6. SHORT-TERM PLAN FOR FISHERY COMPLEX

6.1. Planning Concept

A recent fishery circumstance as decrease of fish catch in the Thai waters makes it necessary to develop Thai fishery in the Andaman Sea and Indian Ocean with alternate fishing methods. Increasing a volume of fish catch from the alternate fishing is expected to promote fish processing industry with using raw material landed at the Phuket Fishing Port. The Fishery Complex Project (FC) will be prepared to support the above, and development of export-oriented fishery industry with the FC will contribute to extending economic effects for development of the southern Thailand. The FC will be formulated with the following concept as discussed in the Master Plan.

- Development of Fishing Port
  - Introduction of Stock Management
  - Development of Tuna Long Line Fishing
  - Promotion of Purse Seine Fishing
- Promotion of Fishery Processing Industry with Using Tuna as Raw Material
- Contribution to Tourism Industry

The above concept will bring formulation of the plan to provide:

1) Fishing port facilities meeting requirements from fish resources management,
2) Fishing port facilities for long liners and larger purse seiners, and
3) Estates for fish processing plants.

Orientation for provision of the necessary facilities for FC will be outlined as follows:

- Investment to fishing port facilities for the existing fishery will be minimized because of few benefits from provision of the facilities.
- Provision of the processing plant estate will be determined with considering the timing and period of constructing a deep-sea wharf. This will be caused by the conditions that landed tuna at the deep-sea wharf be supplied to processing plants in the estate, and that the land for the estate be prepared with supplying dredged material from the approach channel.
- A scale of the facilities should be determined to meet increasing demands from the processing plants, which will be prepared for several years.
- Provision of FC will provide a good occasion to improve management and operation of the fishing port. The Project for FC is expected to bring unification of management and operation in the fishing port, efficient services of berth usage, improvement of environment in the fishing port, enhancement of quality control and provision of a whole sale market.
- Considering the above for feasible implementation of the Project, the year 2007 is most appropriate for the target year for the short term plan.

- As discussed in the master plan, there remains few flexibility in the given area for preparing alternate layout plans in the project. The short-term plan to be in line with the master plan should be formulated under the said conditions. The alternatives for the short-term plan are not considered, since it is understood that no alternate layout plan is prepared for effective evaluation. The following examination is made for determining a scale of the fishing port facilities to meet the requirements in the year 2007.

6.2. Scale of Fishing Port Facilities

6.2.1 Projection of Fishing Boats

(1) Number of boats for the existing fishing

As discussed in "5.3.1 Projection of Fisheries in Phuket", fish resources are over-exploited with fishing by existing trawlers and purse seiners in Thai territory in the Andaman Sea. Requirement of introducing fish resource management is commonly understood for sustainable fishing in the Sea. Under the conditions as discussed in the Master Plan, the short-term plan is to be formulated, based on the number of fishing boats for the existing fishing as same as the present.

The daily number of fishing boats using the wharf for applying to a short-term plan is listed below as discussed in the master plan.

Number of boats using FMO	:	20
Number of boats using private jetties:		26
Total	:	46

(2) Number of tuna long liners

As discussed in "5.3.1 Projection of Fisheries in Phuket", number of tuna long liners is estimated at 175 in the year 2007 as a target year for the short-term plan.

(3) Number of larger purse seiners and carrier vessels

In the master plan stage, the facility for the captioned vessels is planned for three larger purse seiners and carrier vessels. Considering progress for raising fund by the Cooperative, a purse seiner will be employed for preparing a short-term plan.

6.2.2 Scale of Wharves

(1) Evaluation of an existing wharf for landing

1) FMO wharf for landing

Berth length for landing is calculated as:

$$\text{Berth length} = \Sigma(N/t) \cdot L$$

where:

L: Berth length = LOA + allowance

N: Daily number of fishing boats landing fish

r : Berth turnover = (Service time for landing) / (Landing time per boat)

As landing time is different between a purse seiner and a long liner, berth length for two types of boats is calculated. Ratio of purse seiners among the total fishing boats for landing is 80 % in 1995 and daily number of purse seiners using the fishing port is estimated at:

16 boats for purse seiners

4 boats for trawlers

Berth length for landing is calculated as :

Fishing method	Avg. LOA	Avg. Berth length	No. of boats	Sevice time	Landing time per boat	No. of berth
Purse seiner	19 m	22 m	16	8	2	4
Trawler	19 m	22 m	4	8	4	2

The table shows requirement of 6 berths and the length is 22 m x 6 = 132 m.

The calculation results in remaining of 49 m available from the existing berth length of 181 m . Berth congestion is obviously caused by mooring boats for lay-by and the existing berth length will be enough to accommodate the number of fishing boats at the master plan stage without its extension, if the FMO wharf is used solely for landing the volume estimated at same as the present one.

2) Private jetties

Number of fishing boats using the private jetties is estimated at 26, from the viewpoint of maintaining present landing volume at the master plan stage under stock management policy. Private companies have own landing facilities as jetties or seawalls of wooden or concrete. The new policy for the Fishing Port Complex aims at unifying fishing port management and a new landing wharf to accommodate fishing boats presently using the private facilities will be required for the policy. Length for the facilities is estimated with the same method mentioned above.

Fishing method	Avg. LOA	Avg. Berth length	No. of boats	Sevice time	Landing time per boat	No. of berth
Purse seiner	19 m	22 m	21	8	2	6
Trawler	19 m	22 m	5	8	4	3

The length for required 9 berths is 9 x 22 = 198 m.

7 berths of 154m will be newly provided as 2 berths length of 44 m will be allocated to the existing FMO wharf which reserves allowance for 2 berths.

3) Lay-by wharf

The FMO wharf is used for both purpose of landing and lay-by because of no lay-by wharf. The usage causes congestion of the FMO wharf and a new lay-by wharf will be provided for improving landing efficiency.

Considering allowance for accommodating trawlers, operated in Myamma waters, which irregularly call at Phuket Fishing Port, daily number of 57 fishing boats will call at Phuket as discussed in the master plan. With a condition of mooring 5 boats alongside at a berth, total length of the wharf is calculated as

(26 + 31) boats x 22 (m/boat) / 5 = 250.8 (m) and planned to be 250 m.

(2) Wharf for long liners

1) Landing wharf

In spite of present operation of long liners, unclear information is available on operational pattern of the boats for the fishing method and accurate statistics on landing time and volume from the fishing are not available. Considering the above information, berth length for these boats is calculated as

Berth length =

(Aggregate days for all boats for landing in a month)÷(Monthly service days per berth)

Calculation conditions are listed as below:

- Number of long liners: 175
- Number of trips: 19
- Months for operation: 11
- Available time for landing: 12 hours
- Landing time per boat: 3 hours
- Peak ratio to average No. of boats: 50 %

Aggregate days for all boats for landing per month are calculated as

175 x 19 x 1.5/11 x 3/12 = 113.4

The total days per month of 195 divided by monthly service days per berth of 22 is led to

113 ÷ 22 = 5.1

and the number of berth for long liners is 5. Number of calling the fishing port is calculated as

5 x 12/3 = 20

At a master plan stage Thai long liners are expected to be operated with Taiwanese and Chinese boats. The breakdown of 300 boats is:

Chinese	:	75 boats
Taiwnes	:	30 boats
Thai	:	70 boats

Total berth length is 37 x 2 + 19 x 1 + 22 x 3 = 137 m and design length of the berth is 137 m.

2) Lay-by wharf

Average in-port time of long liners is 2 or 3 days and 2 days for in-port time is applied to planning a lay-by wharf. Maximum number of fishing boats staying in the port is

20 (boats/day) x 2 (day) = 40 (boats)

Since same mooring system as Thai offshore boats is applied for long liners, number of lay-by berths is 40 ÷ 5 = 8.

Length of the total berths is calculated with consideration that necessary berth length will be governed by the longest boat size in mooring boats at random.

8 (berths) x 37 (m) = 296 (m)

(3) Wharves for Large Purse Seiners and Carrier Vessels

1) Landing wharves

A general operation pattern is described as 1 month for operation with steaming, 5 days for in-port activities like landing and 1 month for maintenance and repair. Same calculation method as long liners is applied with introduction of 1 purse seiners and total days for all vessels for landing per month is calculated at

1 x 6 x 1.5/11 x 5 = 4.1

where:

- Number of purse seiners: 1
- Number of trips: 6
- Months for operation: 11

- *Landing time per boat: 5 days*
- Peak ratio to average No. of boats: 50 %

Given 22 days for monthly service days of wharves, number of berths is calculated at

$$4 \div 22 = 0.2,$$

namely, one berth will be enough to accommodate the large purse seiners.

Number of berths for reefer carrier vessels is estimated as follows:

Given 31 vessels of carriers, 8 days in a port per trip and 365 service days, number of berth is estimated at one berth as

$$(31 \times 8) \div 365 = 0.68$$

Two berths will be provided for simultaneous mooring for a purse seiner and a carrier vessel. Design ships for the wharves are purse seiner Mahidol owned by DOF and a reefer carrier of 5000 GT class as discussed in the master plan. Required berth length for the vessels is planned to be 210 m with allowance for mooring space and rope length.

(4) Summary of wharf length

1) Landing wharves

Thai offshore fishing boats	:	155 m
Long liners	:	137 m
Deep-sea purse seiners	:	210 m

2) Lay-by wharves

Considering limited waters in the canal and investment efficiency, length of lay-by wharves to be provided will be reduced to 330 m as effective length from the calculated length as above. First priority for lay-by will be given to Thai fishing boats and the remaining wharf will accommodate 25 long liners. Other long liners will be moored in the 410-m-long area along the existing private jetties

6.2.3 Planning of channel and water basin

(1) Approach Channel

1) Design ship

The same ships, as stated in the above, as Mahidol and the reefer carrier vessel of 5000GRT are applied for design the channel and basin.

2) Layout of the approach channel

Width of the channel, as same as the scale of the master plan, is planned to be 100 m, equivalent with about 6 times of breadth of the design carrier vessel.

3) **Depth**

Depth of the channel will require 5.5 m below the chart datum, as discussed in the master paln.

(2) Turning basin

i) Depth

Design depth of the turning basin is 7 m below the chart datum as same as the channel depth.

ii) Area for turning

Considering safe manoeuvring of a 5000 GRT carrier vessel, 230 m, a circle diameter of 2 times of LOA, is recommended by the above standards as the necessary area for a turning basin

6.2.4 Scale of Functional Facilities

Feasibility study will be carried out for the functional facilities on Si Rae Island in the short-term development plan (2005 target year's plan). Outline of the functional facilities is shown as follows.

(1) Project Site

The site for functional facilities on short term development plan will use Si Rae Island side located existing FMO facilities. The area for the project site is approximate 65.4 hectares (408.8 rais) owned by FMO (Refer to Zone A and Zone C in Fig. 5.4.17).

The planned site contains a very large mangrove swamp in the back lot of the existing FMO landing wharf. This swamp will be filled with the sand produced by the dredging work in this project.

The elevation of the planned site on Si Rae Island was fixed at MWL + 1.75m based on the existing FMO landing wharf level, but the elevation of the mangrove swamp was fixed at MWL + 3.75m to accommodate drainage facilities from the project site to the canal.

(2) Infrastructure

1) City Water (and Sea Water)

City water will be supplied to the city water reservoir for FMO's facilities on Si Rae Island from an existing 8 inches main pipe running parallel to the neighboring paved main road, and it will be supplied to all of the FMO's facilities from this reservoir. Sea water system will applied to the FMO fish landing wharf and mooring wharf.

2) **Electricity**

High voltage electricity (33,000V/50Hz) from a main line running parallel to the neighboring main road will be used. High voltage electricity will be supplied only to the electrical sub-station for the FMO's facilities through the electrical incoming station on Si Rae Island site.

3) **Telephone**

The main telephone line running along the neighboring main road will be connected to each facilities on the project site using the electrical wiring post.

4) **Water Treatment Facilities**

One waste water treatment facility will be constructed only for the FMO related facilities on Si Rae Island. Waste water and drainage lines form related facilities will connected to this facility.

(3) **Marketing Hall**

The existing marketing hall will be enlarged 324m to the south, in order to meet the following conditions.

- **Projected fish landing volume**

The new marketing hall will handle the existing fish landings include Phuket Island side and long liners. The projected total fish landing volume in 2005 is given below.

- Existing local trawlers and purse seiners	62,000 ton/year
- Long Liner	21,300 ton/year

- **Operating hours**

Fish landing work will be carried out from 5 a.m. to 8 p.m.

- **Fish landing work**

Fish landing work of the existing will be carried out with fish boxes, but long liners will be carried out without fish boxes.

(4) Office and Others

1) **FMO Office**

- The FMO office will be located in the center of the project site, and in front of the marketing hall. It will accommodate 9 personnel in charge of fishing port operations and 3 personnel in charge of fish quality control and inspection.

- The Wharf Watchman Box will be located at 3 points within the project site. The first box will be located at the fish landing wharf for existing local trawlers and purse seiners and the second will be located at the wharf for long liners, and the third will be located at the mooring wharf. Each box will accommodate 2 personnel, 2 personnel and 1 personnel, respectively.

- An Auction Watchman Box which will accommodate six personnel is planned.

2) DOF Office

The FMO office will be located near the FMO office. DOF office will accommodate 10 personnel including a director, 2 personnel in charge of fisheries resource control and 4 personnel in charge of foods quality control. Main services of DOF is fisheries resource control and quality control of processed fish products for export.

3) Radio Communication System

The supplementary equipment supply to the DOF's radio station will be carried out, and FMO office will be equipped with a radio facilities to contact with DOF's radio station.

4) Custom and Immigration Office

Custom and immigration office for the immigration control for foreign crews and the custom service for frozen tuna in this fishery complex is planed in the FMO office.

5) Fish Agent Office

Existing offices will be leased by FMO to fish agents in future.

(5) Ice Plant and Ice Storage

An ice plant with a production capacity of 180MT/day and ice storage facility with a one day production capacity will be constructed and ice will be provided to long liners by an ice crusher tower on the wharf. The conditions for designing are shown in below;

- Existing ice supply volume to fishery sector in Phuket is estimated to be 555 MT/day. Ice supply and demand is currently balanced, but the there is a tendency for ice demand to be slightly higher than the supply.

- The fish catch volume of long liners is expected to increase to 17,290 tons/year from 1995 to 2012 and an annual shortage of 51,870 tons of ice (177.6 tons/day) is estimated (ice-fish ratio is 1:3/80% operating ratio of ice plants).

(6) Cold Storage

A cold storage facility with a capacity of 600 tons and a temperature setting of up to -25°C, will be installed to temporarily stock the frozen tunas landed by carrier vessels. The conditions for designing are shown in below;

- The volume of fish transported by carrier vessels for one operation is 1,500 tons which volume is equivalent to the purchasing volume of three (3) canning plants.

- The raw material consumption volume of one plant is 40 tons/day. Tuna canning plants customarily purchase only one day's worth of production volume.
- The carrier vessel is able to dock at the fish landing wharf for eight days.
- Therefore, surplus shown in below will need to be stocked in cold storage.

  1,500MT - (40 MT/day/plant x 3 plants x 8 days) = 540MT

(7) Electric Incoming Station

- One electric incoming station will be installed on Si Rae Island, and one electric power station will be prepared for the FMO related facilities and the deep sea port area.
- A generator which will provide the minimum electrical power needs of FMO related facilities on Si Rae Island will be installed as an emergency countermeasure.

(8) City Water Reservoir

- One city water reservoir will be constructed for the FMO related facilities on Si Rae Island.
- The main elements of the city water reservoir will be a underground water reservoir tank, a elevated water tank and a pump house.
- The capacity of the underground reservoir tank will be equivalent to the consumption volume of one half day, as a countermeasure against water cut-off. The capacity of the elevated water tank will be equivalent to the consumption volume of about 2 hours.
- Capacities of the city water reservoirs in each target year is shown as follows.

  – Underground reservoir 500 m^3
  – Elevated water tank 100 m^3

(9) Supply Facility for Sea Water

Sea water will be used to wash the market floor of the existing FMO fish landing wharf, in order to minimize the use of city water. Sea water will be treated by filters and chlorine disinfection system.

Capacity of the water pump: 500 liters/minute (30 ton/hours)

(10) Waste Water Treatment Facilities

- One waste water treatment facility will be constructed only for the FMO related facilities on Si Rae Island.

- Waste water will be treated according to the activated sludge method.
- Treated water will be discharged according to the national environmental standards set by the Thai government.
- The source and volume of waste water are given below.

unit : m^3/day

Market hall	Fish boats	Others	Total
390	295	60	745

(11) Workshop

One workshop building (floor area : approx. 156m^2) will be constructed in the fishery complex. It will be equipped with machines and tools required to the tentative repairing works for pumps and engines, and if someone has a heavy problem in their fishing equipment they will receive the assistance from private mechanics.

(12) Rubbish disposal area

The garbage from new fishery complex will be treated by public garbage collection system. One rubbish disposal area (approx. 50m^2) will be prepared for the large garbage.

(13) Fishing gear repairing area

Area of 600 m^2 for fishing gear repairing will be provided due to the below conditions;

- This area is the fishing gear repairing for local purse seiners
- Ten (10) percent of the daily coming purse seiners into the fishing port (12 boats) will be carried out the large repairs within three (3) days.

(14) Fishing gear storage

There are 20 agents, therefore, storage facilities in 20 different lots are required.

(15) Fish Box Storing Area

The size of fish box storing area will be considered with fish boxes of local boats landed on FMO side and Phuket island side. Therefore, fish box storing area sized 40 x 80 m will be allocated behind the mooring jetty.

(16) Service Building for Wharf Workers

Service building for fishermen and truck drivers will be allocated behind FMO fishing port and center of the project site. Service building is composed with canteen (324 seats), restaurant (44 seats), kiosk and other service facilities such as shower and rest room.

6.3. Development of Industrial Estate for Fish Processing Factories

6.3.1 Relocation of Fish Processing Factories and Need to Develop the Industrial Zone

(1) Present Status of the Industrial Zone

Industrial zones in Thailand have developed rapidly in the face of aggressive investments since 1987. Presently, there are 52 industrial zones, including those under construction.

