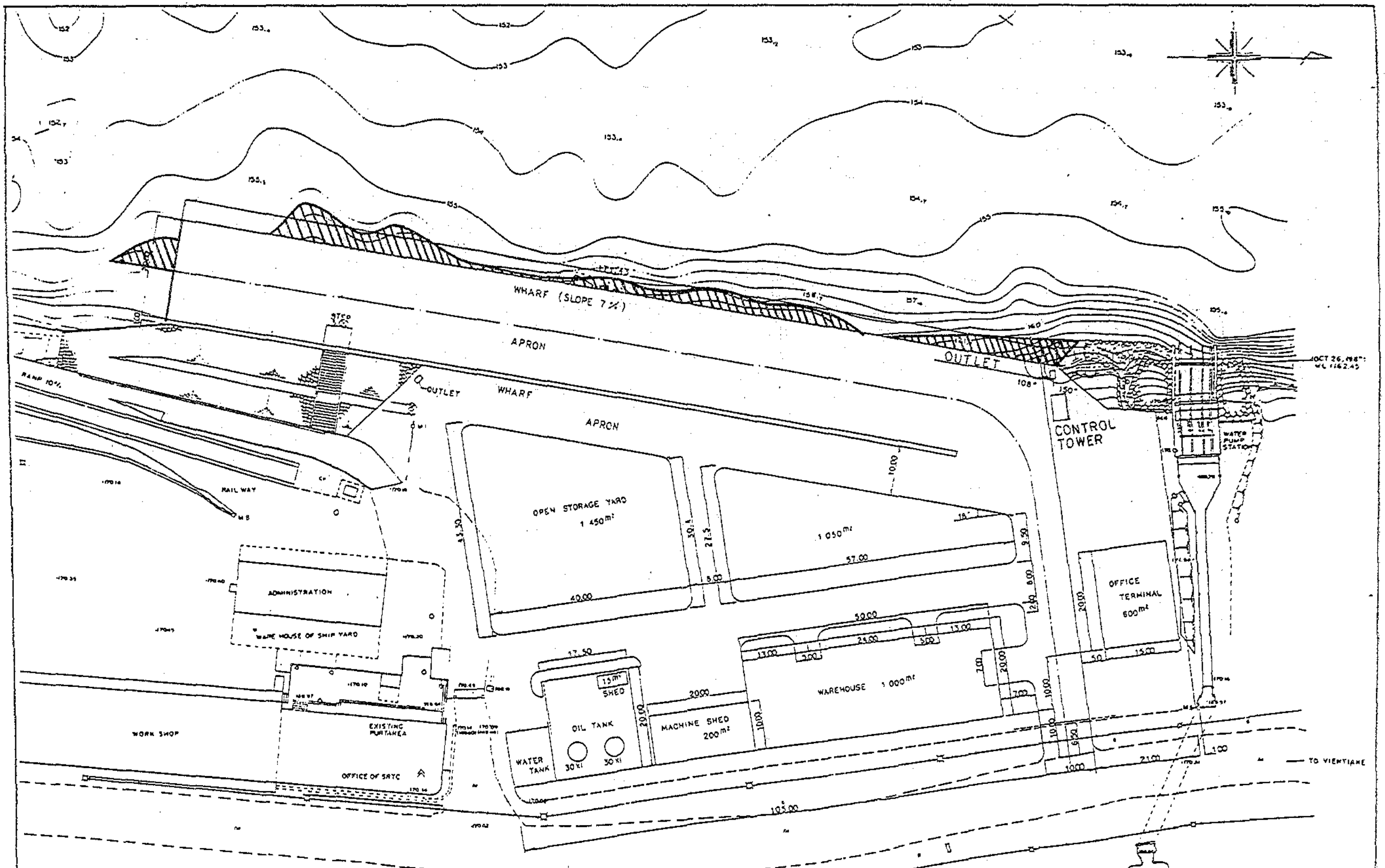


Fig. 6-6 Dredging Area

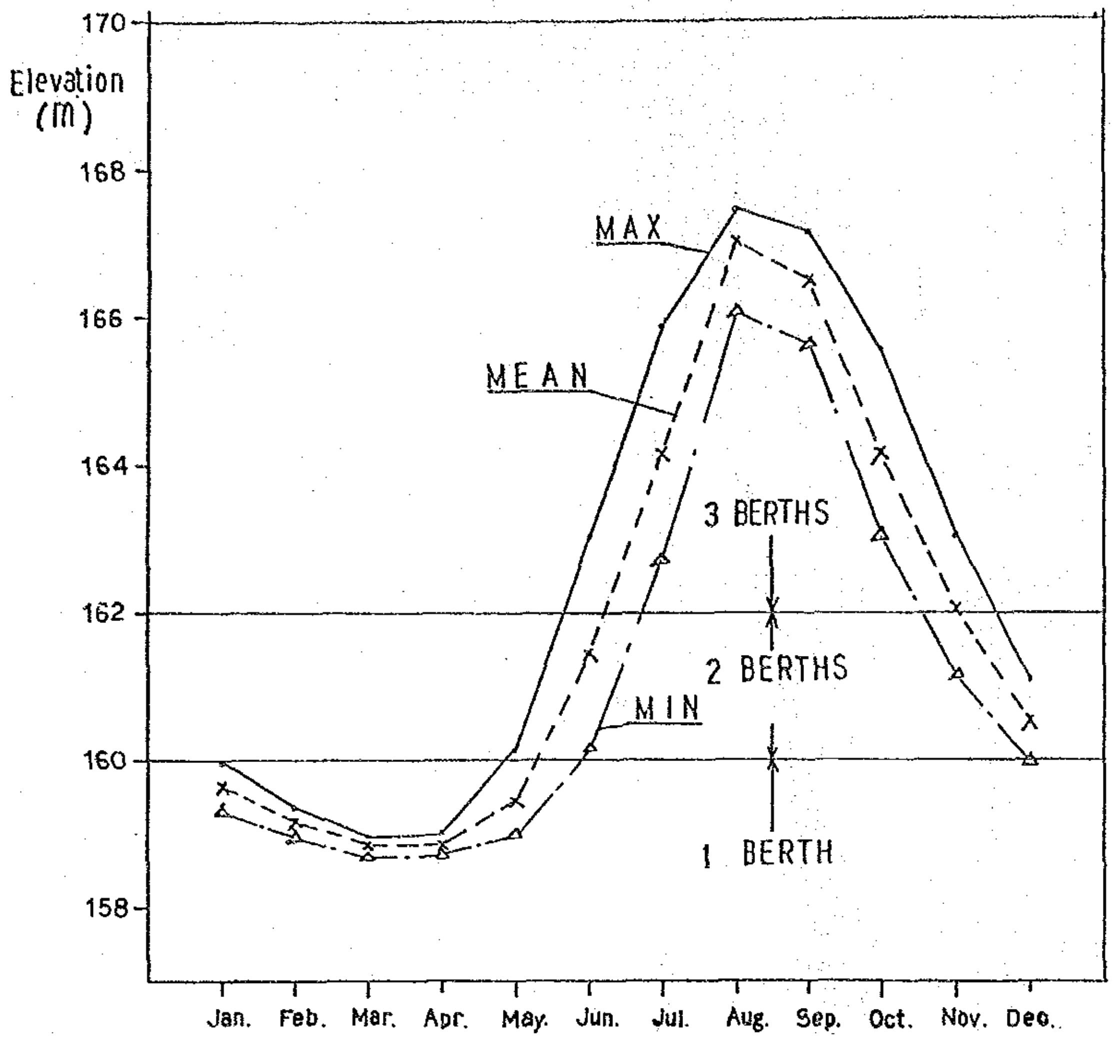


Fig. 6-7 The Relationship between Mean Daily Water Level and the Number of Usable Berths

CHAPTER 7 BASIC DESIGN

CHAPTER 7 BASIC DESIGN

7.1 Design Policies

The basic design of the Port of Laksi was made based on the request by LAO PDR, and the natural conditions, port use conditions, demand forecasts, and port planning, all of which were described in Chapters 2 through 6, and in accordance with the following basic policies:

(a) To pay careful attention to the natural conditions.

(b) To select suitable structure types and construction methods to match the site conditions.

The details of the above basic policies are as follows:

(1) To Pay Careful Attention to the Natural Conditions

1) To gain an understanding of approximately 13 m of the Mekong River's stage change and velocity, and the Project Site geology, and to reflect the understanding in the basic design.

2) To pay careful attention to the existing facilities (pump station, ramp, etc.) in the vicinity of the Project Site so as not to create detrimental effects, such as siltation and scouring, to the facilities.

3) To select structure types capable of withstanding battering by driftwood.

(2) To Select Suitable Structure Types and Construction Methods to Match the Site Conditions

1) Structure types must be simple and allow for easy operations and maintenance.

2) Structure types must be selected to allow for both equipment cargo handling and manual cargo handling.

3) For the selection of materials and construction methods, priorities must be given to those which are obtainable and applicable in LAO PDR.