Currently, the development and construction of industrial zones have moved from Zone 1 in the metropolitan area of Bangkok to Zones 2 and 3, due to the government policy promoting regional decentralization of industries.

Industrial zones are largely categorized according to the developer and their use. There are two types of industrial zone developers. One is the Industrial Estate Authority of Thailand (IEAT) under the Ministry of Industry and the other is private firms.

In addition, there are also two categories of industrial zone use. One is the General Industrial Zone (GIZ) and the other is the Export Processing Zone (EPZ). General industry firms are found in the GIZ and firms which export more than 80 percent of their products are in the EPZ.

Moreover, a well developed infrastructure is available to tenants in the industrial zone and they are eligible to receive tax privileges and benefits under the investment promotion law and the Industrial Estate Law.

(2) Relocation of Fish Processing Factories and Need to Develop Industrial Zones

The Seventh National Economic and Social Development Plan was prepared by the Government of Thailand with the major objectives of redistributing income and regional development. Based on these objectives, the Thai government initiated a policy to relocate processing factories from the surrounding area of Bangkok to other regions, in order to promote environmental conservation around Bangkok and to resolve the regional disparities between urban and rural areas. In addition, the government has provided tax privileges for relocated firms under the investment promotion law.

This Project includes relocating existing fish processing factories from the urban area of Bangkok (Zone 1) to Phuket (Zone 3) and supports the national policy of industrial decentralization. As there is no industrial estate in Phuket, developing one is essential in order to relocate the firms there. Therefore, developing such an estate should be implemented in the Project.

6.3.2 Scenario For Developing an Industrial Zone for Fish Processing Factories

(1) Type of Industrial Zone

One of the relocation incentives for fish processing factories moving from Zone 1 to Phuket is the development of an industrial zone. The industrial estate proposed in this Project should be categorized as an EPZ, since the factories are mainly involved in export activities. As a result, it is essential that IEAT participates in the development of an industrial estate.

(2) Industrial Estate Developer

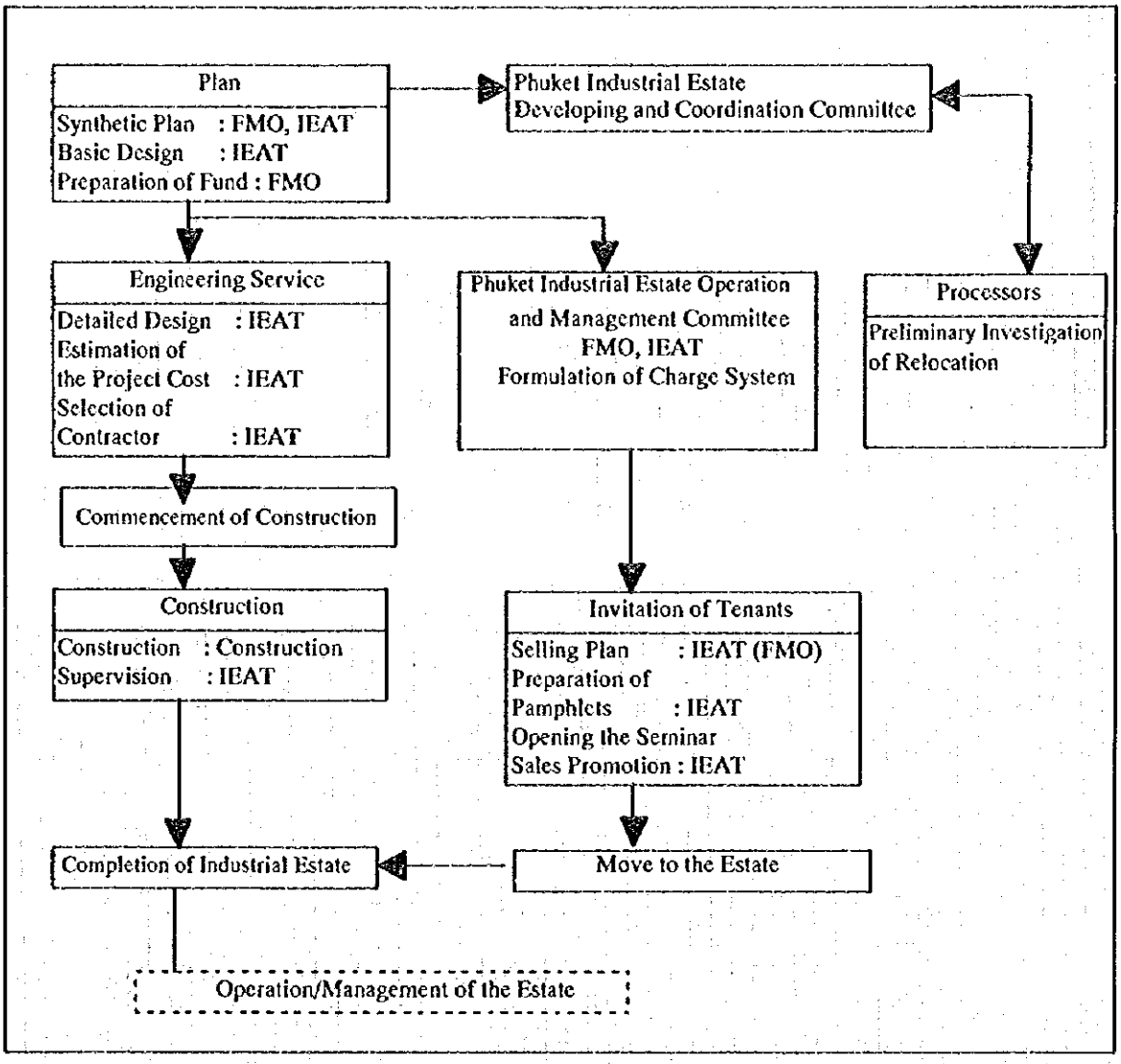
The industrial estate in the short-term project will be located behind the fishing port; and it will be a part of the fishery complex owned by FMO. Despite the fact that the implementing agency of this complex will be the FMO, it is recommended that the industrial estate is developed jointly by both FMO and IEAT, due to IEAT's technical expertise in this area. FMO which has no experience in developing an industrial estate needs the cooperation of IEAT to draw up and implement a development plan. The expertise involved in developing an industrial estate will differ according to the type of development and the system of management and operations that will be established. Specific details are described in section 7.2.

(3) Organizing a "Phuket Industrial Estate Developing and Coordination Committee" (PIEDCC)

The industrial estate which is proposed in this project differs from other industrial estates because the processing industry which is targeted is limited. Moreover, the incentives to attract the processing factories do not only include tax privileges, but also low interest financing for relocating, securing manpower, and a lower purchase price of raw material. Therefore, a Phuket Industrial Estate Developing and Coordination Committee should be organized, in order to ensure smooth implementation of the industrial estate and recruitment of factories. The members of the committee and their functions are outlined as follows.

Member	Function and Duty
Public	
1. DOF	Promote and adjust project formulation of the project for developing an industrial estate
2. FMO	Formulate and implement the project for developing an industrial estate
3. IEAT	Formulate and implement the project for developing an industrial estate
4. IFCT	Financing private investment capital for factories relocating to Phuket
5. Phuket Provincial Government	Indirectly support and cooperate with the project for developing an industrial estate
	Indirectly support and cooperate with the project for developing an industrial estate
6. Phuket City Government	Indirectly support and cooperate with the project for developing an industrial estate
7. Phuket Labor Office	Convey the objectives and contents of the project to develop an industrial estate to its members and feedback their opinions to the Committee
Private	Convey the objectives and content of the project to develop an industrial estate to
8. Thai Food Processor's Association (TFPA)	its members and feedback their opinions to the Committee
9. Thai Frozen Food Association (TFFA)	Convey the objectives and content of the project to develop an industrial estate to others in the same trade and to cooperate with the project
10. Representative of the importers of raw material	Indirectly support and cooperate with the project to develop an industrial estate
11. Phuket Chamber of Commerce	

(4) Joint Development of an Industrial Estate by FMO and IEAT



Based on the flow chart above, the Project to develop the industrial estate will be implemented according to the following procedure.

- Organize a "Phuket Industrial Estate Developing and Coordination Committee". A development plan will be prepared by FMO and IEAT based on the opinions, support, and cooperation of the relevant agencies and private firms.
- FMO and IEAT will prepare a concrete and comprehensive plan for the industrial estate, based on the development plan. IEAT will draw up the basic plan of the industrial estate and FMO will be responsible for securing the investment funds.
- IEAT will be responsible for providing engineering services such as detailed design, estimated project cost, selecting the constructor, etc. based on the basic design.

- In conjunction with the engineering services, FMO and IEAT will organize the "Phuket Industrial Estate Developing and Coordination Committee" and formulate a system of charges based on the cost of the project.

- Processors conduct preliminary investigations on the relocation of factories based on the information collected during the period of engineering services.

- Constructor begins the construction work under IEAT supervision, following the completion of engineering services.

- During the construction period, FMO and IEAT will be responsible for preparing the sales plan, pamphlets, holding sales promotion seminars, and inviting potential tenants.

- Processors begin their move to the estate after its completion.

6.3.3 Scale of Processing Factories

Feasibility study will be carried out for the processing factories on Si Rae Island in the short-term development plan (2005 target year's plan). An outline of the processing factories is shown as follows.

(1) Project Site

- The project site for the estate will use the area on Si Rae Island where existing FMO facilities are located. The area of the estate is approximately 29.4 hectares (183.5 rais) owned by FMO (Refer to Zone B-and Zone B-2 in Fig. III.5.4.2).

- Processing factories estate will be located behind the fisheries facilities. Site will be allocated six (6) blocks and average of each area will be 4.5 hectares (28 rais). Moreover, another one (1) block will be allocated for the construction of water reservoir , etc.

- The elevation of the planned site on Si Rae Island was fixed at MWL + 1.75m based on the existing FMO landing wharf level, but the elevation of the mangrove swamp was fixed at MWL + 3.75m to accommodate drainage facilities from the project site to the canal.

(2) Infrastructure

1) City Water

- City water will be supplied to the city water reservoir only for the estate on Si Rae Island from an existing 8 inches main pipe running parallel to the neighboring paved main road. This reservoir water will be supplied to processing factories from through the main pipe running parallel to the neighboring main estate road.

- The main elements of the city water reservoir will be a underground water reservoir tank, a elevated water tank and a pump house.

- The capacity of the underground reservoir tank will be equivalent to the consumption volume of one half day, as a countermeasure against water cut-off. The capacity of the elevated water tank will be equivalent to the consumption volume of about 2 hours.

- Capacities of the city water reservoirs in each target year is shown as follows.

Underground reservoir tank	1,250 m^3
Elevated water tank	200 m^3

2) Electricity

- One electric incoming facility for estate will be installed at the sub power station on Si Rae Island. High voltage electricity (33,000V/50Hz) from a main line parallel to the neighboring main road will be used. Each factory will be provided with its own transformer. High voltage electricity from the substation will be supplied to each factory through the parallel to the neighboring main estate road.

- Total capacity of electric power station is 6,000 KVA.

- A generator which will provide the minimum electrical power needs for each factory will be installed as an emergency countermeasure.

3) Telephone

The main telephone line running along the neighboring main road will be connected to each facilities on the project site using the electrical wiring post.

4) Water Treatment Facilities

- One waste water treatment facility will be constructed for the fish processing factories estate on Si Rae Island (capacity : 2,700 m3/day).

- Waste water will be treated according to the activated sludge method.

- Treated water will be discharged according to the national environmental standards set by the Thai government.

- Each fish processing factory will be equipped with a small septic tank unit, oil-traps, and catch basin with screens, in order to carry out preliminary treatment of waste water.

(3) Processing Factory Facilities

The components of one fish processing factory are as follows.

1) Area of the site:

4.5ha (28 Rai)

2) Production Factory (one storied building) One Building

Production capacity: 40 tons/day of raw material

Production line: 3 lines

Operating hours/days: 8 hours/300 days

Major machines: Cookers, conveyors, autopackers, measuring equipment, pouring equipment for seasoning and cooking oil, vacuum seamers, can washing machines, retorts, labeling machines and boilers

Total Floor area: 5,750m^2

3) **Cold Storage (one building)**

Scale: Rated capacity 1,000 tons (actual capacity 600 tons)

Room Temperature: -25°C

Number of rooms: 250 ton capacity x 4 rooms

Handling method: Forklift

Floor area: 1,400m^2

4) **Service Building (two one storied buildings)**

Locker room for workers: 260 persons x 2 rooms

Shower room: 36 persons x 2 rooms

Toilet and washing area: 2 rooms each

Canteen and kitchen: 280 seats

Total floor area: 1,300m^2

5) **Dormitory (two buildings each two storied)**

The dormitories will accommodate 75 percent of the total number of employees (500) or 368 people.

Number of workers accommodated: 184 personnel

Number of persons per room: 4 persons

Number of rooms: 46 rooms

Total floor area: 2,750m^2

6.3.4 Financial Analysis of Canned Skipjack/Tuna Factory Relocated from Zone 1 to Phuket

All the existing tuna canning factories have different production capacities, location, and financial conditions (fixed assets, liabilities, depreciation, etc.). With understanding, this analysis aims at determining whether the investment for relocation of a factory from Bangkok to Phuket is profitable or not. Profitability difference is compared between "with-case" of relocating a factory and "without - case" of no relocation with setting a averagely-sized .factory as the case for analysis. The result is shown in Appendix 6.3.4. As a result, relocation of the demonstration factory with the project will produce more profits than a factory without relocation.

6.4. Design of Fishing Port Facilities

6.4.1 Setting up design conditions

(1) Wave conditions

1) Calculation method

Wave deformation is calculated around the project site for obtaining design waves for coastal structures, and for obtaining input wave data for calculation of sedimentation in the channel.

Calculation of wave deformation is carried out, applying an energy balance equation with consideration of angular spreading of irregular waves. The equation is expressed below:

$$\frac{\partial}{\partial x}\left(C_g \cos\theta \cdot D\right)+\frac{\partial}{\partial y}(C_g \sin\theta \cdot D)+\frac{\partial}{\partial \theta}\left(\frac{Cg}{C}(\frac{\partial C}{\partial x}\sin\theta-\frac{\partial C}{\partial y}\cos\theta)D\right)=0\cdot$$

where, x and y denote coordinates, θ is wave direction, D is directional spectrum, Cg is wave group velocity, and C is wave celerity.

Distribution of wave heights around the project site is calculated with numerically solving the equation with finite difference method, namely, the wave distribution is obtained through calculation of wave deformation at calculation grid points in the area from wave characteristics with spectrum given outside of the calculation area.

As wave spectrum at the calculation boundary, the frequency spectrum named the Bretschneider and Mitsuyasu type and the wave directional distribution function named the Mitsuyasu type are given as shown below:

$$S(f)=0.257 H_{1/3}{}^2/T_{1/3}{}^4 f^{-5}\exp\left(-1.03/T_{1/3}{}^4 f^{-4}\right)$$

$$G(\theta;f)=G_0\cos^{2s}(\theta/2)\quad,\quad G_0=\left[\int_{\theta_{min}}^{\theta_{max}} G(\theta;f)d\theta\right]^{-1}$$

where, s_{max} denotes a wave spreading parameter.

The above spectrum is given as boundary conditions and wave heights are calculated from offshore grids to shoreline grids.

Side boundary conditions are given as follows:

- Sea boundary: Same spectrum be given in and out of the boundary.
- Land boundary: Wave energy be absorbed at the boundary.

2) Calculation conditions

i) Calculation area

The calculation area is 10 km x 10 km as shown in Figure 6.4.1.

ii) Offshore wave conditions

a. Design wave

Direction of a 30-year return period wave categorized in an SW wave group is estimated to be western from the wave statistics but the western waves are sheltered by Phuket Island. Among waves in the SW group, the most probable wave highest wave, namely, design wave height, is understood to be 2.75 m of a SSW wave from the table showing wave occurrence with directions as shown in "5.2 Natural Conditions". Wave period of the design wave is estimated at 6.9 seconds from the statistical analysis on correlation between wave heights and periods.

Regarding waves in an NE wave group, calculated wave height of 0.9 m, shown in "5.2 Natural Conditions", is applied as a 30-year return period wave. A wave period corresponding to the wave height is estimated at 4.0 seconds with calculation based on the Wilson method.

The above calculation is at High Water Level as a tide condition.

b. Representative waves for calculating sedimentation in the channel

The waves which represent the wave field in the project site are selected from the wave occurrence table. Wave conditions for the calculation are shown in the following table giving the several wave heights representing each prevailing direction.

Direction	E	SSE	SSW
Wave height	0.75m	1.25m	2.75m
	0.25m	0.75m	
		0.25m	

A tide for the calculation is Mean Water Level.

3) Calculation results

Wave distribution around the project site is shown in Figures from 6.4.2 to 6.4.5 which are employed for determining design wave heights for shore facilities.

Figures from 6.4.6 to 6.4.10 show wave distribution for calculating sedimentation.

(2) Soil conditions

Soil investigation was carried out in the proposed project site for two major objectives. The first is to obtain soil characteristics for designing shore facilities in and out of the canal. Another objective is to acquire soil information for dredging, land filling and the related environmental impact assessment. The bore hole locations are shown in Figures 6.4.11 and 6.4.12. The bore holes for the former objective are BH1, BH2, BH3, BH4 and BH7, and the remaining bore holes are for the latter objective.

The results of soil investigation are summarized as follows:

1) FMO area

From the ground surface to about -7 m below CD, the layers are composed of very loose sand or silt with no N value. Under the layers, there exist stiff silt layers with N value of more than 10. No bed rock is found but dense silt layers will be ideal foundation for steel sheet piles of the wharves.

2) Deep-sea wharf area

The soil information for the area is given by BH3 and BH4. The seabed elevation at the bore locations are shallow as -0.2 m and 0.4m and the soil properties are of mainly soft silt and clay layers from the surface of the seabed to -8.7m. Below the layer, stiff silt with sand layer exists with N value of more than 60. High weathered limestone layer with N value of more than 100 is found beneath the above layer.

3) Channel area

BH5, BH6 and BH8 are located in the vicinity of the planned channel. BH5 and BH6 give the same soil characteristics of the shallower layers as mentioned above. The layers are of silt/clayey sand and percentage of grain sizes less than silt ranges from 6 to 48 and from 36 to 44 for BH5 and BH6, respectively. The percentage is between 35 and 43 for BH8. The results indicate that sand contents are approximately in the range from 50 to 60 %.