The basic design was carried out in conformity with the above policies.

7.2 Design of Port Facilities

7.2.1 Design Conditions

(1) Features of Structures

From Chapter 6, the features of structures are as follows:

	Riverside Wharf	Inland Side Wharf
Actual Wharf Length	171.8 m	96.5 m
Apron Width	20 m	10 m
Wharf Crown Elevation	MSL 170 to 158 m	MSL 170 m

(2) Objective Boats

Maximum Size: 140 DWT, 34 m (length), 1.4 m (draft), and 7 m (breadth).

Average Size: 60 DWT, 30 m (length), 1.2 m (draft), and 6 m (breadth)

(3) Durable Year

As the standard of durable years for civil engineering structures, such as for mooring, etc., does not exist in LAO PDR, it was determined to use 50 years for the durable years of the port structures.

(4) Concerned River Conditions

1) Water Stage:

Based on records obtained during a 62 year period (1923 to 1984), the water stages for the port facility design were determined as follows:

Highest High Water Stage: MSL 170.75 m
Lowest Low Water Stage: MSL 157.76 m

2) Waves:

As the Project Site locates in the Mekong River and the fetch length is short and the wave height is small, it was determined not to consider wave height in the structure design.

(5) Design Earthquake:

Earthquakes in the vicinity of the Project Area, according to past records, have been few in number and those were of small scale. Seismic force is not taken into consideration in this country, therefore it was determined not to take it into account in the Project facility design.

(6) Wind Velocity:

Maximum wind velocity: $V = 37$ m/sec.
(from an easterly direction)

(7) Rainfall Intensity:

Rainfall intensity: $I_{50} = 67.8$ mm/hr
(50 year probability)

(8) Live Load:

By taking account of uniformly distributed load (W = about 1.0 ton/m^2) and vehicle load (T-20 truck load and 25-ton truck crane load), the design live load of 2.0 tons/m^2 was used.

(9) Soil Condition:

1) Existing Ground:

(a) From the present ground level (approximately MSL 170 mm) to MSL 168 m: Clayey soil

$C = 2$ tons/m^2, $\gamma = 1.9$ tons/m^3

(b) From MSL + 168 m to MSL + 160 m: Clayey soil

$C = 6$ tons/m^2, $\gamma = 2.1$ tons/m^3

(c) From MSL 160 m to MSL 152 m: Silt,

$C = 3$ tons/m^2, $\gamma = 2.0$ tons/m^3

(d) From MSL 152 m to MSL 150 m:
Silt mixed with cobblestones,

$C = 3$ tons/m^2, $\gamma = 2.0$ tons/m^3

(e) Below MSL 150 m: Hard clay layer,

C is more than 50 tons/m^2, γ= 2.0 tons/m^3

2) Filling Sand:

Sandy soil,

ϕ=30°, γ'= 1.0 ton/m^3

(γ= 1.8 tons/m^3 in air)

3) Filling and Backfilling Stone:

ϕ=35°, γ'= 1.0 ton/m^3

(γ= 1.8 tons/m^3 in air)

(10) Structural Materials

1) Concrete:

To use normal concrete

Standard design strength: Fc = 180 to 240 kg/cm^2

2) Reinforcing Bar:

Round bar: SR-24, σ_{sa} = 1,400 kg/cm^2

Deformed bar: SD-30, σ_{sa} = 1,800 kg/cm^2

3) Steel Material:

	SKY50, σ_{sa}	= 1,900 kg/cm^2
Sheet pile:	SY30, σ_{sa}	= 1,800 kg/cm^2
Structure steel:	SS41, σ_{sa}	= 1,400 kg/cm^2

7.2.2 Design Outline

(1) Design of Mooring Facility

After a thorough evaluation of the following points, a decision was made to use the sheet-pile type mooring facility for the ramp structure at the Port of Laksi:

- Natural characteristics of the Mekong River.
- Geological characteristics of the Project Site.
- Port use conditions and port operation and maintenance situations in LAO PDR.
- Economic aspects.
- Construction aspects.

As underwater tie-rod installation and coping-concrete placement work are very difficult to accomplish, a decision was made to use a concrete-block gravity wall type structure at the end of the ramp that is lower than MSL 160 m.

Typical cross sections of the mooring facilities are shown in Figs. 7-3 through 7-5.

In LAO PDR the most common type of mooring facility is the slope type (the wharf front is not vertical). The slope type mooring facility is preferable from the viewpoint of having a stable embankment, being easy to construct, and having low construction costs. However, the slope type poses various problems for boat berthing and cargo handling work. Therefore, the vertical type, in spite of the slope type, was selected as the recommendable structure type for the Port of Laksi.

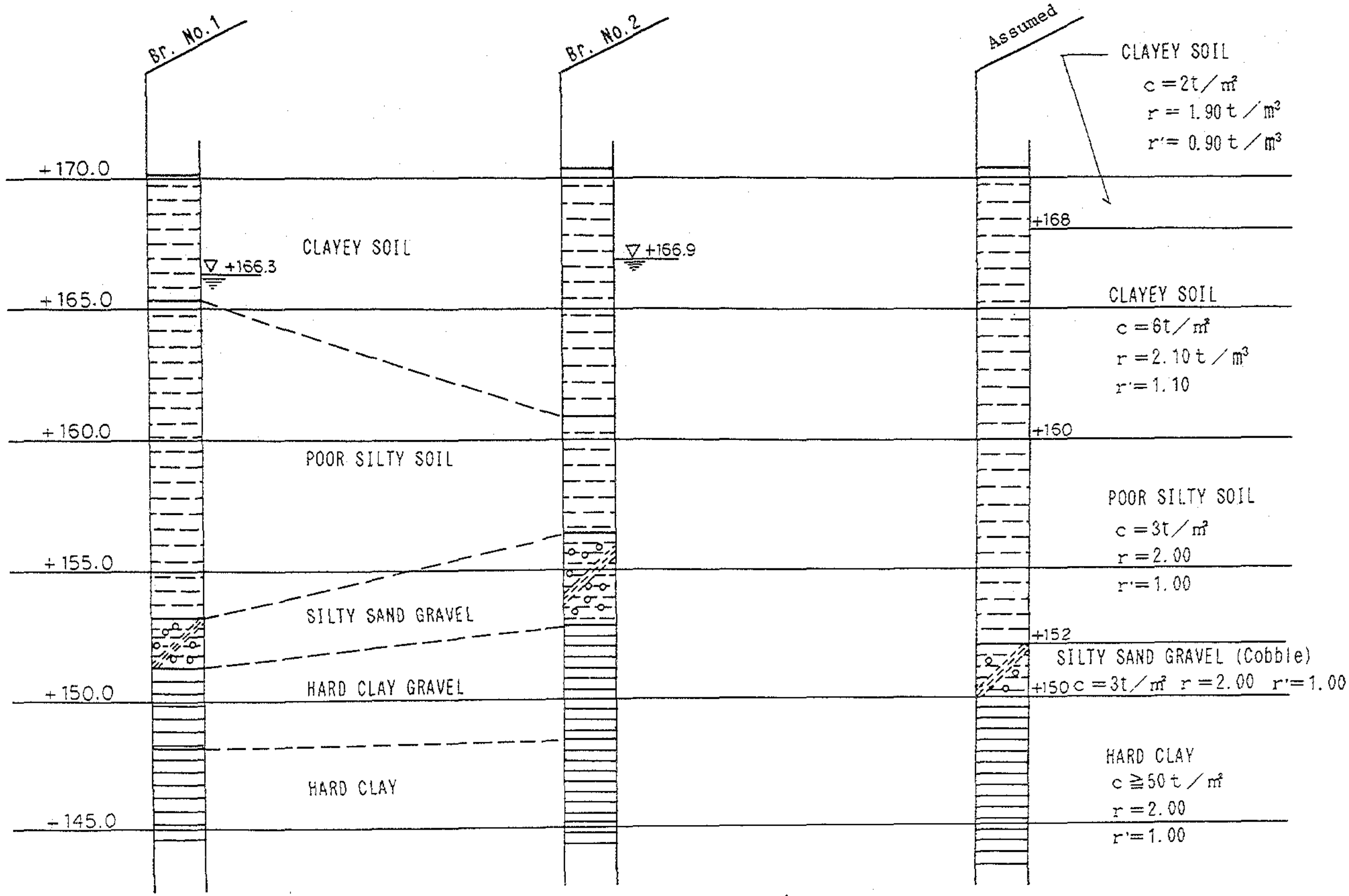


Fig. 7-1 Assumed Soil Columnar Section

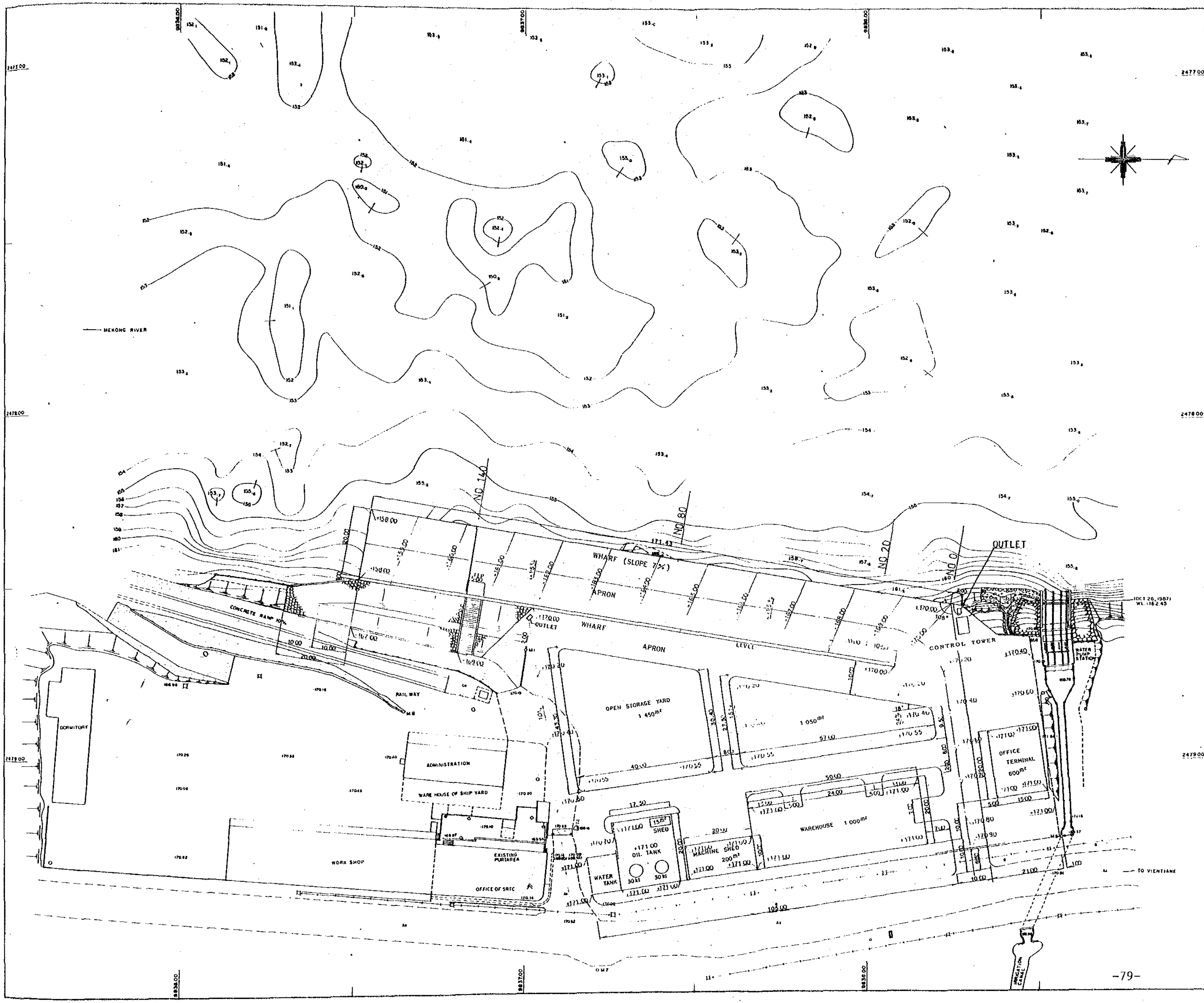


Fig. 7-2

Plan of Laksi Port

GENERAL NOTES

DESCRIPTIONS	DWG NO.

REFERENCE DRAWINGS

NO	DATE	DESCRIPTIONS	BY	APPD

REVISIONS

THE PROJECT FOR IMPROVING
THE VIENTIANE RIVER PORT(PORT OF LAKSI)
IN
THE LAO PEOPLE'S DEMOCRATIC REPUBLIC

SUBMITTED	APPROVED	SCALE	REV. NO
		1:1000	

DATE | DWG NO.

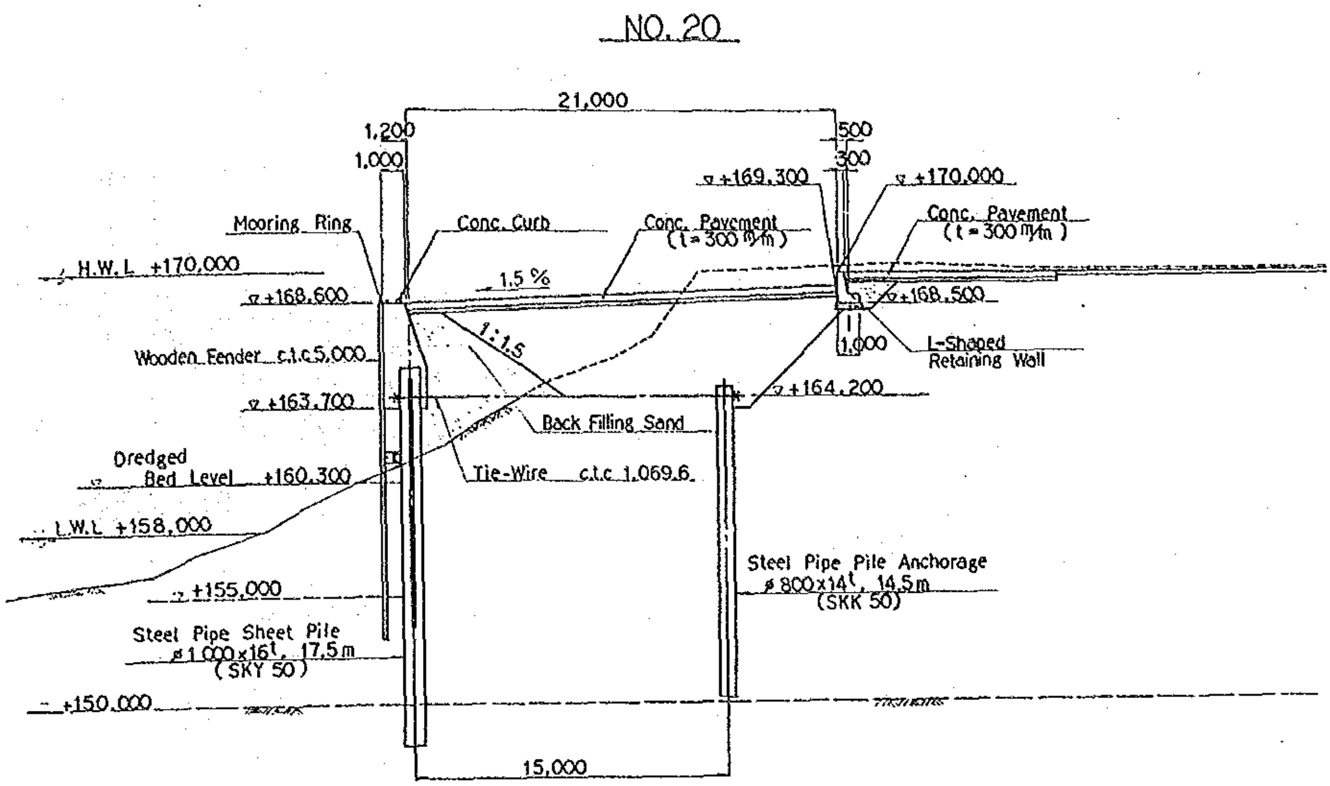


Fig. 7 - 3 Cross Section of Mooring Facility (1)