(3) Design conditions

1) Mooring facilities

i) Design vessel

* Thai trawler & purse seiner: 60 GT
* Long liner: 170 GT
* Large purse seiner: 499 GT
  Reefer carrier : 5,000 GT

ii) Design depth

a. Landing wharf

* Thai trawler & purse seiner : 3 m
* Long liner : 3.5 m
* Large purse seiner
  Reefer carrier : 7.5 m

b. Lay-by wharf

* Long liner, purse seiner and trawler : 2.5 m

No berth is planned for larger ships

iii) Surcharge

* Landing wharf : uniformity load w = 1.0 ton / m^2
* Lay-by wharf : uniformity lord w = 0.5 ton / m^2
* Large purse seiner & carrirer vesel : uniformity lord w = 1.0 ton / m^2

live loads wheel loads (T - 20)

iv) Seismic force

* Horizontal seismic force coefficient : Kh = 0.05

v) Tide

Highest High Water (HHW)	1.72 m
Mean High Water Spring (MHWS)	0.91 m
Mean High Water Neap (MHWN)	0.14 m
Mean Sea Level (MSL)	0.00 m
Mean Low Water Neap (MLWN)	-0.70 m
Mean Low Water Spring (MLWS)	-1.53 m
Lowest Low Water (LLW)	-2.29 m

vi) Approach velocity of a vessel

* Thai trawler & purse seiner : 0.35 m/sec
* Long liner : 0.3 m/sec
* Carrier vessel : 0.2 m/sec

vii) Soil characteristics

Wharf for smaller boats : silt, N value 0 - 2

Deep-sea wharf : up to -5 m from seabed silt, N value 0 - 2

: deeper than - 8 m sand, N value 10

6.4.2 Design of landing wharves

(1) Wharf for existing fishing boats

The steel sheet pile structure will be applied for landing wharves for the captioned boats as discussed in the master plan. In the plan, 3.5 m in depth is the design depth of the facilities to accommodate the boats. Harbour Department is planning to deepen the existing channel depth to be - 4 m and the new mooring facilities is planned to be 4 m deep for providing tentative services for boats requiring the depth. It is understood that dredging to -4m deep will bring instability of the existing wharf.

Lay-by wharves are designed to be -3.5 m in depth and initial services will be rendered as lay-by wharves to be -2.5 m. In the case that additional landing wharves for long liners will be needed for meeting future demands, the wharves of -3.5 m will be provided with dredging the basin depth of -2.5 m.

The two different quay walls of steel sheet piles are shown in Figures 6.4.13 and 6.4.14.

(2) Design of deep-sea wharf

The structure of the deep-sea wharf will be an open-type wharf with steel pipe piles, for minimization of impacts to sea and seashore environment from currents and littoral drift.

An access road will be of a trestle type founded with pipes of the same material so as not to change topography of the shore with provision of the structure. The structure is illustrated in Figures from 6.4.15 to6.4.17.

6.4.3 Design of channel and basin

(1) Estimate of siltation rate

Seabed material along the channel and basin is of silt and the existing channel is dredged with both slopes of 1:10, depth of -3 m, and width of 60 m. The capital dredging to deepen the existing channel to be -4 m with the same gradient is planned by Harbour Department. The proposed channel will be provided with the same gradient 1:10.

(2) Estimate of sedimentation in the channel

Sedimentation volume in the channel is estimated with calculation of volume of suspended sediment to be settled in the channel, which is generated by waves and tidal currents. The external force of waves is calculated and discussed in "5.2 Natural Conditions". With calculating tidal currents, process of sedimentation in the channel is estimated under the conditions of two kinds of external force to generate sedimentation .

1) Tidal currents

i) Calculation method

Currents in the spring tide are calculated around the project site with applying the numerical model of three-dimensional single layer, which is expressed with governing equations as below:

Equation of continuity:

$$\frac{\partial \eta}{\partial t} + \frac{\partial M}{\partial x} + \frac{\partial N}{\partial y} = 0$$

Equation of motion:

$$\frac{\partial M}{\partial t}+\frac{\partial uM}{\partial x}+\frac{\partial vM}{\partial y}+g(h+\eta)\frac{\partial \eta}{\partial x}+\frac{gn^2\sqrt{M^2+N^2}}{(h+\eta)^{7/3}}M-A_H\left(\frac{\partial^2 M}{\partial x^2}+\frac{\partial^2 M}{\partial y^2}\right)=0$$

$$\frac{\partial N}{\partial t}+\frac{\partial uN}{\partial x}+\frac{\partial vN}{\partial y}+g(h+\eta)\frac{\partial \eta}{\partial y}+\frac{gn^2\sqrt{M^2+N^2}}{(h+\eta)^{7/3}}N-A_H\left(\frac{\partial^2 N}{\partial x^2}+\frac{\partial^2 N}{\partial y^2}\right)=0$$

where,

t, x, y : time and coordinates,

η, M, N, u, v : water level from still water, steamline flow volume, average flow velocity

h : depth from stillwater

A_H :Coefficient of horozontal mixing

n :Manning's coefficient of roughness

g :gravitational accelation

With solving the above equations under conditions which are given by tide fluctuation at open boundaries for calculation, water level and current velocity distribution in the field are calculated hourly. Coastlines are boundaries moving with corresponding to tide levels. Semi-implicit difference method is applied to the calculation.

ii) Calculation conditions

Calculation area and grid system are used as same as those in calculating tidal currents.

Semi-diurnal tide with amplitude of (M_2+S_2) = 1.2 m is given on the open boundaries. Manning's coefficient of roughness and horizontal mixing are 0.02(MKSunit) and 10 m^2/sec, respectively.

iii) Calculation results

Figures 6.4.18 and 6.4.19 show current distribution of maximum velocity at flood and ebb tides in the calculation field. Figures 6.4.20 and 6.4.21 show current distribution patterns at high water level and low water level. The figures indicate the current pattern as observes is simulated in spite of slight difference in maximum current velocity and current directions.

2) Estimate of sedimentation

i) Calculation method

The Bijker's numerical model(1980) is employed for calculation of siltation rates which are generated by waves and tidal currents .

As indicated in Figure 6.4.22, suffixes O and 1 define all components at upstream and downstream of the channel. The numerical model of Bijker expresses horizontally moved volume of suspended sediment $S(x)$ and sedimentation volume in the unit width of the channel ΔS as follows:

$$S(x) = (S_0 - S_1)\exp(-\beta x) + S_1$$

$$\Delta S = \left[(S_0 - S_1)\left\{1 - \exp(-\beta B / \sin\alpha)\right\}\right]\sin\alpha$$

where,

S_0, S_1: horizontally moved volume of suspended sediment at upstream of the channel and horizontally moved volume of suspended sediment at kinematic equilibrium in the channel

α : angle between current direction and the channel

B : channel width

β: attenuation ratio which is expressed as following equation in Bijker's numerical

model.

$$\beta = w_s C_{b0}(1 - h_{*0}/h_{*1})/(S_0 - S_1) \quad , h_{*i} = w_s h_i / \varepsilon_i \quad , i = 0,1$$

where, w_s is fallvelocity of soil particles, C_b is concentration of suspended solid near seabed , h is depth and ε is average vertical dispersion coefficient.

Bijker calculated values of $S_0, S_1, C_b, \varepsilon$ with following assumptions:

① Dispersion coefficient is constant vertically.

②Concentration of suspended solid is distributed as a logarithmic curve.

③Bottom concentration of sedimentation is calculated, based on moved volume of bed load generated by waves and currents, elevation of moving sediment and moving velocity.

④Horizontal movement volume of suspended load (S) approximates to volume with multiplying average profile concentration of sediment by flow quantity.

Based on the above assumptions, the following equations are applied.

Distribution of vertical concentration: $C(z) = C_b \exp(-w_s z / \varepsilon)$

Average profile concentration: $\overline{C} = (C_b \varepsilon / w_s h)\left\{1 - \exp(-w_s h / \varepsilon)\right\}$

Total suspended load: $S = \overline{u} \cdot \overline{C} \cdot h$

Avearge vertival profile dispersion coefficient: $\epsilon = 0.16\overline{u}h\sqrt{g} / C_h$

Concentration of bed load $C_b = Q_b / \left(6.23 r \sqrt{\tau_{cw} / \rho}\right)$

where, $\bar{u}$ is average velocity, C_h is Chezy's coefficient, Q_b is bed load rate calculated from Bijker's formula, τ_{cw} is bottom shear force, r is roughness height.

In applying the Biker's model, a channel is divided into segments of 100m in length along the channel and siltation rates are calculated in each segment with calculating waves and currents based on the above conditions for a unit time. Annual sedimentation rates are estimated with accumulating the calculated rates in all segments, considering occurrence of waves. In calculating, conditions of currents in each segment are changed every hour and are acting for 12 hours.

ii) Calculation conditions

a. Alignment

Three options for channel alignment are examined to determine the most appropriate through the calculation of the above. Dredging records in the existing channel shows the annual volume is between 30,000 m³ and 190,000 m³.

Case	Depth of channel	Depth	Length
Existing	- 3 m	60 m	2 km
Option 1	- 7 m	100 m	4.2 km
Option 2	- 7 m	100 m	4.1 km

Depth of the proposed turning basin is - 7 m below the chart datum.

b. External force and seabed material

The calculation for sedimentation is made with employing wave and hourly current distribution obtained as above.

As the first step of the calculation, a sedimentation rate at each segment for a tide cycle is calculated with giving every hourly current pattern for each representing wave. Considering annual occurrence percentage of each representing wave, annual sedimentation rate is obtained for each wave. Annual sedimentation rate along the channel is estimated wit summing up the annual rates for six representing waves.

iii) Calculation result

By calculation of these external forces to generate siltation, annual rates of siltation per metre along the channel is estimated with applying the Bijker's model and the result is shown in Figure 6.4.23. Total rates of siltation in the cases are tabulated below:

Case	Annual siltation rate	Remarks
The existing	110,000 m^3	Dredging records: 30,000 -190,000 m^3
Option 1	400,000	
Option 2	490,000	

The figure shows that rate around 2 km off from the origin in Option 1 is larger than the rate in Option 2 because there exist faster currents crossing the channel in Option 1. It also idicates that the rate around 2.5 km off in Option 1 decreases due to little difference in elevation between the existing seabed and the channel bottom. It is pointed out that the rate in Option 2 increases in the part between 3 km and 4 km from the origin since relatively faster currents exist in the shallow water area.

3) Selection of layout of channel and estimate of annual dredging volume

Maintaining the channel will require annual dredging from 400,000 m^3 to 500,000 m^3, as a result of the above calculation. The option 1 might be selected from a viewpoint to minimize maintenance cost.

But negative opinions from an environmental viewpoint to preserve living coral on the coasts of two islands(Ko Taphao Noi, Ko Taphao Yai) are expressed by Harbour Department and OEPP on the above selection, because the ship traffic along the channel might harm the coral.

Considering the above situation and practical possibility of promoting the project, the channel layout should be proposed as to avoid possible impacts to ecosystem. Therefore, the channel layout of Option 2, located north of Ko Taphao Noi, is selected for the new channel and is shown in Figures 6.4.24 and 6.4.25.

The above selection results in necessity of annual dredging of 500,000 m^3 for maintaining the channel.

6.4.4 Layout of Fishing Port Facilities

As described in the planning premises for the short-term plan, provision of wharves will be a minimum scale to minimize investment cost. In spite of difference in length of a lay-by wharf between the master plan and the short-term plan, the fishing port facilities for the latter will be provided almost as same scale as the former.

General layout of the facilities are illustrate in Figures 6..4.24 - 6.4.25に示す。

6.4.5 Design of Functional Facilities

(1) Structure and Specification of the Main Functional Facilities

The entire project site will be constructed on a landfill and all functional facilities, with the exception of small and lightweight buildings, will require piling work.

1) **Marketing Hall**

The new marketing hall is an enlarged version of the existing marketing hall. Therefore, it will be designed in accordance with the main structure and specification of the existing marketing hall. But FMO has its own reform plan for the existing marketing hall at present, and receives the advice of EU countries. They hope to change the building width from 10m to 20m, but they have not completed a detailed reform plan as yet. Therefore, the study team prepared its own tentative plan of a marketing hall. Reinforced concrete will be used for the main structure; and a corrugated asbestos cement sheet with a steel frame will be used for the roof in this plan for a new marketing hall.

2) **FMO Office**

The reinforced concrete structure and concrete hollow block walls predominantly used in office buildings in Thailand will be used in the FMO office. A steel frame roof will be used to make the building lightweight, and a roof tile or asphalt shingle sheet will be ustilized as roofing material, to give the building a high grade external appearance in comparison to the other facilities. Colonnades will be added around this building in order to shut out the strong sunlight and to create a multipurpose semi-outdoor space.

3) **Ice Plant and Ice Storage**

Main steel structures and concrete hollow blocks (also concrete ventilation blocks) will be used in facilities in order to lighten the total load. Corrugated asbestos cement sheets and corrugated plastic sheets (for skylight) commonly used in plant buildings in Thailand will be used in these facilities.

(2) Preliminary Design of Functional Facilities

The layout plan of the functional facilities in the short-term development plan is shown in Fig. 6.4.28.

The drawings of the main functional facilities are shown in Fig. 6.4.29 to Fig. 6.4.40. Total floor areas, types of foundations and structures of the main functional facilities in the short-term development plan are shown in Table 6.4.1.

6.4.6 Design of Processing Plant Facilities

(1) Structure and Specification of the Main Processing Plant Facilities

Almost all of the project site will be constructed on a landfill and all the facilities, with the exception of small and lightweight buildings, will require piling work.

1) **Processing Plant Building**

Main steel structures and concrete hollow blocks (also concrete ventilation blocks) will be used in the facilities in order to make the total load light. Corrugated asbestos cement sheets and corrugated plastic sheets (for skylight) commonly used in plant buildings in Thailand will be used in these facilities.

2) Administration Building

The reinforced concrete structure and concrete hollow block walls predominantly used in office buildings in Thailand will be used in the FMO Office. A steel frame roof will be used to make the building lightweight, and a roof tile or asphalt shingle sheet will be utilized as roofing material, to give the building a high grade external appearance in comparison to the other facilities. Colonnades will be added around this building in order to shut out the strong sunlight and to create a multipurpose semi-outdoor space.

(2) Preliminary Design of Functional Facilities

Layout plan of the functional facilities in short-term development plan is shown in Fig.6.4.28.

The drawings of the processing plant facilities are shown in Fig. 6.4.38 to Fig. 6.4.40. Total floor areas, types of foundation and structures of processing facilities in short-term development plan are shown in Table 6.4.1.

6.5. Implementation Plan

6.5.1 Construction schedule

(1) Construction conditions

1) Climatic and marine conditions

General information on winds around the project site are summarized below:

- Western winds, normally less 4 knots, prevail in the south west monsoon season.
- Winds from east to north east directions, less than 3 knots, prevail in the north east monsoon season.
- The project site is not be affected by the SW monsoon, wind speed of which is little greater than the NE monsoon.

About 2400 mm rain falls mainly in the SW monsoon season and fewer rainfall is recorded in the NE monsoon season.

Tropical depressions moving from the Pacific Ocean pass through the southern Thailand during November and December. The depressions sometimes cause rough sea.

Under the above climatic and marine conditions, construction work will not be affected by winds and waves because the wharves for the existing fishing boats and long liners will be provided in Klong Tha Chin. The deep-sea wharf constructed outside of the canal may be affected by these depressions, however, work efficiency will not be deteriorated annually as the sea around the project site is generally calm.

2) **Consideration to the existing fishing activities**

Construction work will be conducted in the canal where the existing fishing boats will sail near construction craft. The work should not affect traffic of the fishing boats in the port and the channel. The consideration will be required for dredging and construction of a deep-sea wharf, which larger craft will be employed for.

(2) Construction method

1) **Wharves for the existing fishing boats and long liners (in Klong Tha Chin)**

The mains structure is of steel sheet piles which will be driven with pile-drivers on craft after dredging the planned basin. The key point for the work is consideration not to interrupt landing fish at the existing wharf. For avoiding interruption of landing fish , it is proposed that the newly constructed wharf near the canal mouth be completed first and the part be provided for temporary use.

2) **Channel dredging**

Dredging will be carried out in the range of about 4 km and dredged material will be landed in the area behind the FMO facilities. For maintaining efficiency of the dredging work, a boat with booster pumps will be provided to transport dredged spoil to the dumping area. Density of discharged material by pipelines is 30%, which means 70% of the material is sea water. In order to prevent dispersion of turbidity from the dredged spoil, temporary cofferdams of sand and rocks, which separate the area into six blocks, will be provided as illustrated in Figure 6.5.1. Spillways at every cofferdam will work for reducing discharging velocity of water and the function will minimize dispersion of turbidity. When spilled water before discharging to the canal contains turbidity more than environmental criteria, the water will be treated for final discharge.

3) **Deep-sea wharf for larger purse seiners and reefer carrier vessels**

Construction of the wharf will be carried out after completion of dredging the proposed area with introducing pile-driving craft.

A stock yard for the long piles will be prepared in the open area on the west bank of the canal. Steel piles from the yard will be loaded into floating pontoons at a temporary jetty of H-shaped piles. The pontoon with piles will be towed by a tug boat to the construction site and piles will be driven with pile-drivers on craft.

The work should not interrupt traffic of fishing boats sailing in the existing channel.

4) **Access road**

The part of the access road in the sea will be constructed with placing pre-cast concrete bridges on trestles of steel pipe piles for shortening construction period for marine work.

5) **In-port road system**

The road system in the port area will be constructed with improving the subgrade with the sand compaction pile method for preventing settlement.

(3) Conditions on purchasing material and equipment

Almost material and equipment are available in Bangkok and Phuket. Several kinds of steel production are available there, but steel pipe piles and sheet piles are not produce in Thailand. These production should be imported from overseas countries.

Large construction equipment for land work is available, however, construction craft for dredging and driving piles are not acquired in Thailand. It will require contracts with foreign firms for hiring such equipment from the vicinity like Singapore.