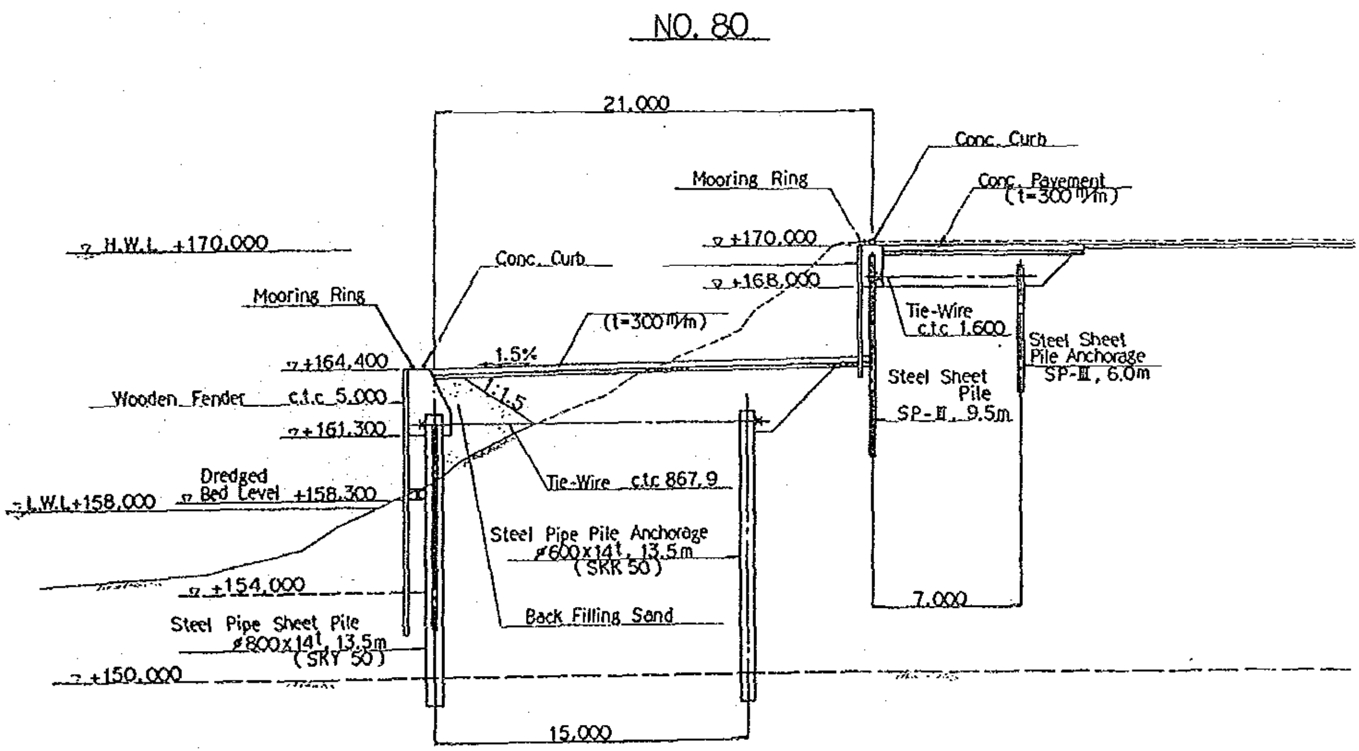


Fig. 7 - 4 Cross Section of Mooring Facility (2)

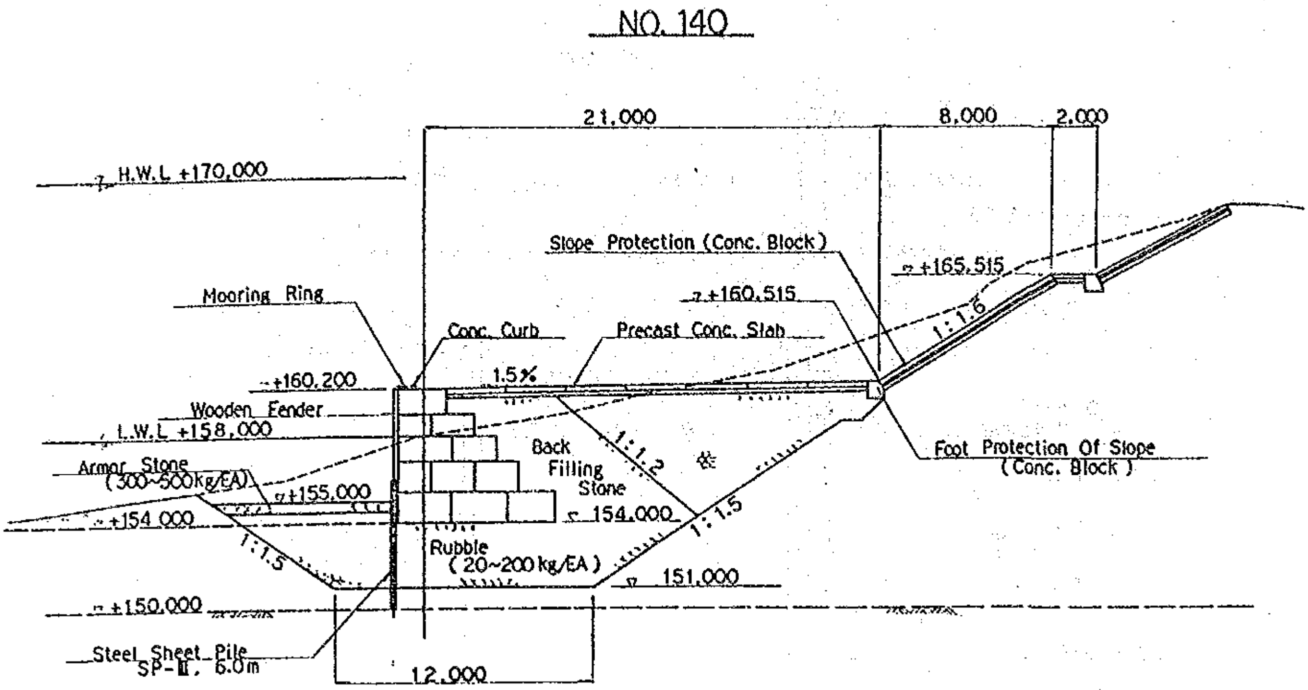


Fig. 7-5 Cross Section of Mooring Facility (3)

7.3 Building Design

7.3.1 Design Conditions

Project Buildings:

(1) Administration Office/Terminal Building:
15 m x 20 m (two-stories)

(2) Warehouse: 20 m x 50 m

(3) Machine Shed: 20 m x 10 m

(4) Equipment Control Shed: 15 m^2

Presently there are no set standards nor specifications for building design in LAO PDR; each project uses its own design standards and specifications. It was decided, therefore, to adopt Japanese design standards for Project buildings -- the effects of seismic forces were not taken into account as mentioned in a previous section.

The design wind velocity of 37 m/sec and the design floor load of 2.5 tons/m^2 were used for the office building design.

7.3.2 Building Design Summary

Taking into consideration geological and weather conditions, simplicity of construction, the utilization, as much as possible, of locally available construction material, and the ease of maintenance, the following types of building structures were selected:

(1) Administration Office/Terminal Building:

1) Foundation: Spread foundation. No piles to be used.

2) Building Structure: Reinforced concrete, rigid-frame type.

3) Roof: Concrete slab topped, for waterproofing purpose, by
asbestos corrugated sheeting.

4) Interior and Exterior Walls: Concrete block or brick.
Interior walls: Stucco.
Exterior walls: Mortar sprayed.

5) Ceiling: Gypsum board

6) Floor: Concrete, trowel finish

7) Toilet and Kitchen: Waterproof and fireproof finish.

(2) Warehouse:

1) Foundation: Spread foundation. No piles to be used.

2) Building Structure: Reinforced concrete, rigid-frame type.

3) Roof: Corrugated asbestos sheeting on steel I-beams (crossbeams).

4) Interior and Exterior Walls: Concrete block
Exterior walls: Mortar sprayed
Interior walls: Paint sprayed

5) Floor: Concrete, trowel finish

(3) Machine Shed:

1) Foundation: Spread foundation. No piles to be used.

2) Building Structure: Reinforced concrete, rigid-frame type.

3) Roof: Corrugated asbestos sheeting on steel I-beams (crossbeams).

4) Floor: Concrete, trowel finish

(4) Equipment Control Shed:

1) Foundation: Spread foundation. No piles to be used.

2) Building Structure: Reinforced concrete wall type.

3) Roof: Corrugated asbestos on steel beams.

4) Interior and Exterior Walls:
Interior walls: Plaster
Exterior walls: Mortar

5) Floor: Concrete, trowel finish

(5) Control Tower

1) Foundation: Spread foundation. No piles to be used.

2) Tower Structure: Reinforced concrete wall type.

3) Roof: Corrugated asbestos sheeting on steel beam.

4) Interior and Exterior Walls:
Interior walls: Plaster
Exterior walls: Morter

5) Floor: Concrete, trowel finish

7.4 Incidental Facilities

7.4.1 Electrical Work

1) Electric Service Wire:

EDL will install a 3 phase, 360 kva, 50 Hz service wire from the EDL's main supply line to the receiving board in the port area.

2) Transformer Facility:

A transformer facility is to be installed where the received high voltage will be stepped down to 220V, 50 Hz.

3) Main Wire in the Port Area:

39 mm^2 main wires are to be installed to supply electricity within the port area.

4) Lighting Facility:

The lighting standards are to be 20-lux in the port yard, 200- lux in office spaces. Yard illumination is to be provided by 700W mercury lamps.

5) Telephone Facility:

Service wire is to be installed from a terminal board in the Project Site to the management building.

6) Intercommunication System

A communication system shall be provided by installing intercoms, and the associated cabling, between the management office, warehouse, material and equipment storage, equipment control warehouse, and the control tower.

7.4.2 Water Supply Facility

1) Water Supply to Boats:

The water supply line from the main line (which runs beneath the main road) to the storage tank in the port area will be installed by the Water Supply Company (WSC).

50 mm diameter pipe is to be installed from the storage tank to the riverside water supply outlets.

2) Management Office

Independent pipe line is to be installed from the storage tank to the management office.

7.4.3 Fuelling Facility

65 mm diameter pipes are to be installed from the two underground fuel tanks (30 kilolitre capacity each) to the riverside fuelling stations.

7.4.4 Fire Fighting Equipment

Fire fighting equipment is to be located throughout the port area for use in containing fires that might possibly break out in buildings, cargo areas, or onboard moored ships.

1) Tank Capacity

The tank capacity for providing sufficient amounts of fire fighting water to two fireplugs simultaneously was established as 14 m^3 based on Hydrant Installation Standards.

AS the tank water will be used for supplying boats, the total capacity of the tank shall be 21 m^3.

2) Location of Fireplugs

Fireplug locations are shown in Fig. 7-11. Four fireplugs will be installed.

3) Piping arrangement

For the sake of economy, piping to be used for supplying fire fighting water will also be used for supplying water to boads. The pipe diameter was determined as 100 mm.

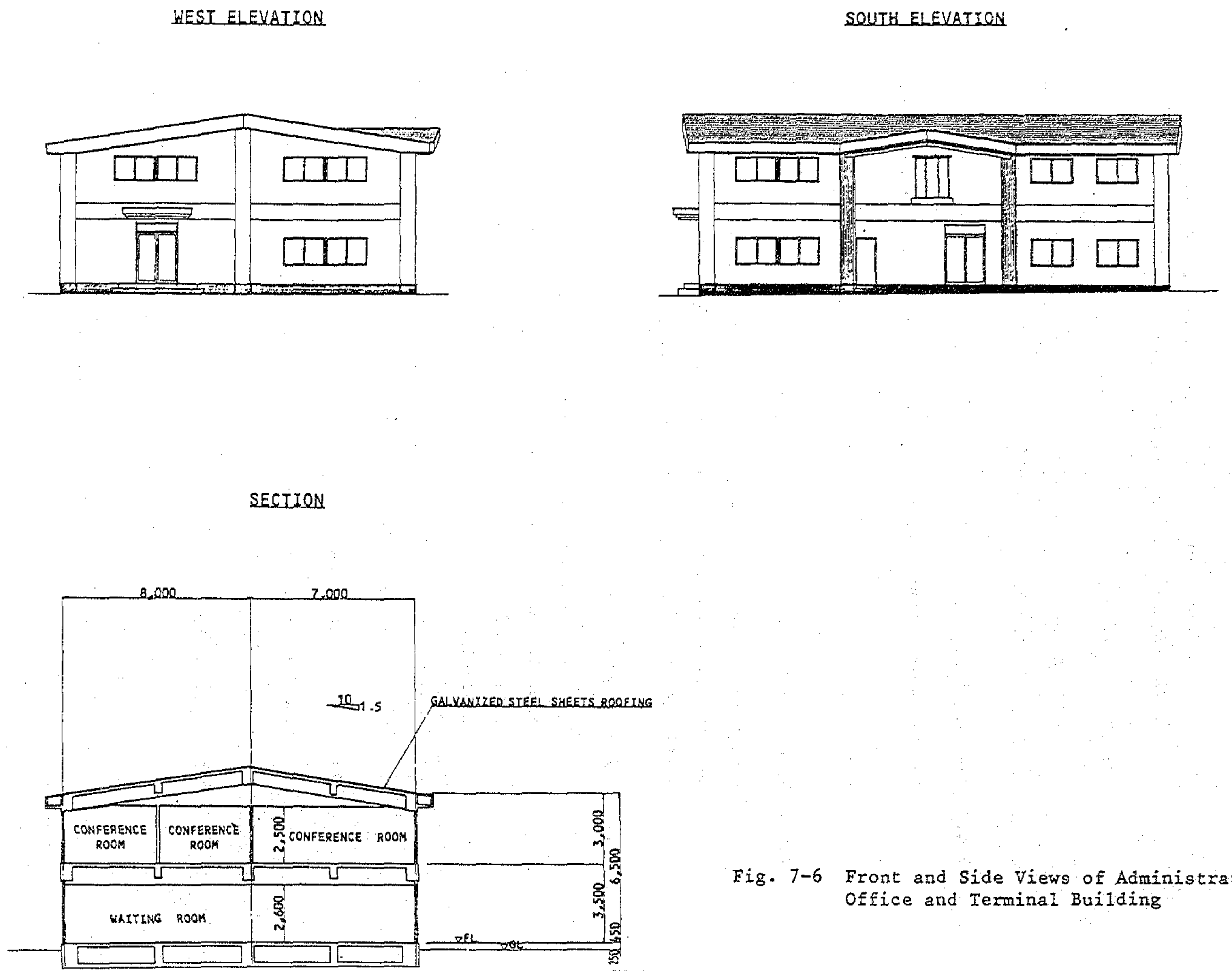


Fig. 7-6 Front and Side Views of Administration Office and Terminal Building

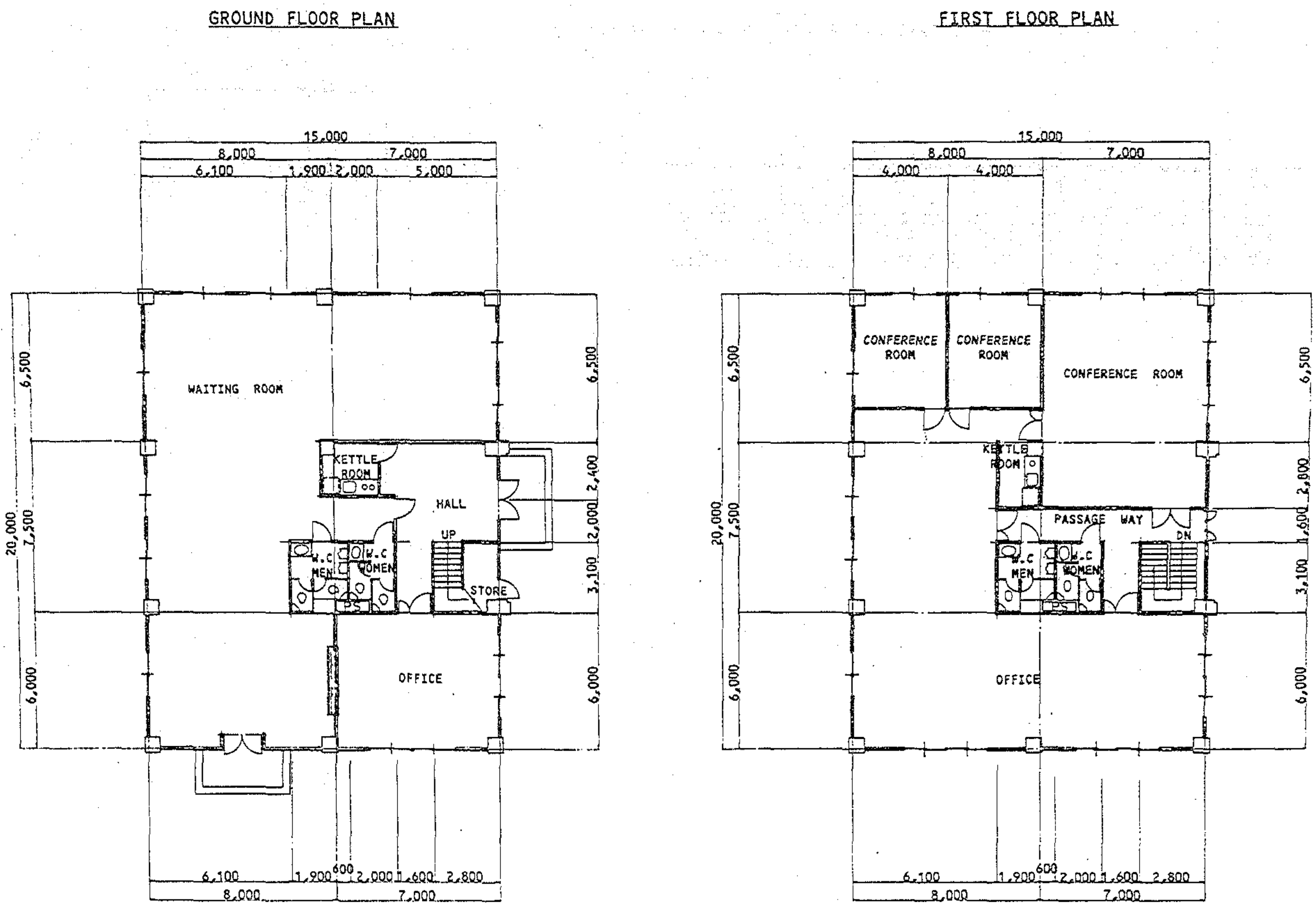