(4) Implementation plan

As preparation for staring construction, several steps will be necessary. After confirming implementation of the project and finance sources, 5 months will be required for loan agreement, 6 months for recruiting a design consultants and 12 months for detailed design. During the consulting services period, loan for construction will be arranged almost at same time. If construction contract is awarded in 5 months, 26 months will be required totally for comencement of construction. Table 6.5.1 is prepared with the above conditions.

In planning the implementation plan, it is considered that the landing and lay-by wharf will be constructed in Klong Tha Chin at first in order to operate long liners as soon as possible. The plan shows that channel dredging will start in early stage to secure time for settlement of filled land for the processing plant estate.

A deep-sea wharf will be completed to meet timing of operation of processing factories for appropriate investment.

6.5.2 Cost estimate

(1) Conditions for cost estimate

The project cost is estimated with following conditions:

- Costs of all items are estimated as of December in 1996.
- The exchange rate as of the month is applied among Thai Baht, US $ and Yen.

  1 US$ = Baht 25.33 = ¥ 108.93
- No inflation ratio
- Costs for foreign currency portion include:
  - Depreciation costs of imported equipment
  - Imported material and products
  - Foreign currency portion of indirect costs
  - Costs for engineering services by foreign consultants

- Exemption of import tax on imported material
- Physical contingency for civil works is included in the costs as follows:
  - Wharves, bridge trestle and deep-sea wharf : 15 %
  - Dredging and road system : 5 %
- The engineering services fee is 10%.

(2) Project cost

A summary of the cost estimate is shown in Tables 6.5.2, 6.5.3 and 6.5.4. These tables are prepared for clarifying investment modes as public and private investment.

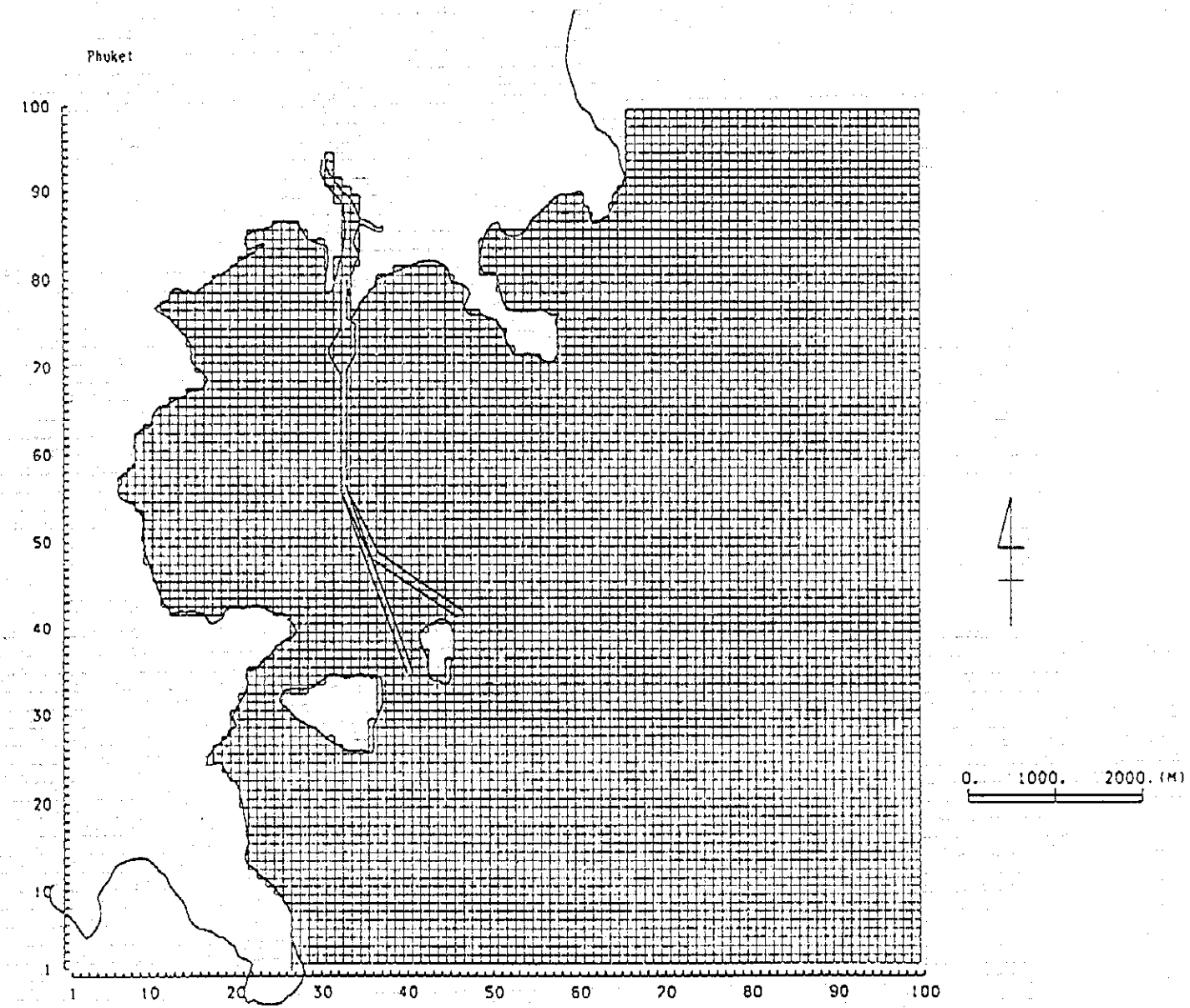


Figure 6.4.1 Area of Wave Forecasting indicated New Approach Channel

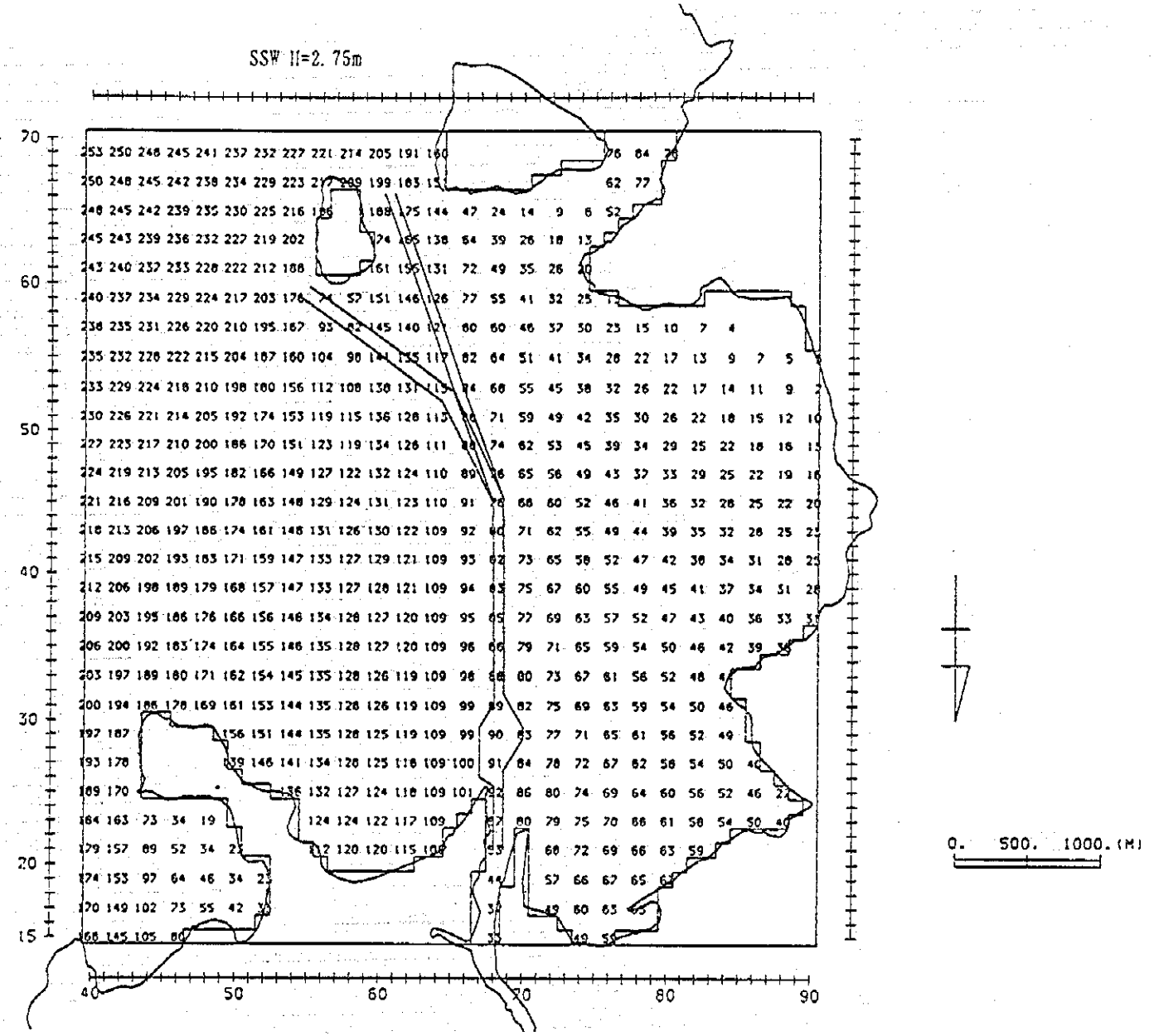


Figure 6.4.2 Distribution of Wave Height (No.1)

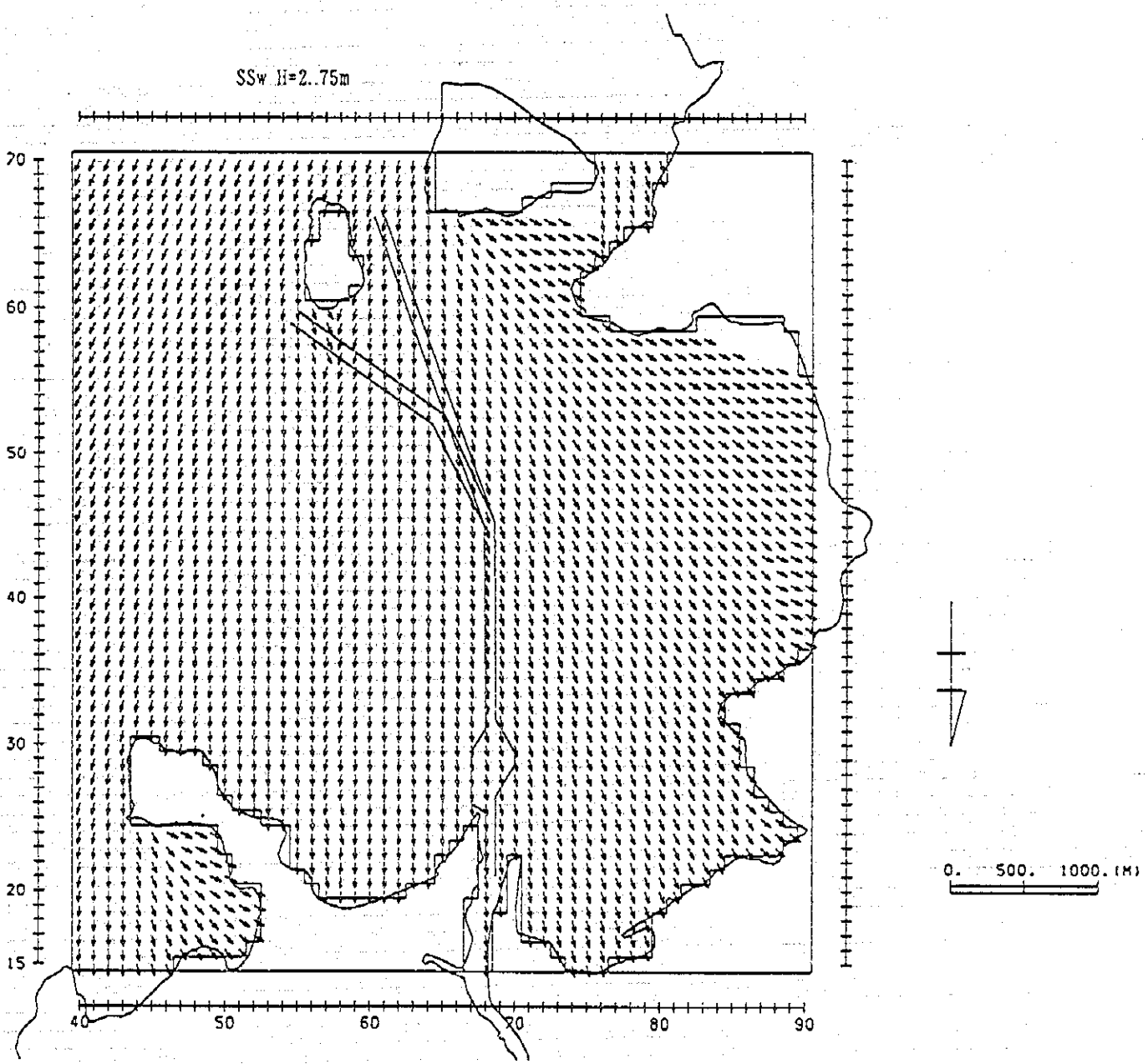


Figure 6.4.3 Wave Direction (No.1)

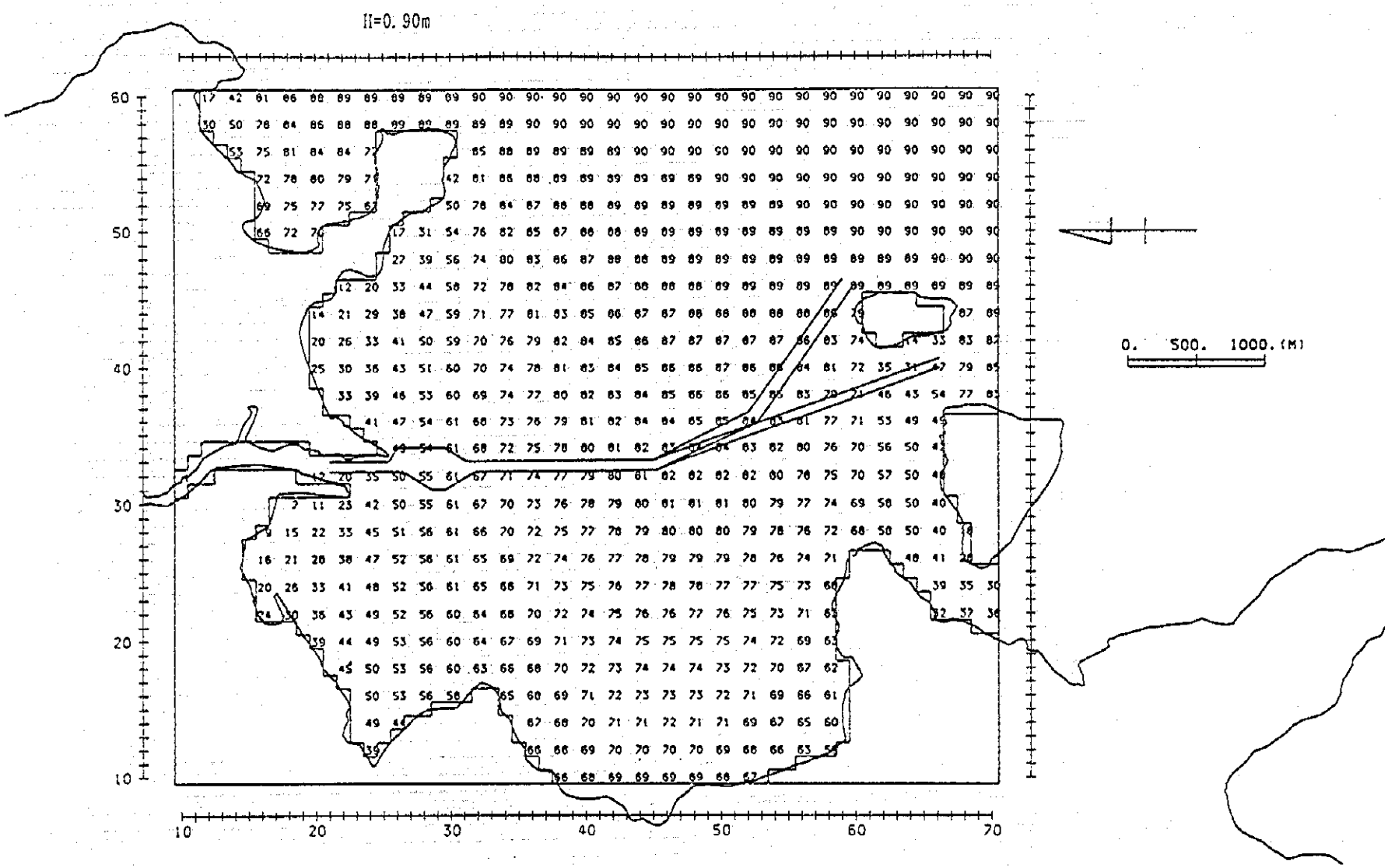


Figure 6.4.4 Distribution of Wave Height (No.2)