Fig. 7-7 Plan View of Administration Office and Terminal Building

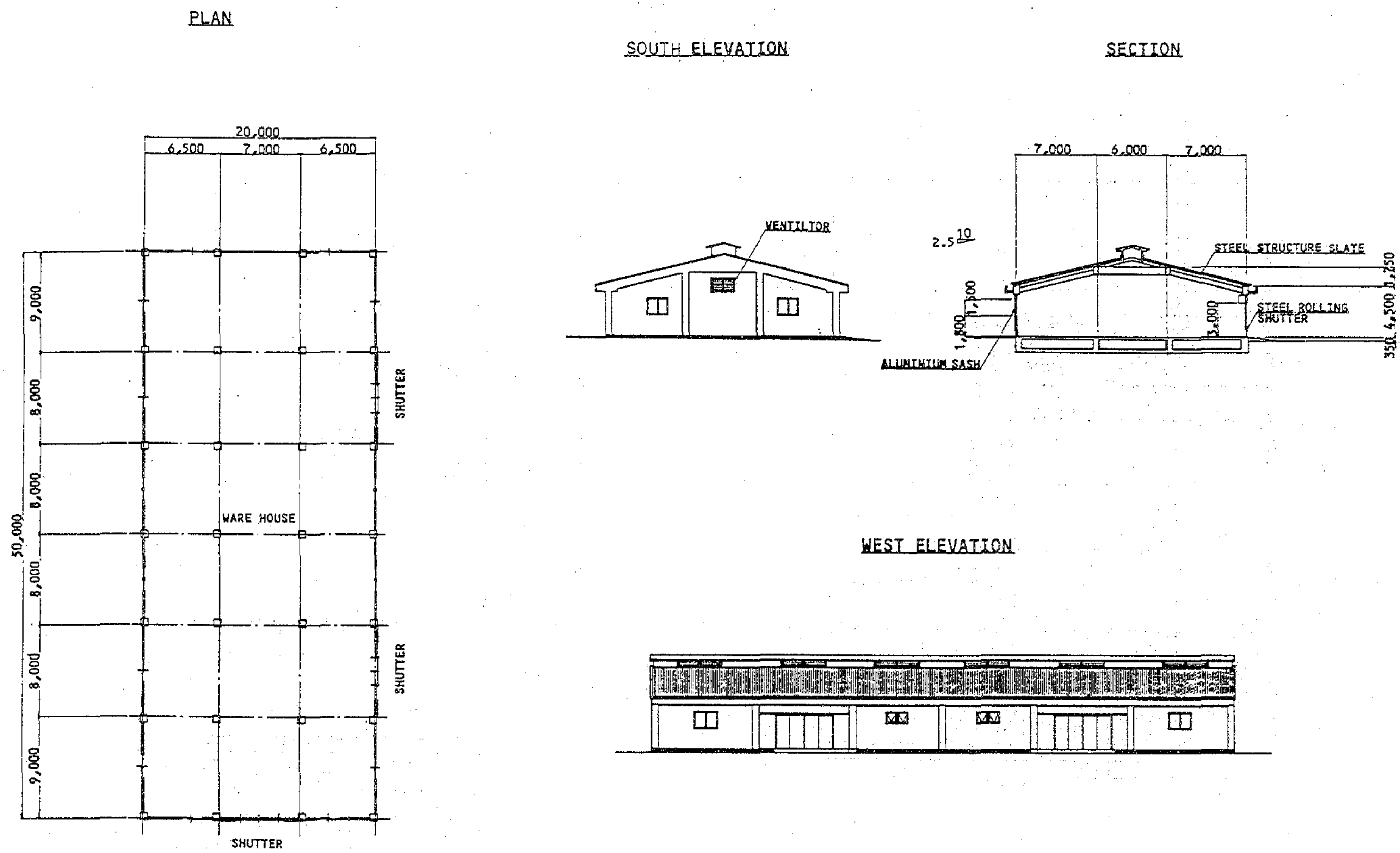


Fig. 7-8 Warehouse Front and Side Views

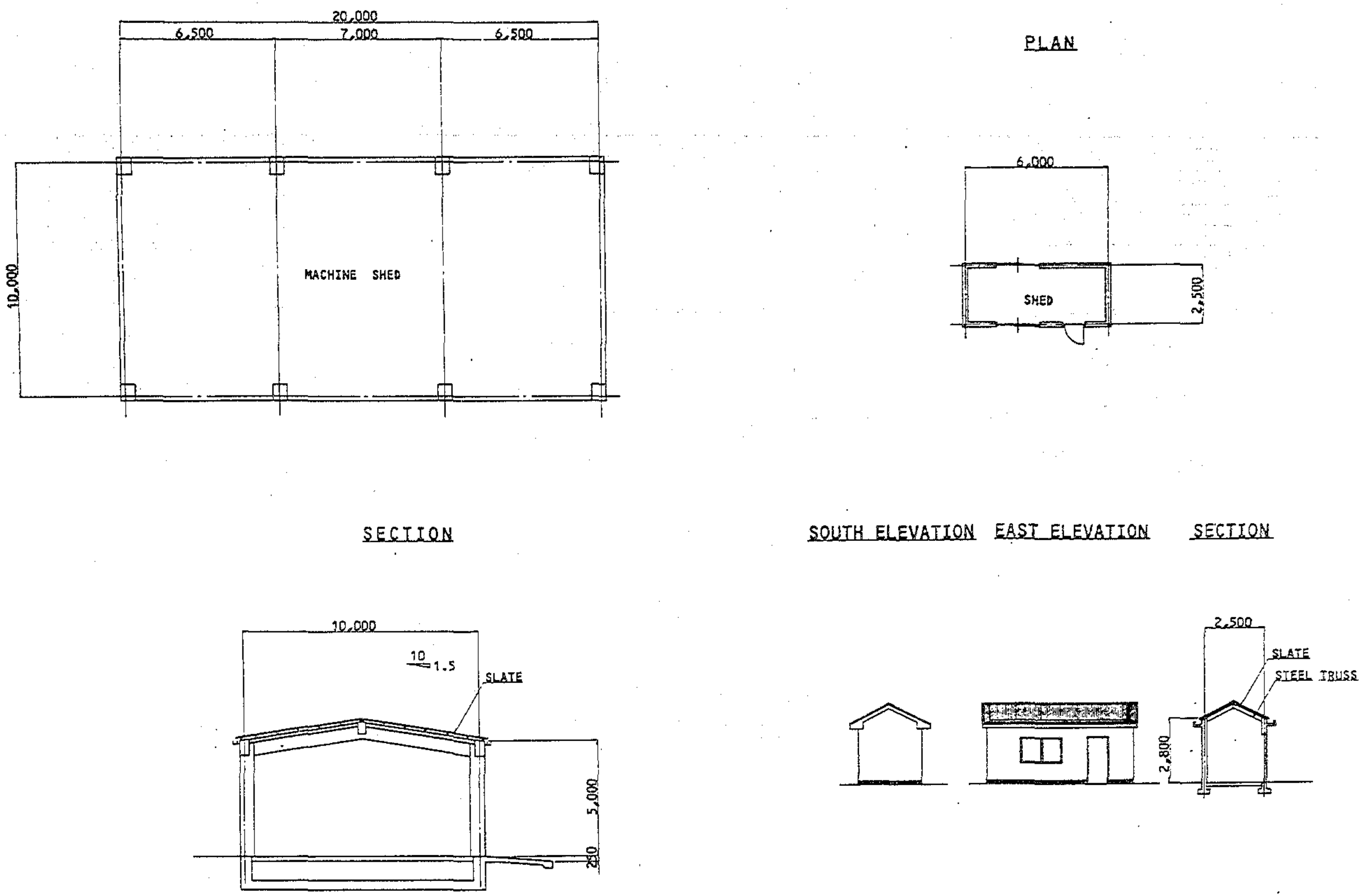


Fig. 7-9 Machine Shed and Equipment Control Shed, Plan, Front, and Side Views

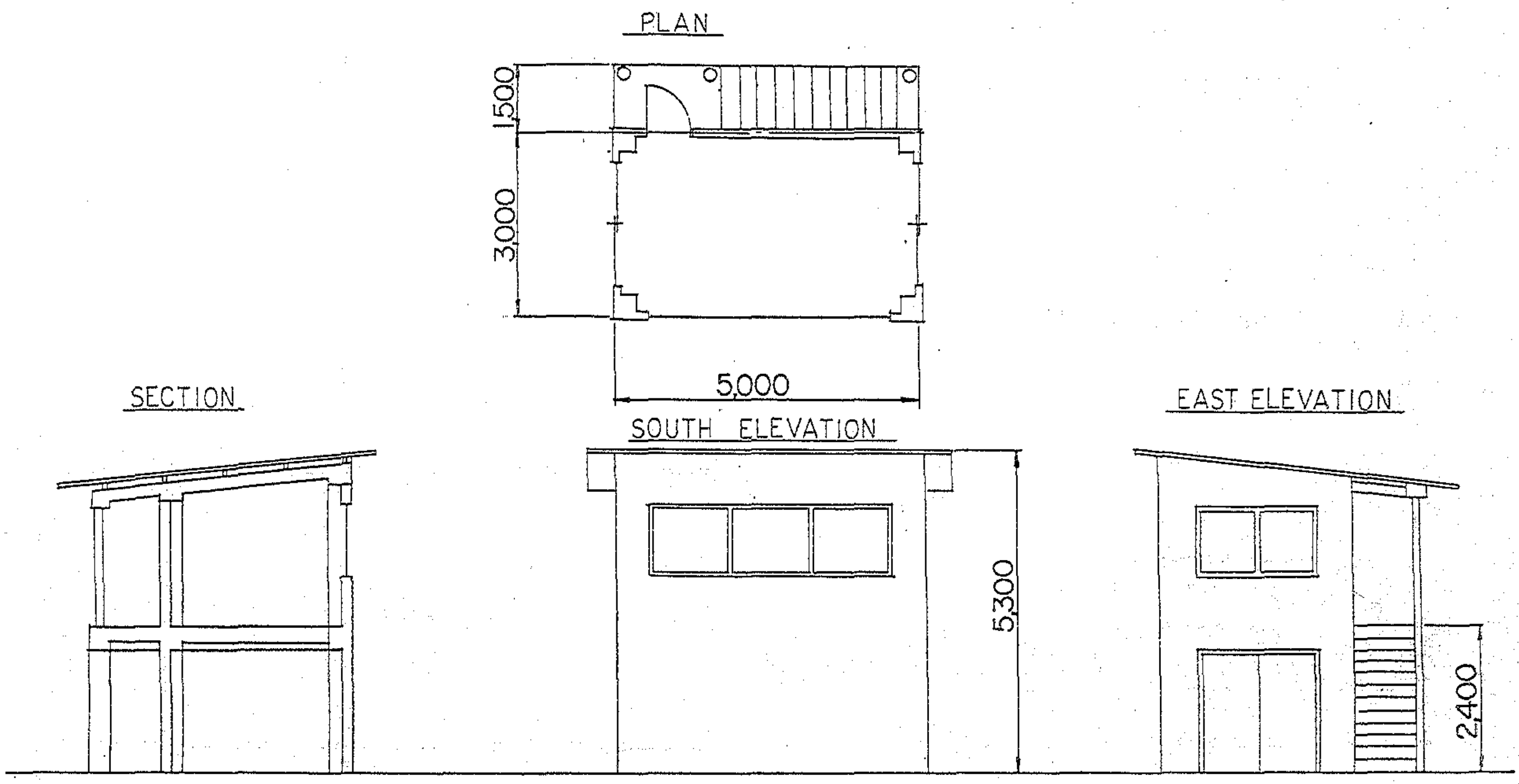


Fig. 7-10 Control Tower Front View and Plan

WATER, OIL, DRAINAGE & SANITARY DISTRIBUTION