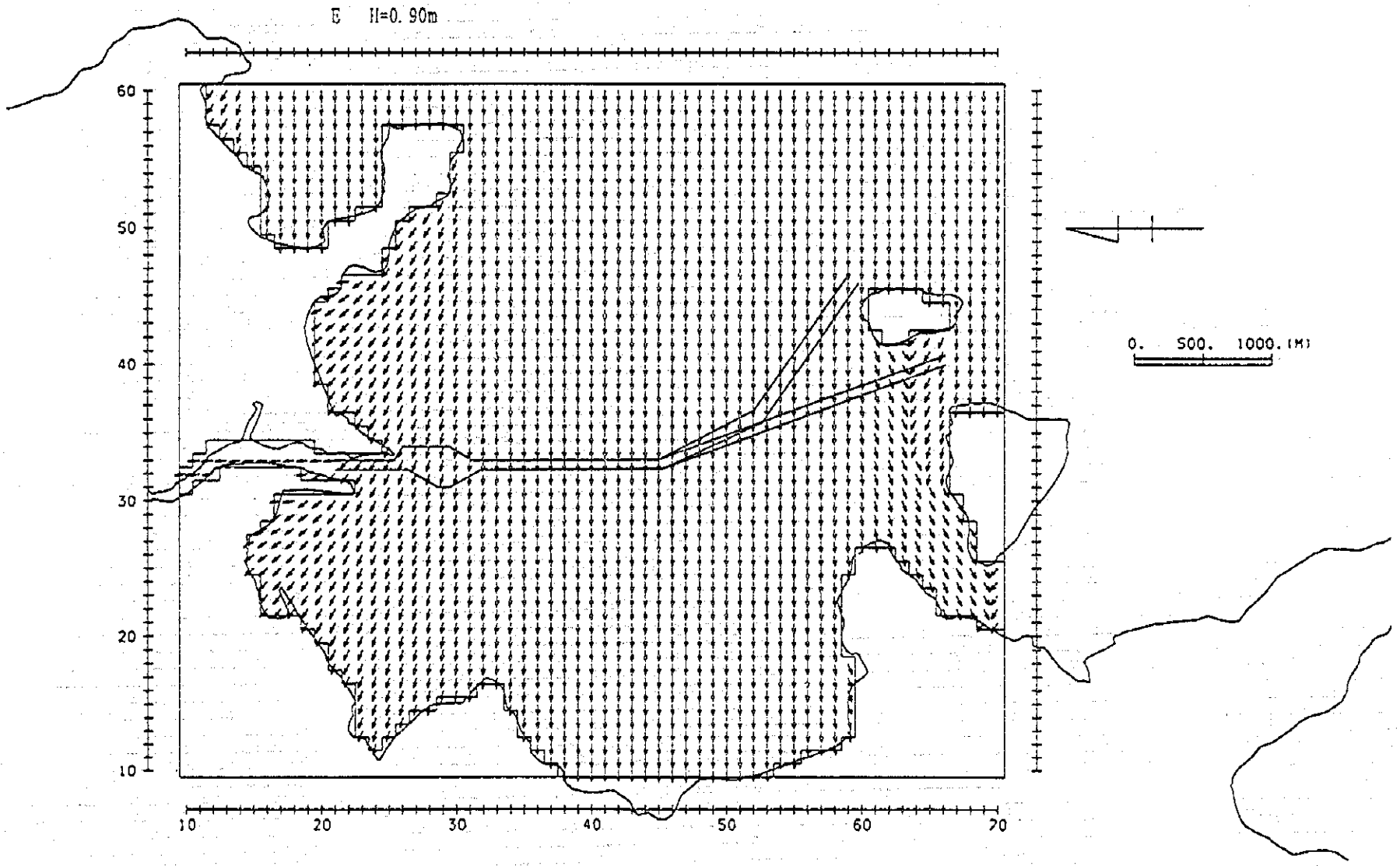


Figure 6.4.5 Wave Direction (No.2)

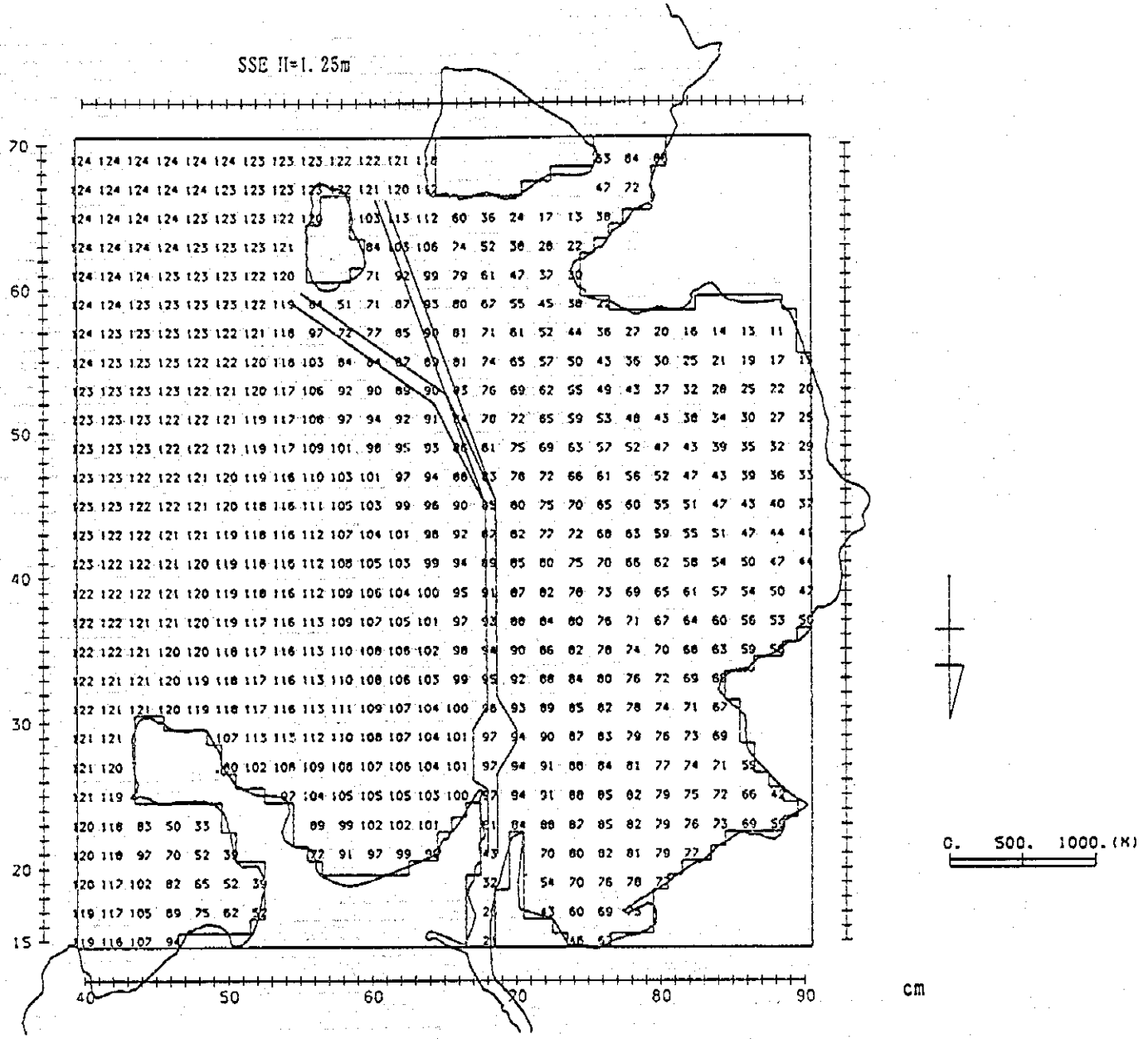


Figure 6.4.6 Distribution of Wave Height (No.3)

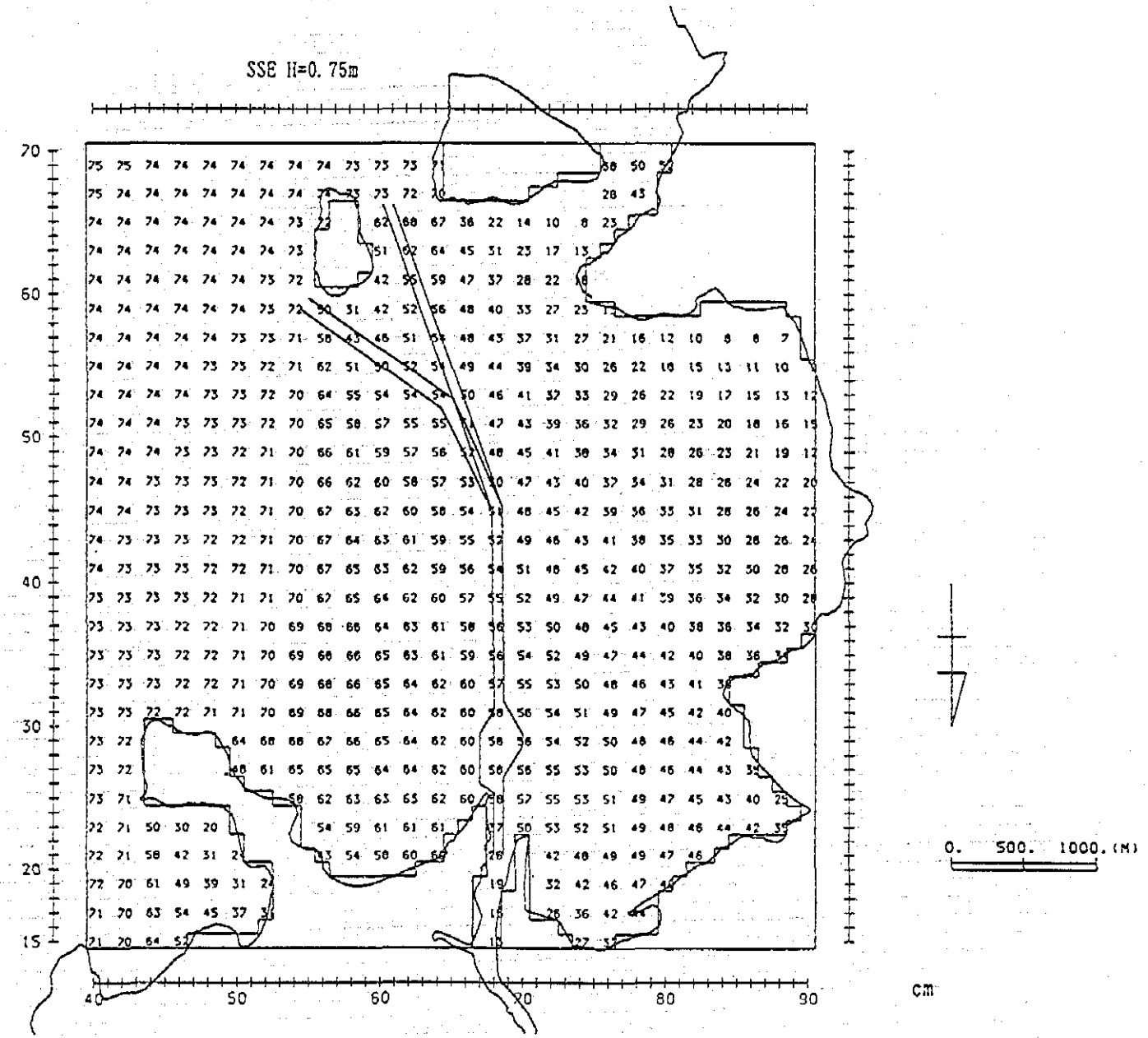


Figure 6.4.7 Distribution of Wave Height (No.4)

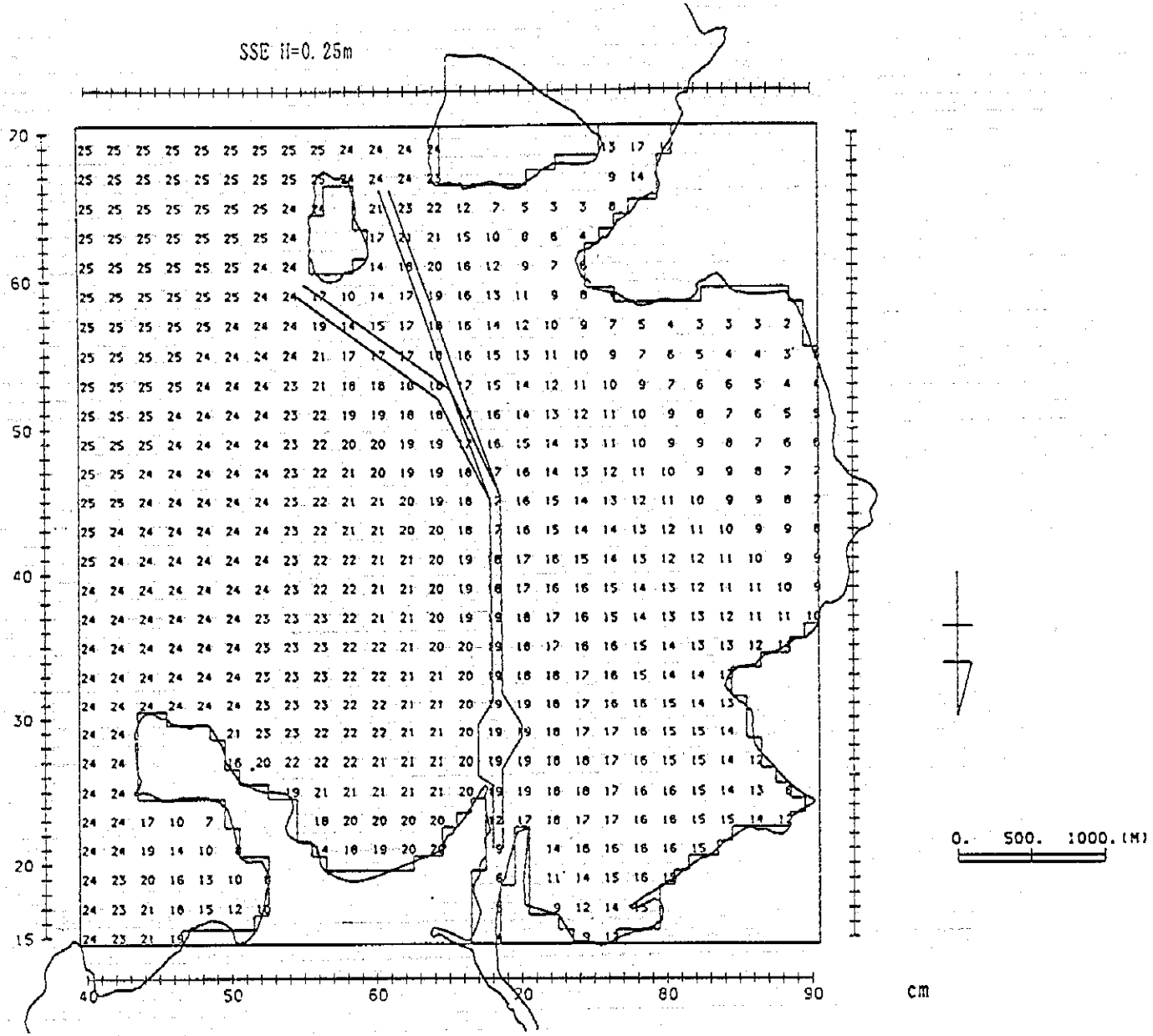


Figure 6.4.8 Distribution of Wave Height (No.5)

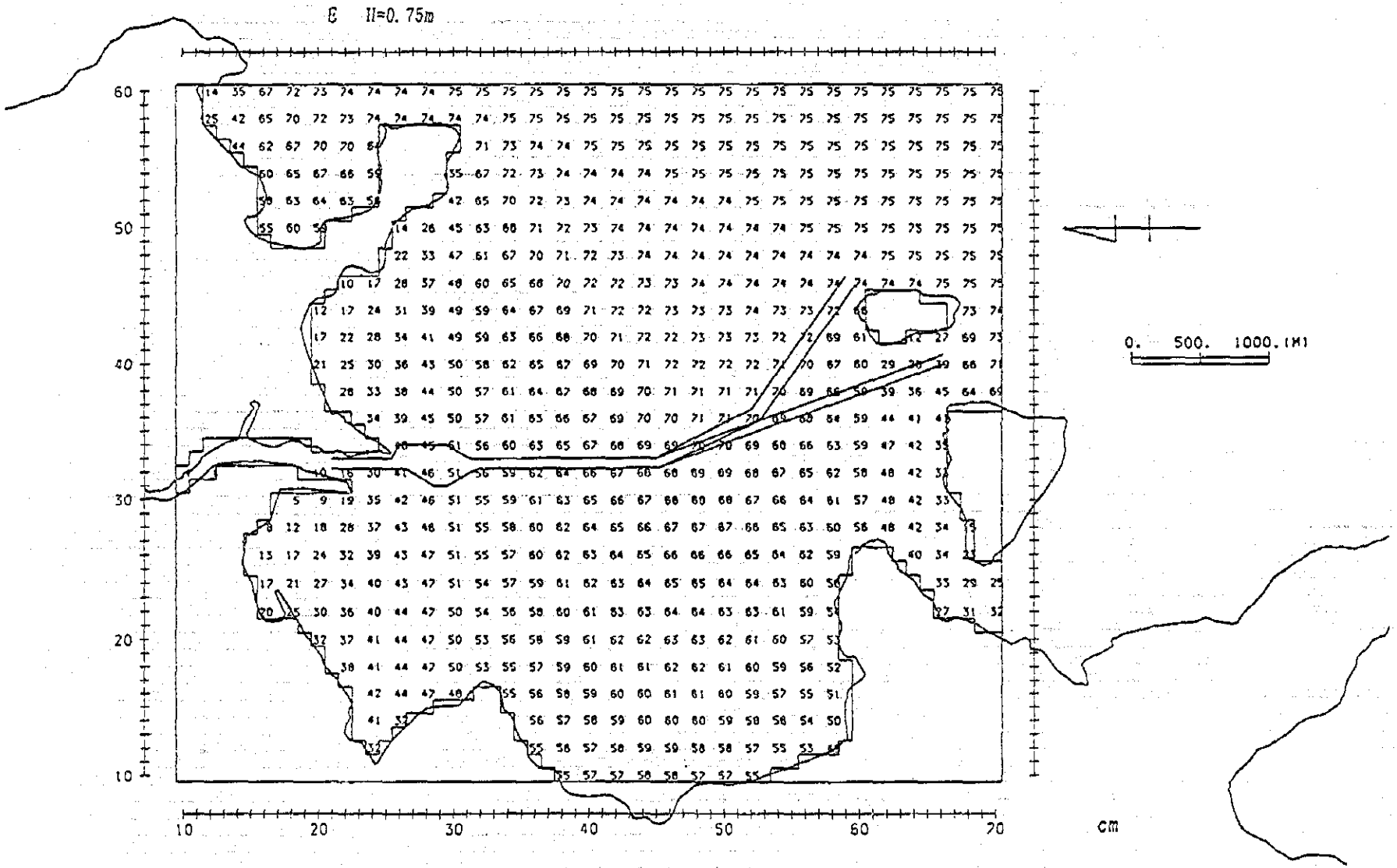


Figure 6.4.9 Distribution of Wave Height (No.6)

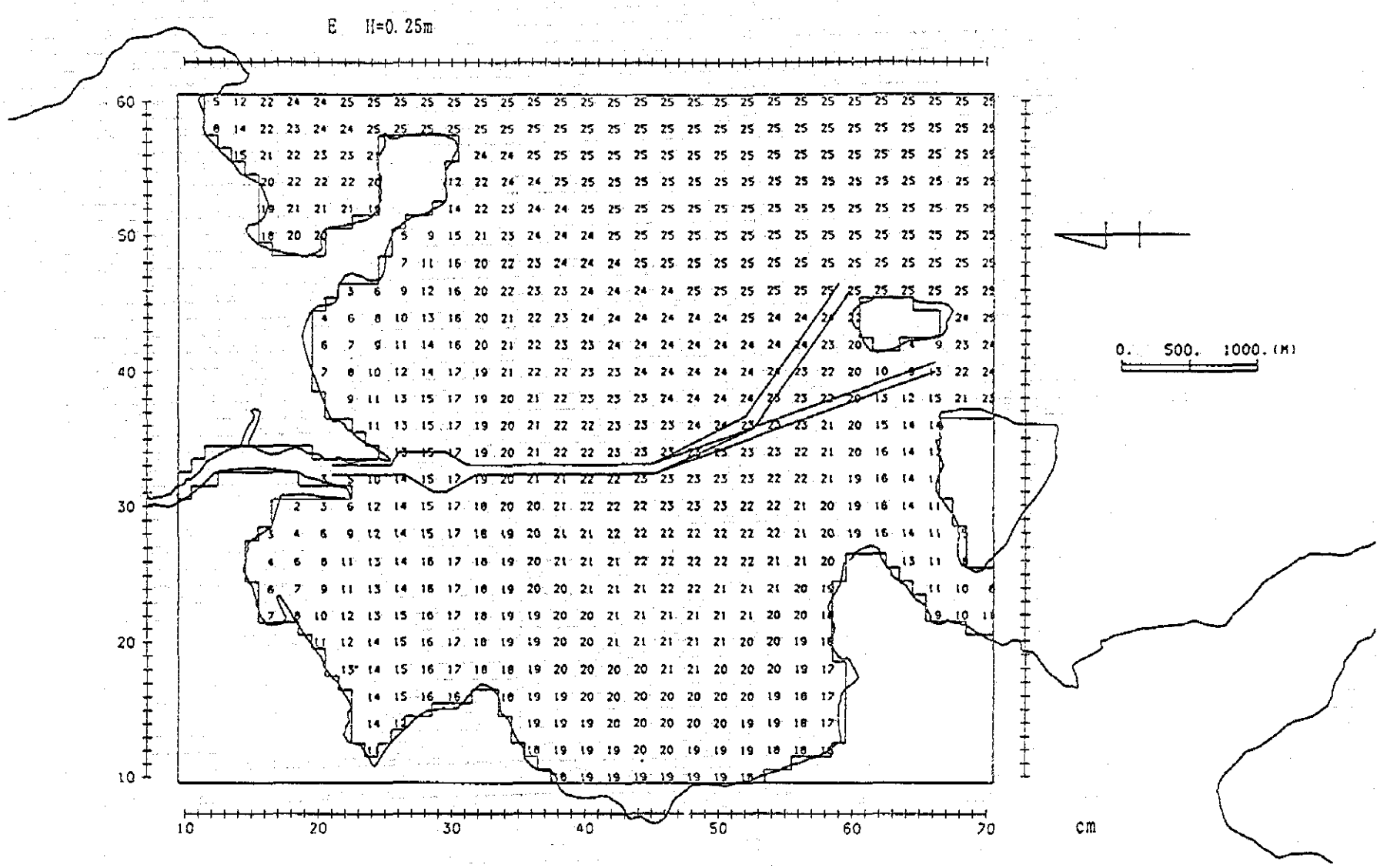


Figure 6.4.10 Distribution of Wave Height (No.7)

GEOLOGIC CROSSSECTION
PHUKET FISHERY COMPLEX PROJECT
PHUKET , THAILAND

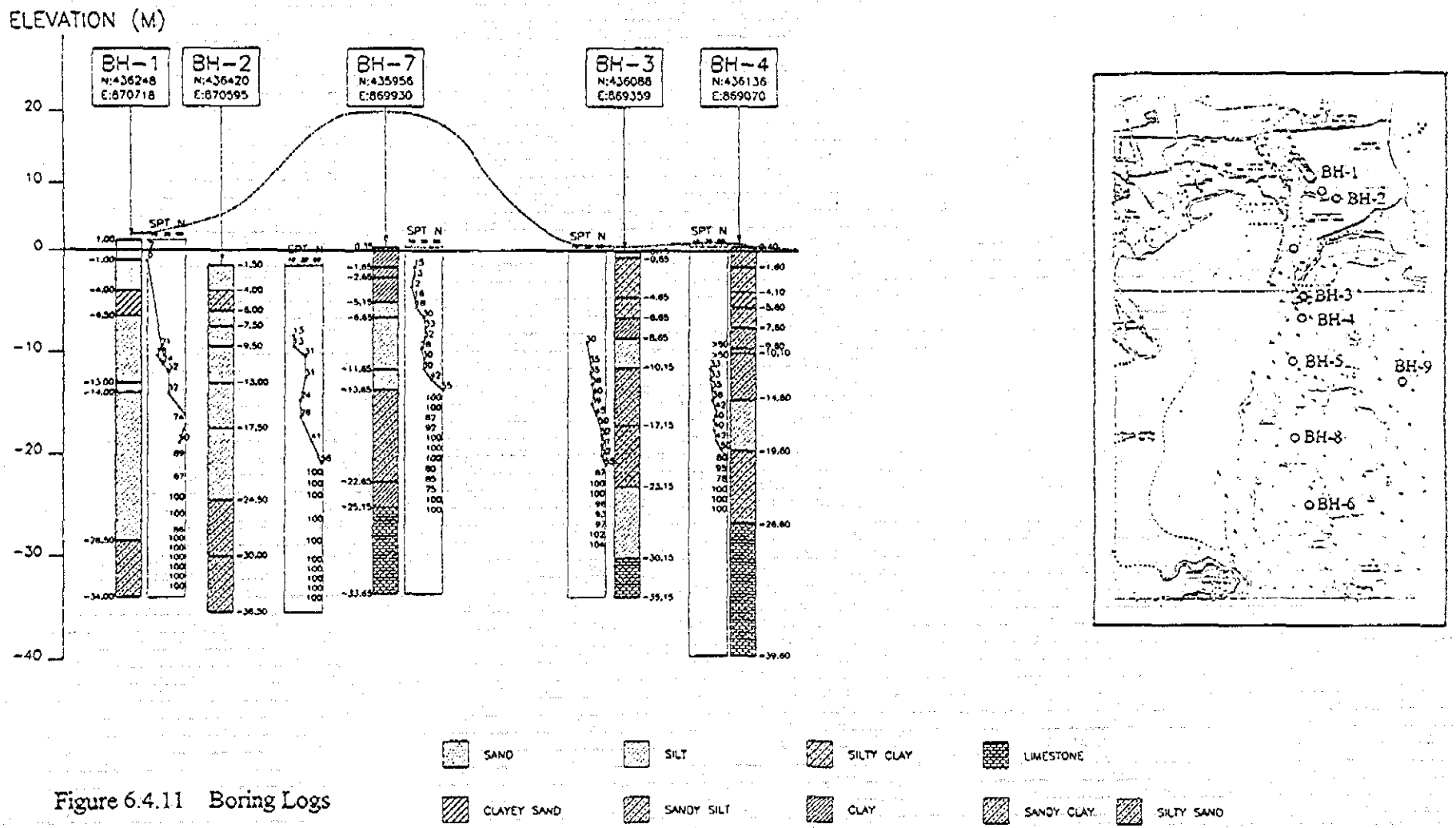
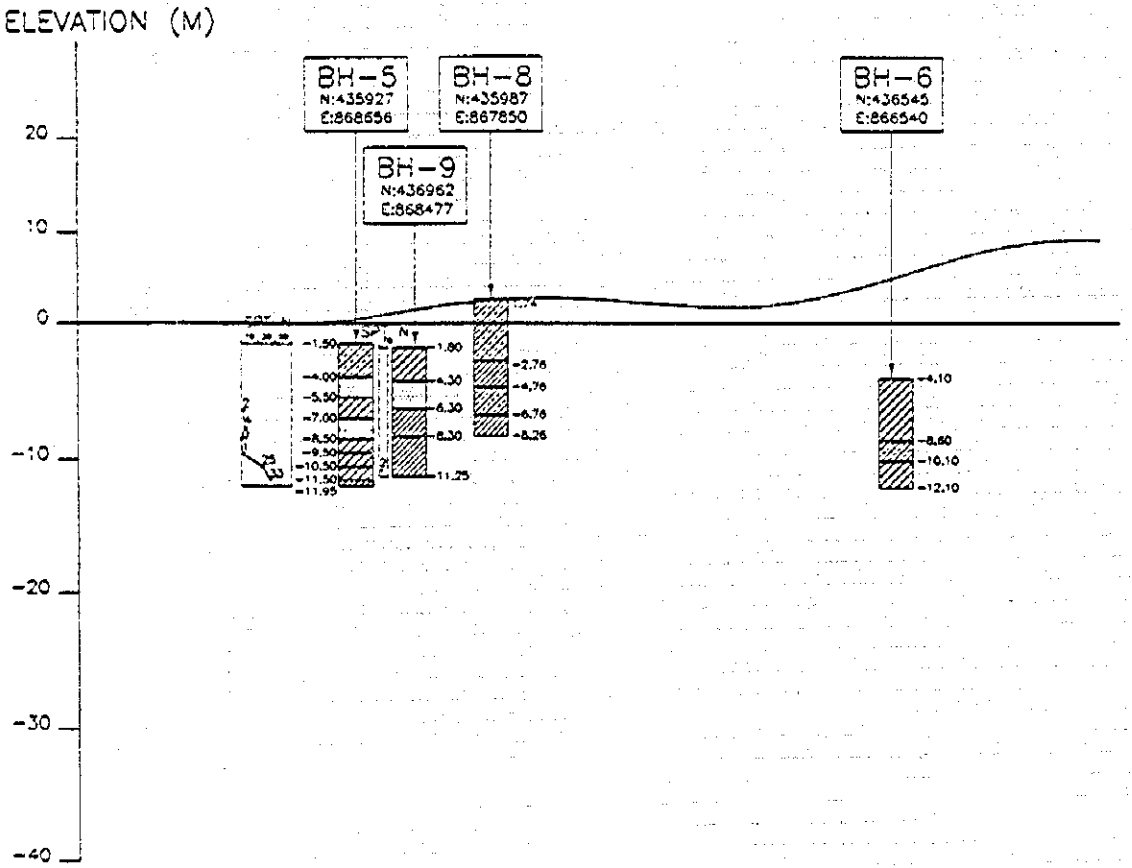
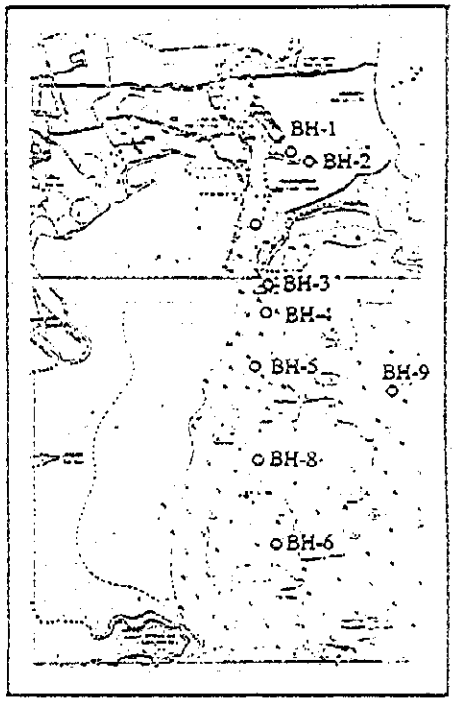