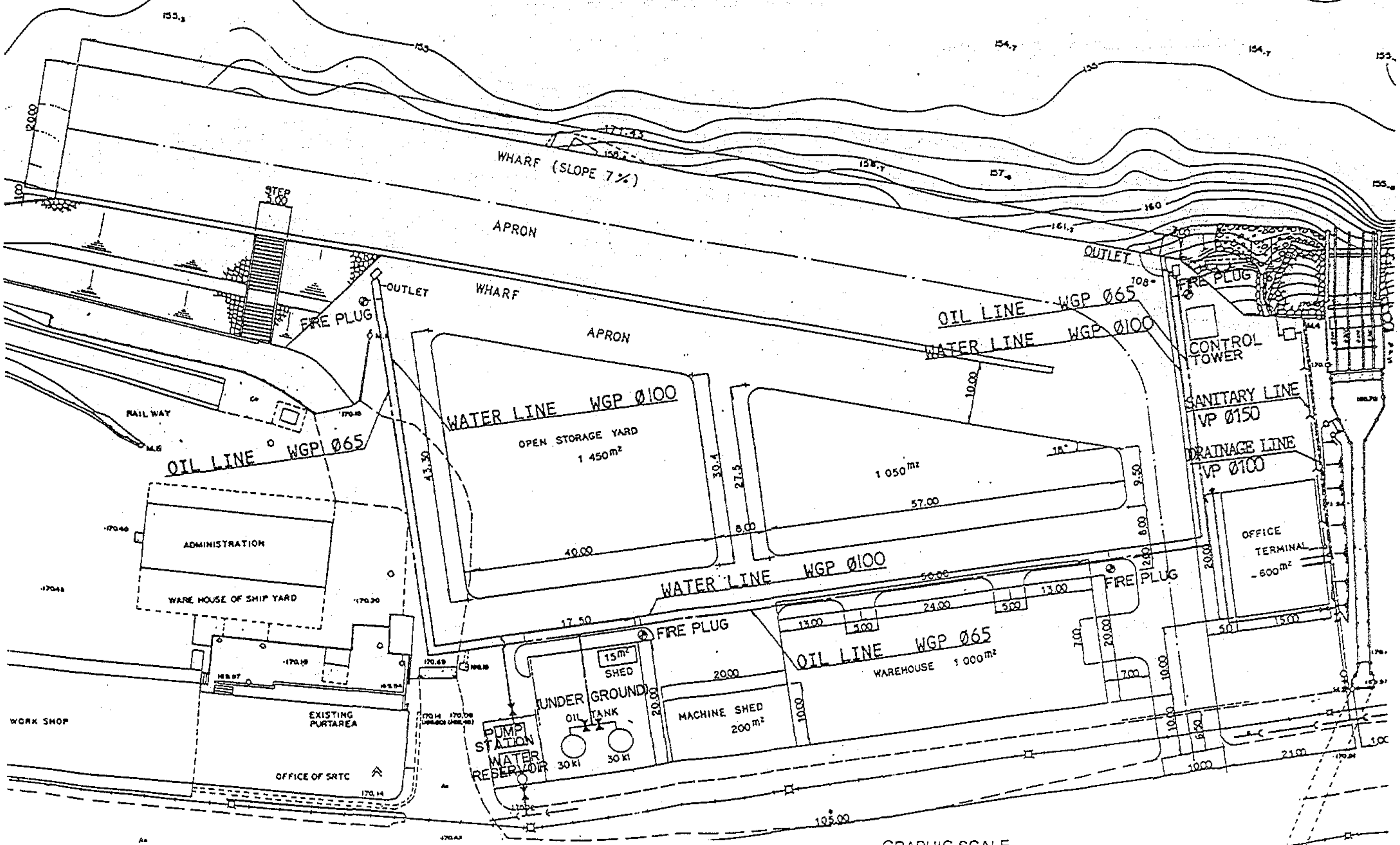


Fig. 7-1 Water and Fuel Supply Piping Arrangement

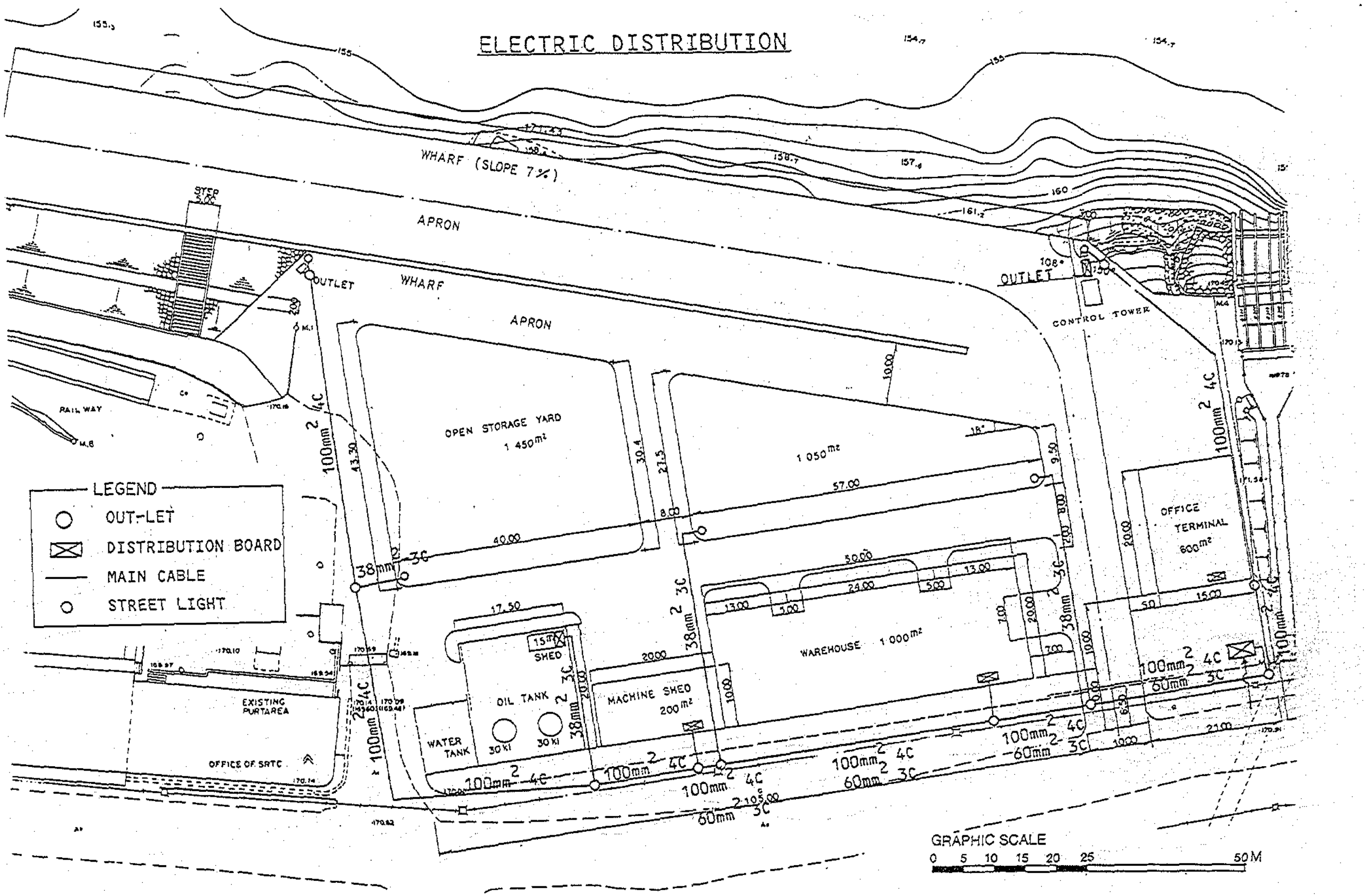


Fig. 7-12 Electrical Wiring Arrangement

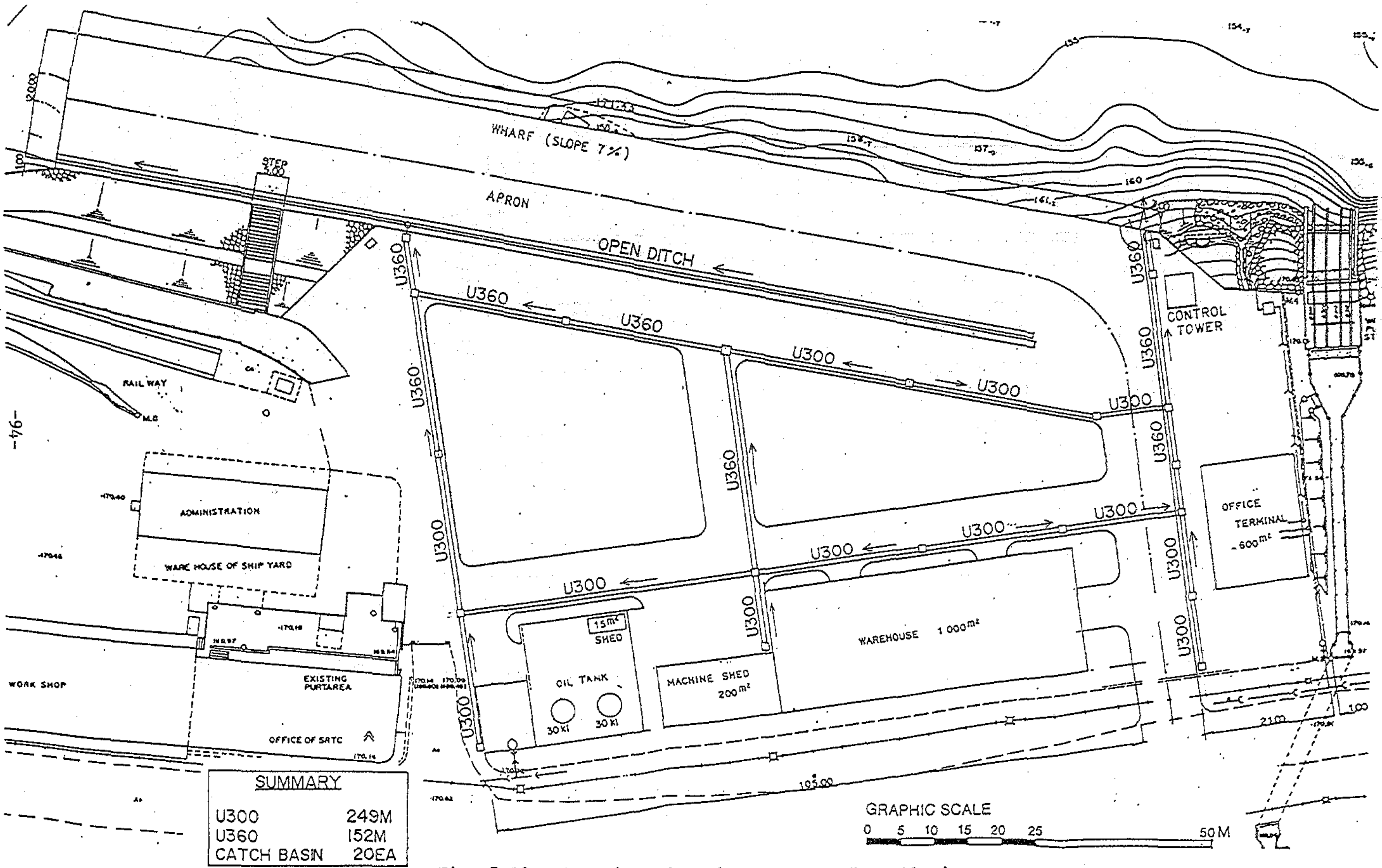


Fig. 7-13 Plan View of Drainage System Installation

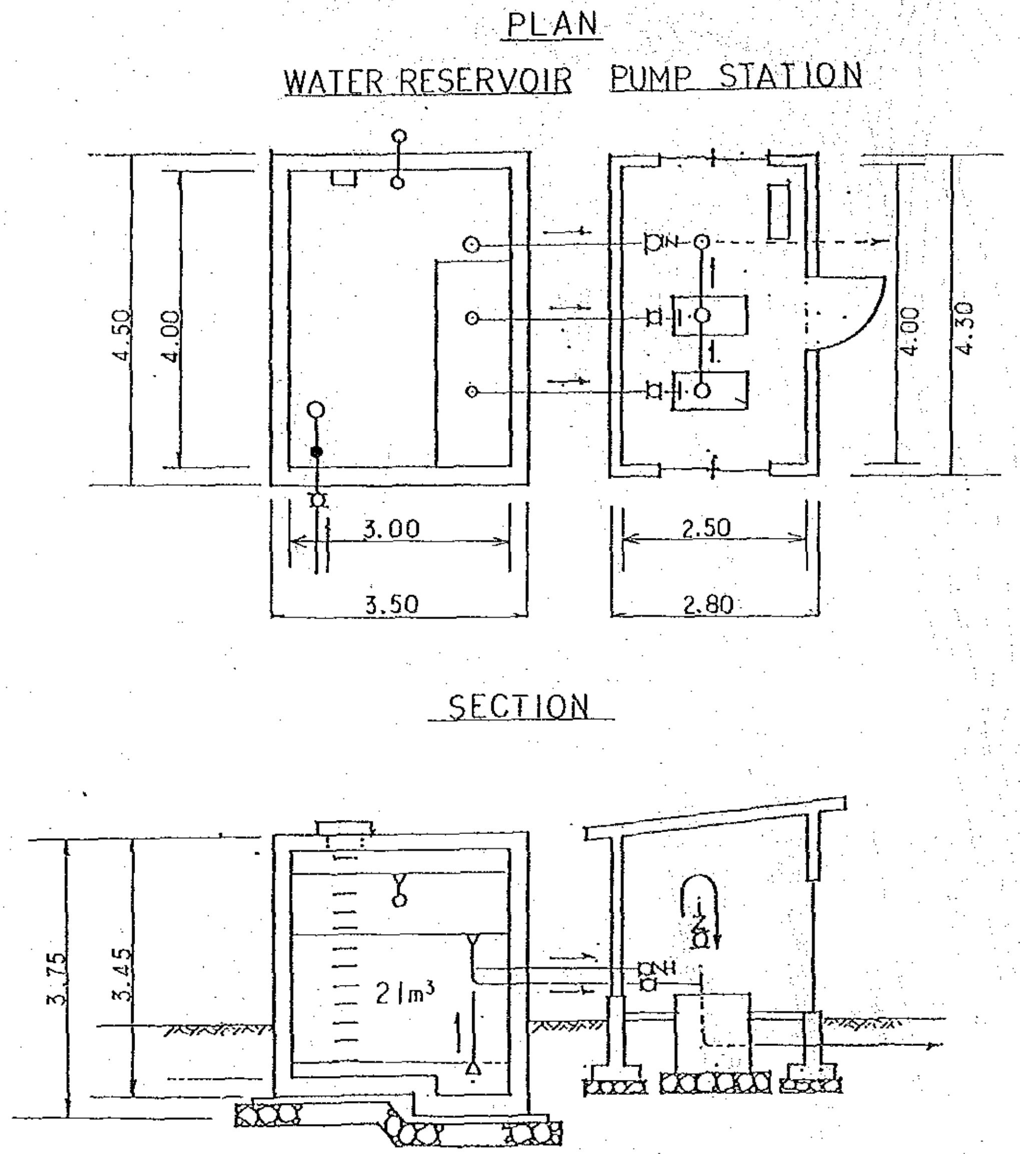


Fig. 7-14 Plan and Section of Fire Extinguishing Equipment Installation