Figure 6.4.11 Boring Logs

GEOLOGIC CROSSSECTION
PHUKET FISHERY COMPLEX PROJECT
PHUKET , THAILAND





SAND | SILT | SILTY CLAY | LIMESTONE
CLAYEY SAND | SANDY SILT | CLAY | SANDY CLAY | SILTY SAND

Figure 6.4.12 Boring Logs

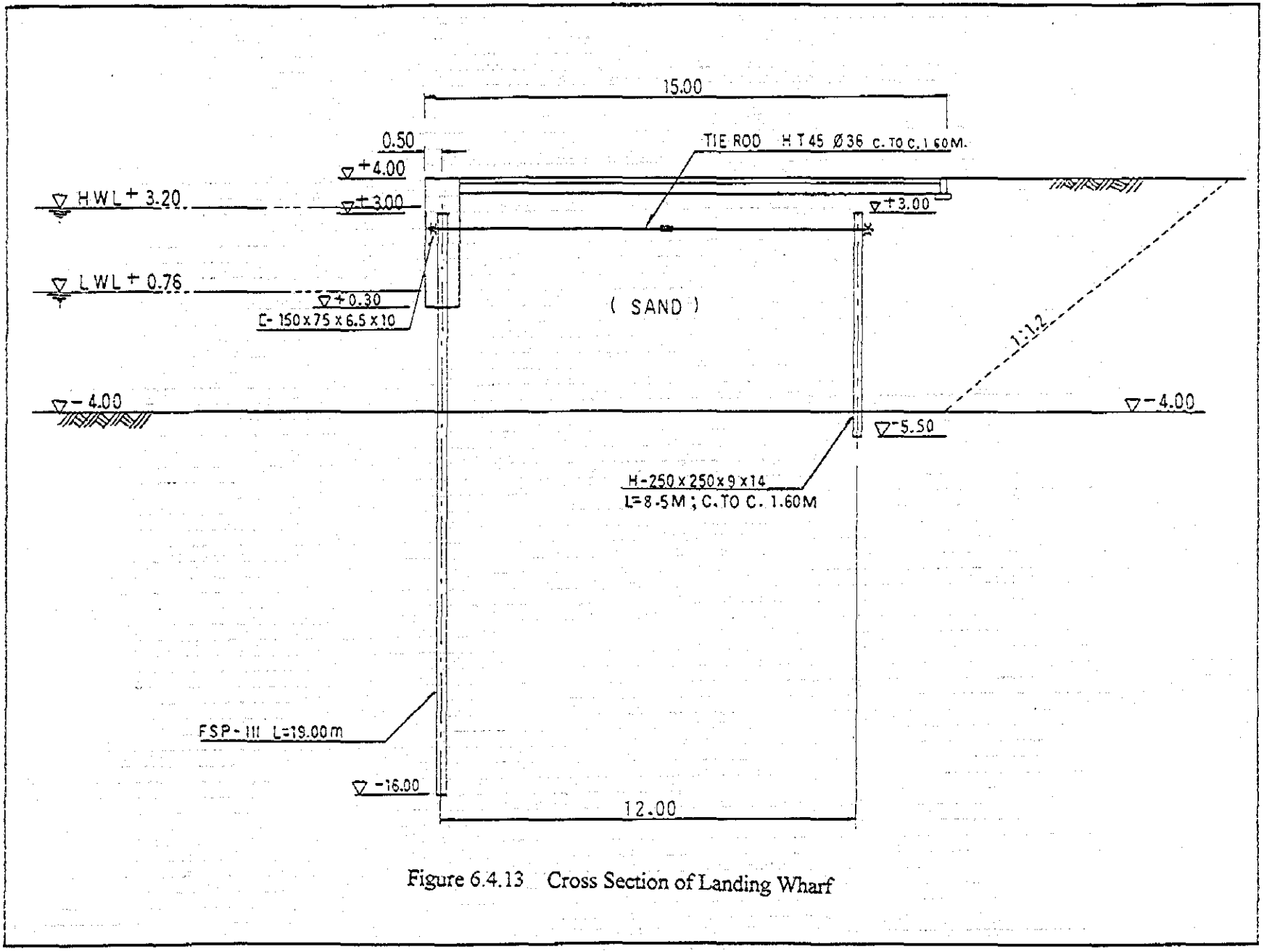


Figure 6.4.13 Cross Section of Landing Wharf

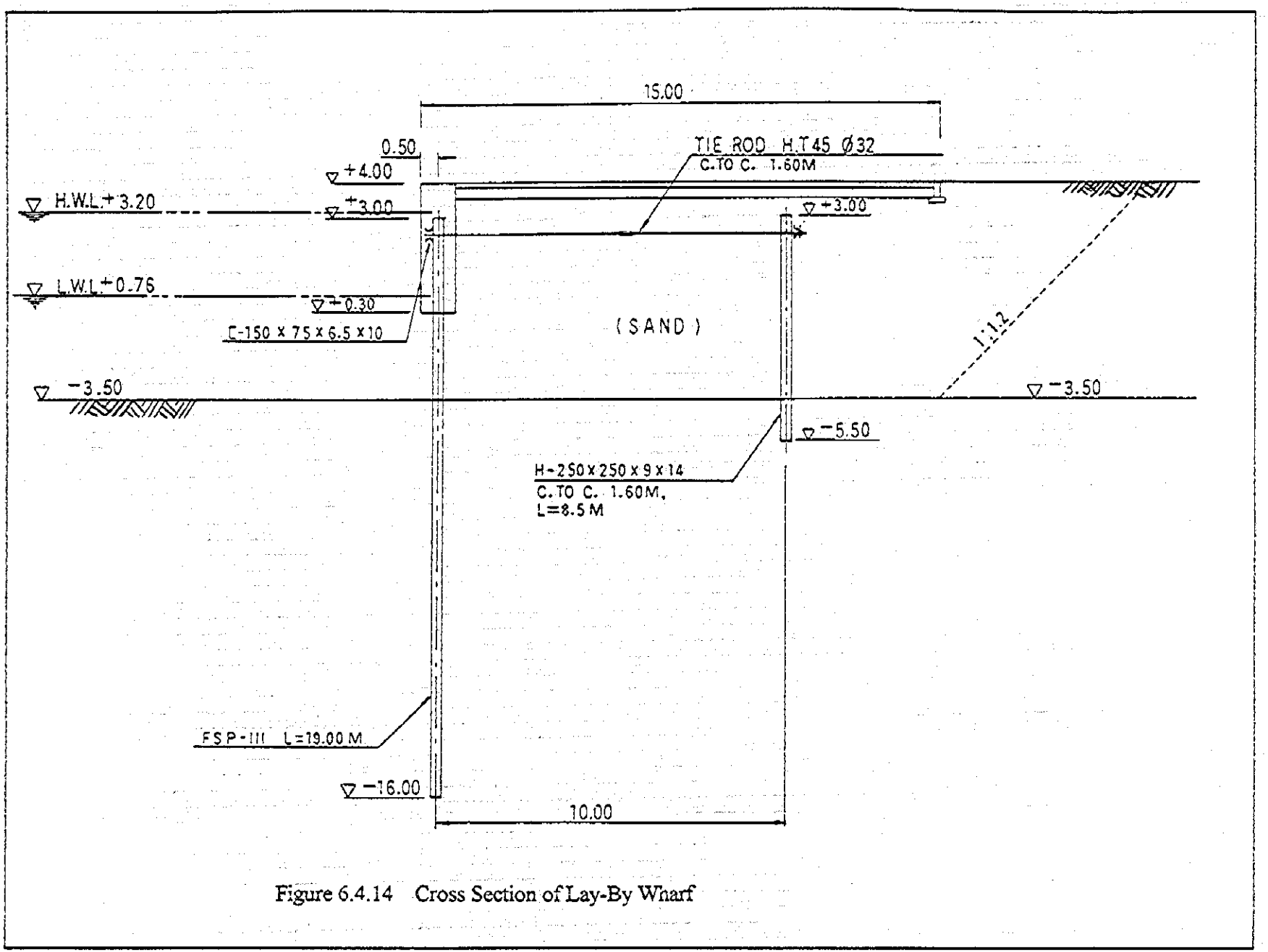


Figure 6.4.14 Cross Section of Lay-By Wharf

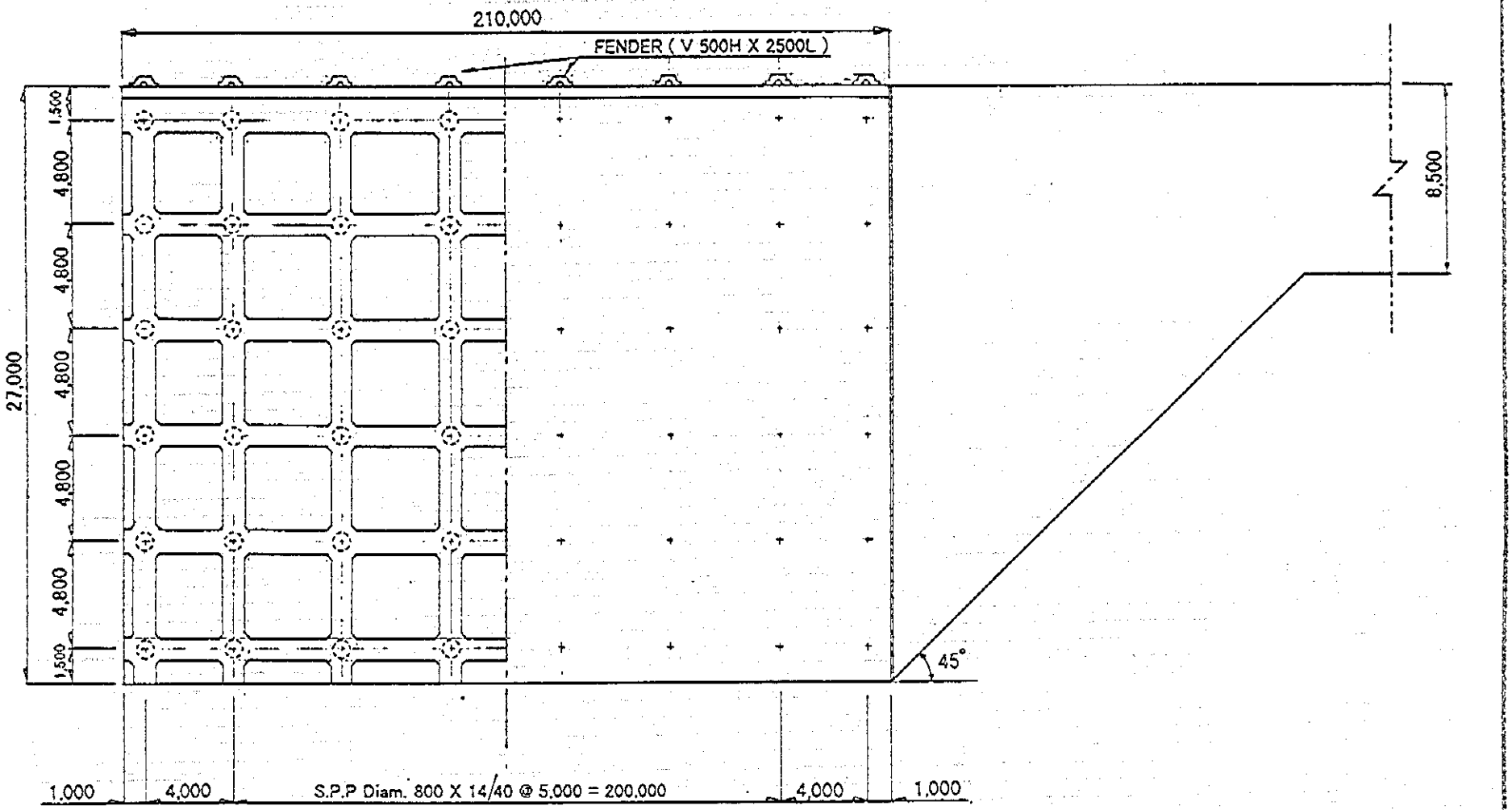


Figure 6.4.15 Plan of Deep Sea Wharf

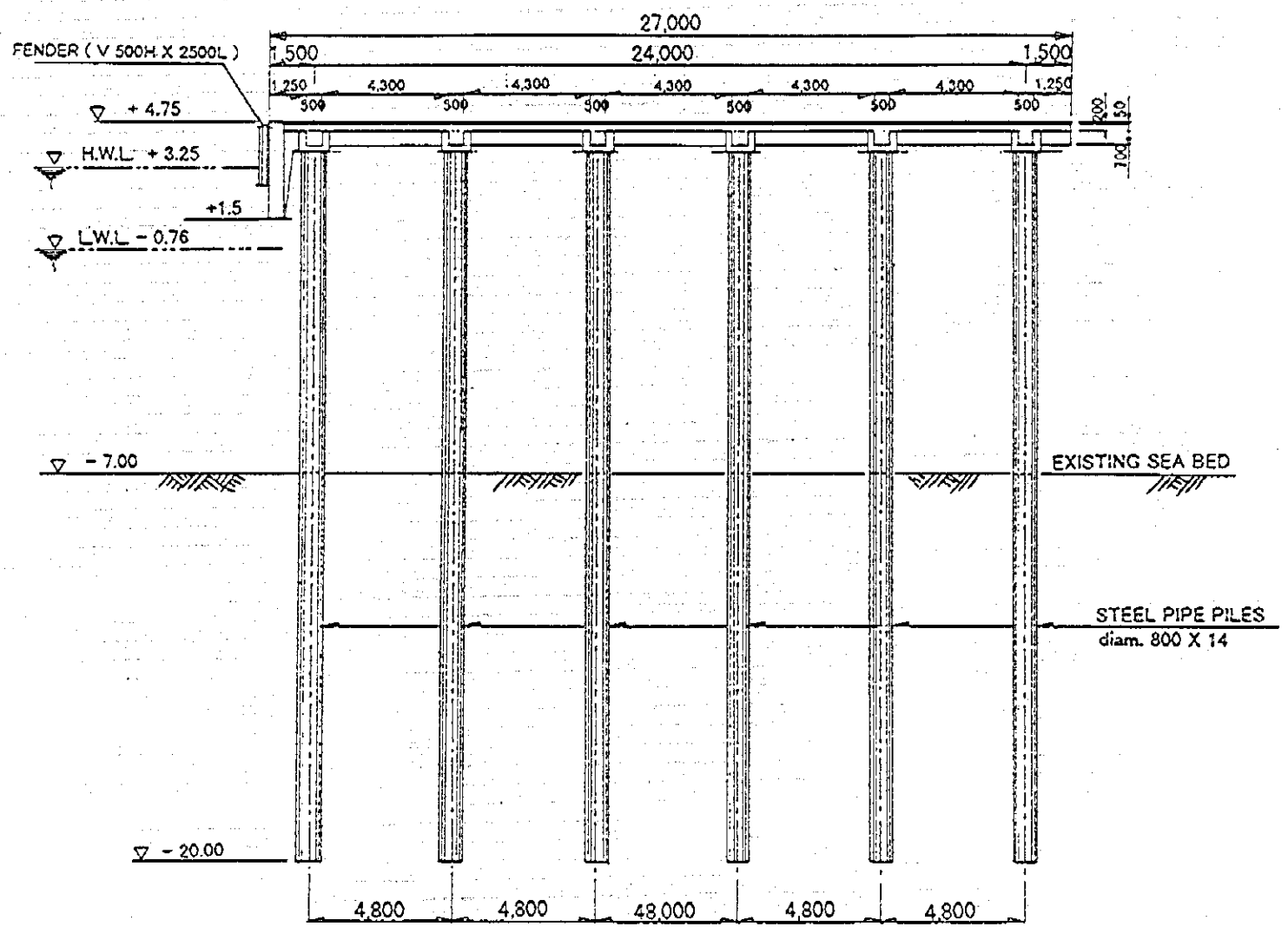


Figure 6.4.16 Cross Section of Deep Sea Wharf

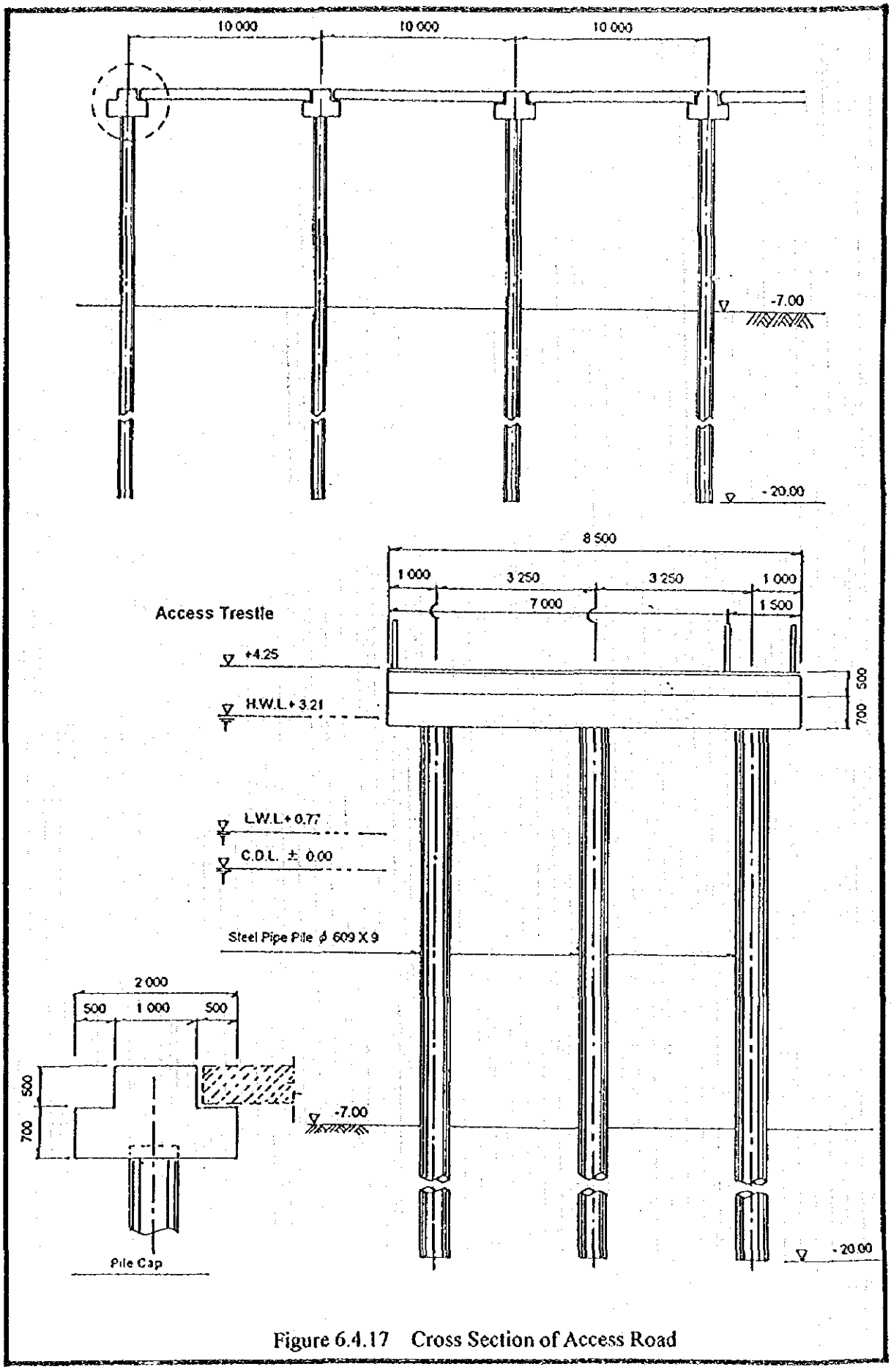


Figure 6.4.17 Cross Section of Access Road

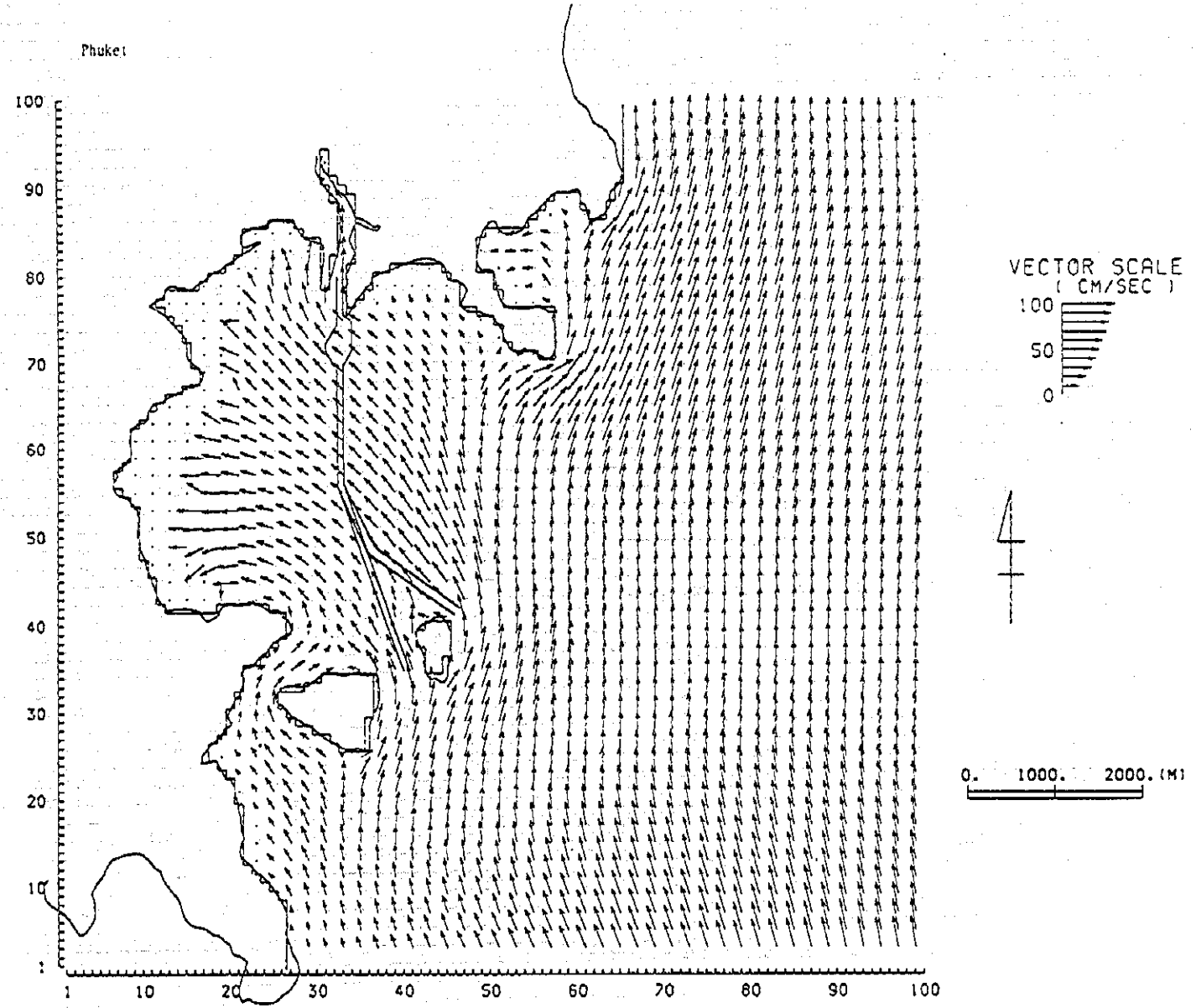


Figure 6.4.18 Tidial Current Diagram (No.1)

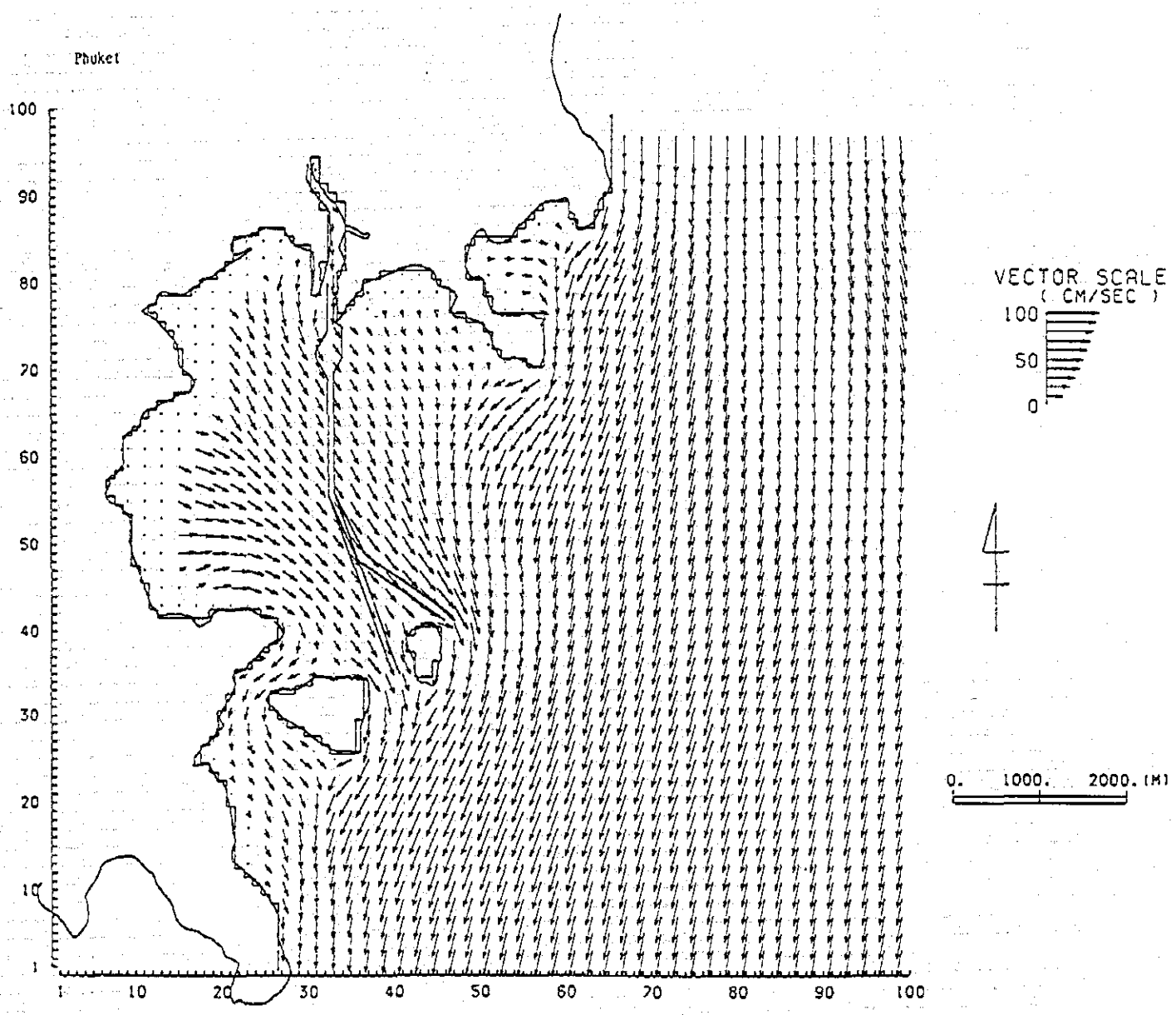


Figure 6.4.19 Tidial Current Diagram (No.2)

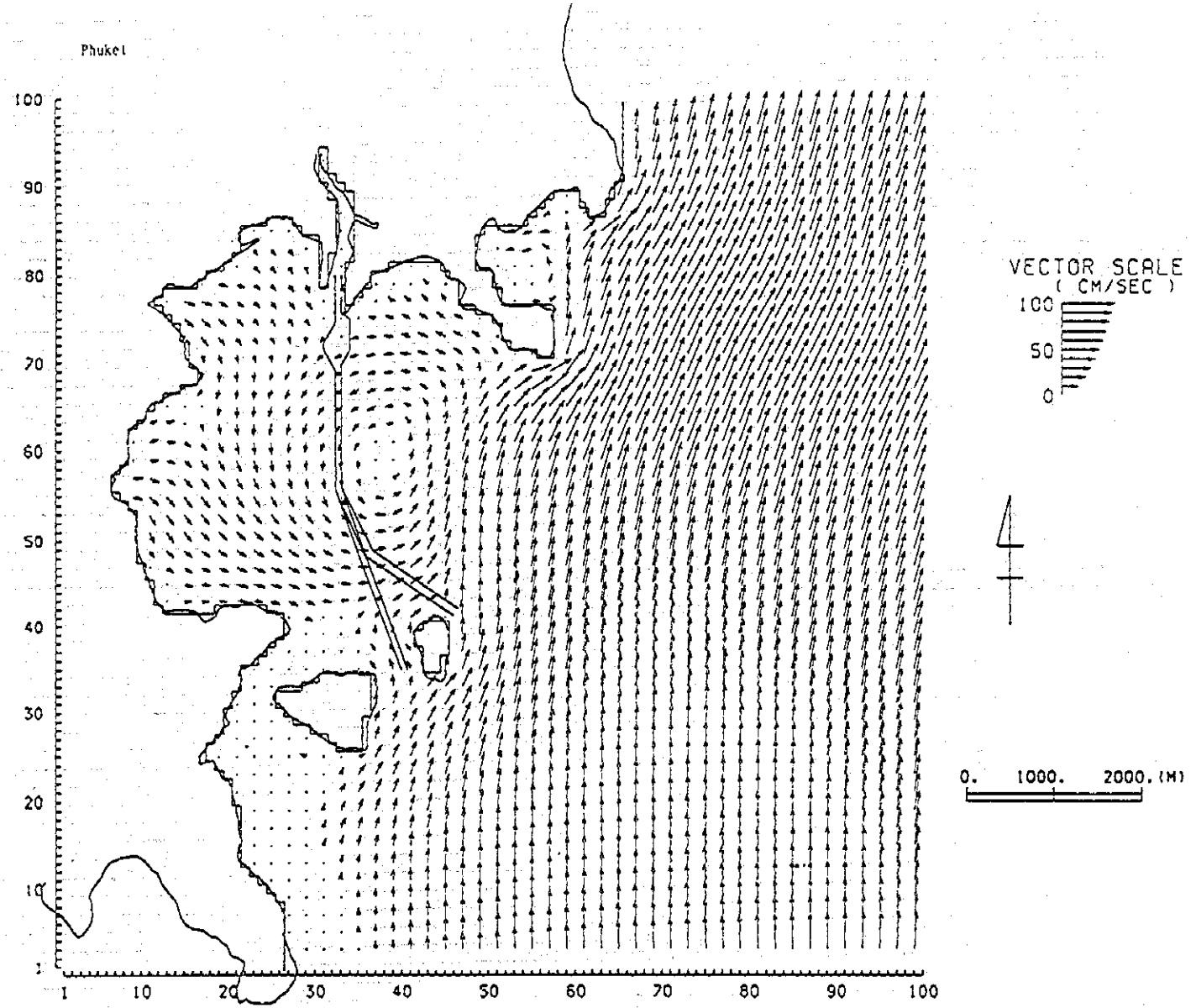


Figure 6.4.20 Tidial Current Diagram (No.3)

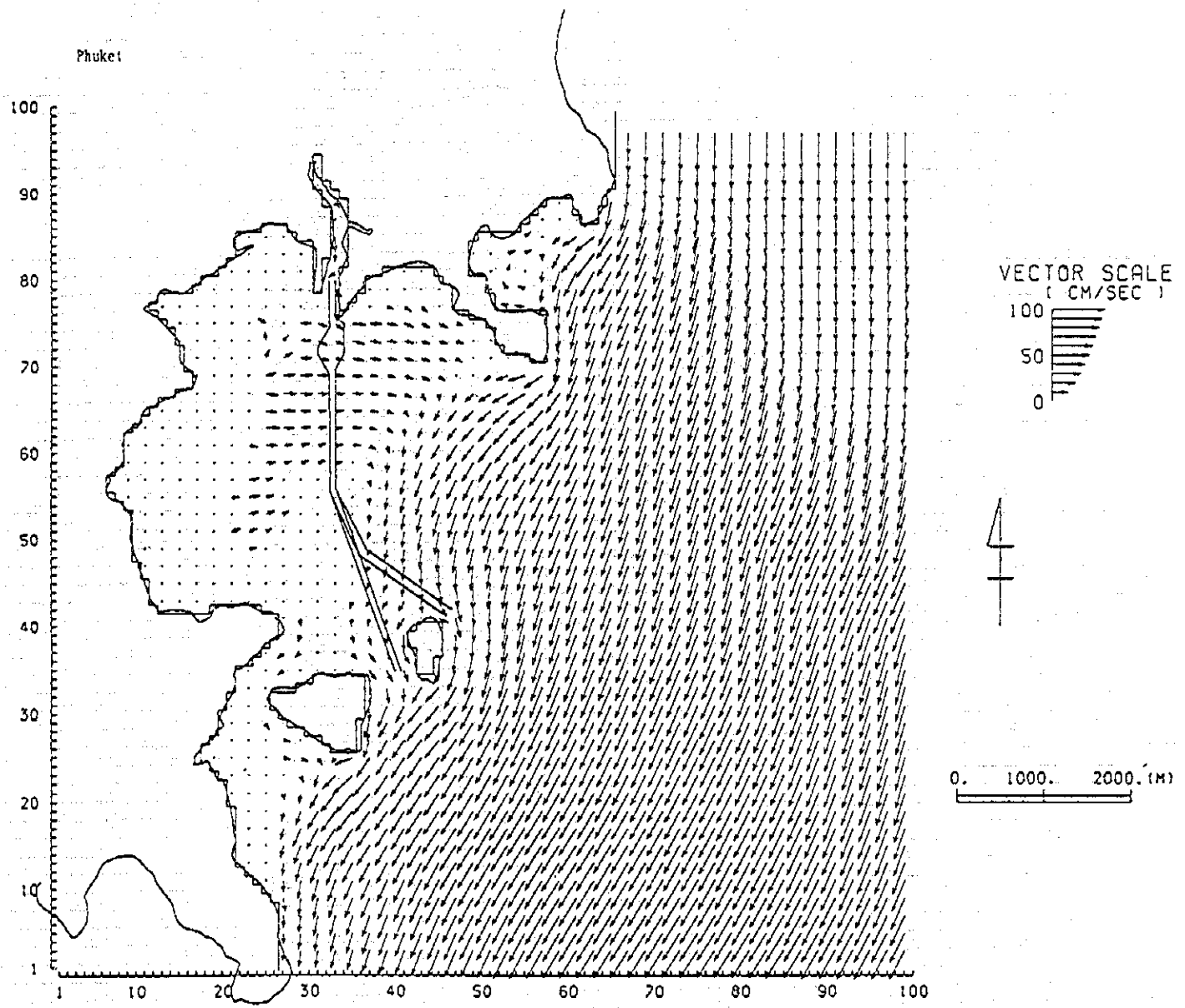


Figure 6.4.21 Tidial Current Diagram (No.4)

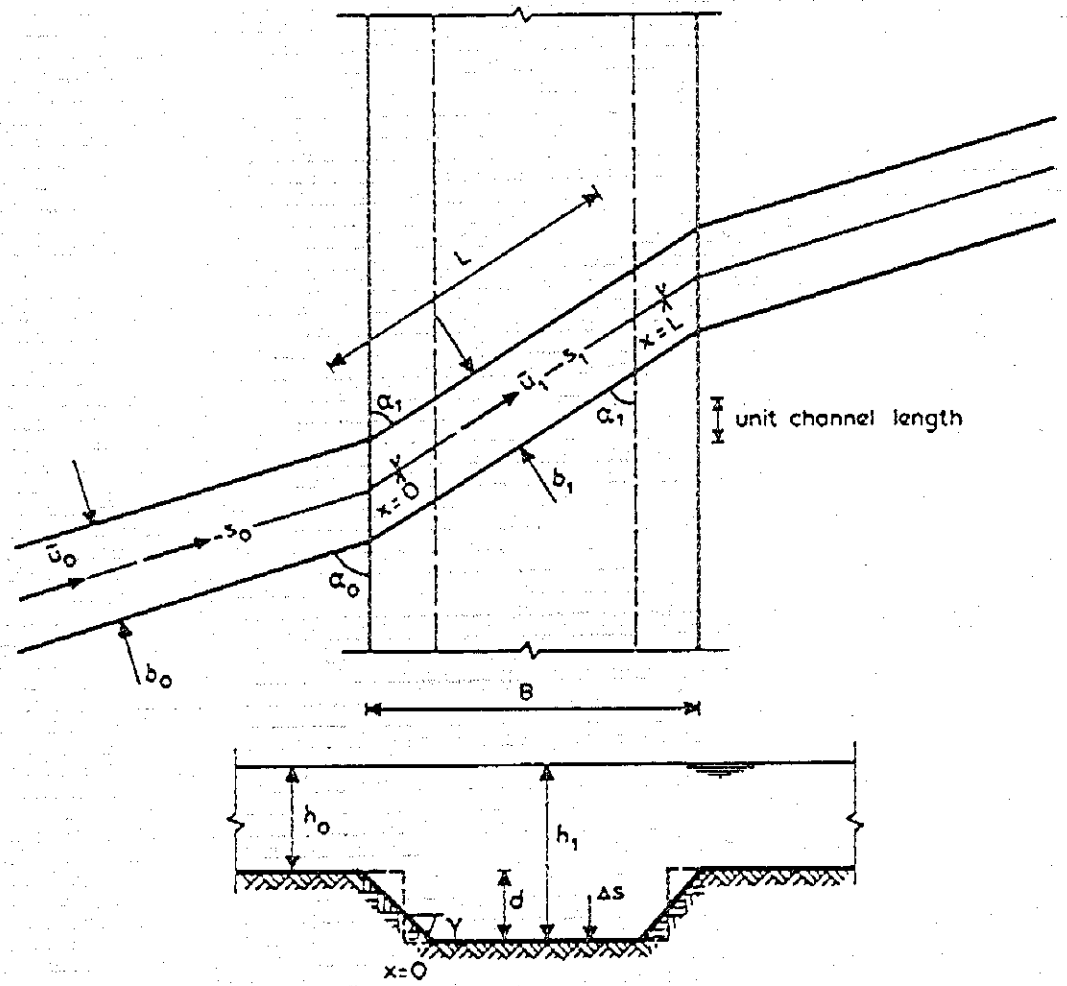


Figure 6.4.22 General Description of Bijker's Numerical Model

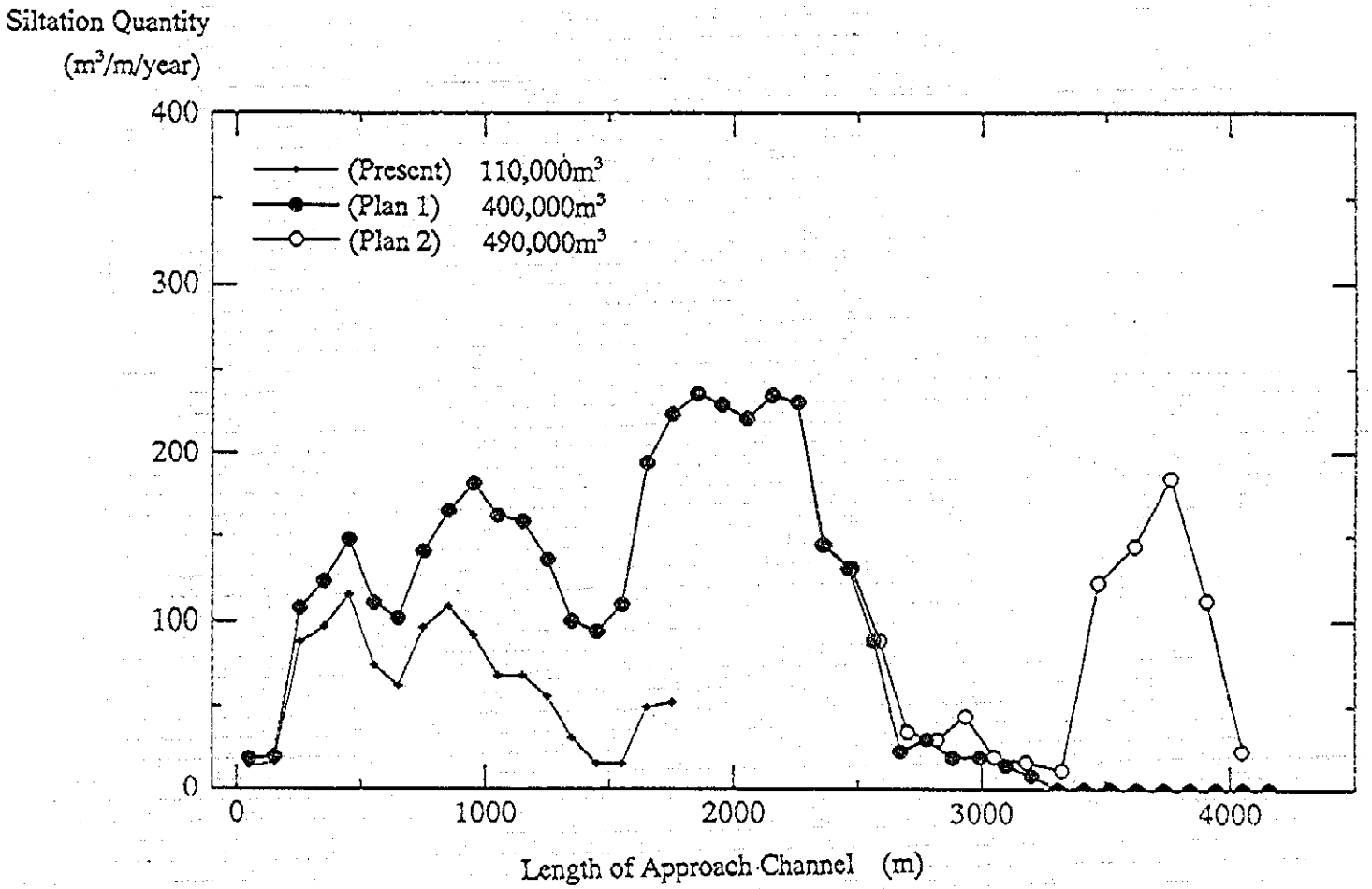


Figure 6.4.23 Distribution of Siltaiton Quantity at Approach Channel

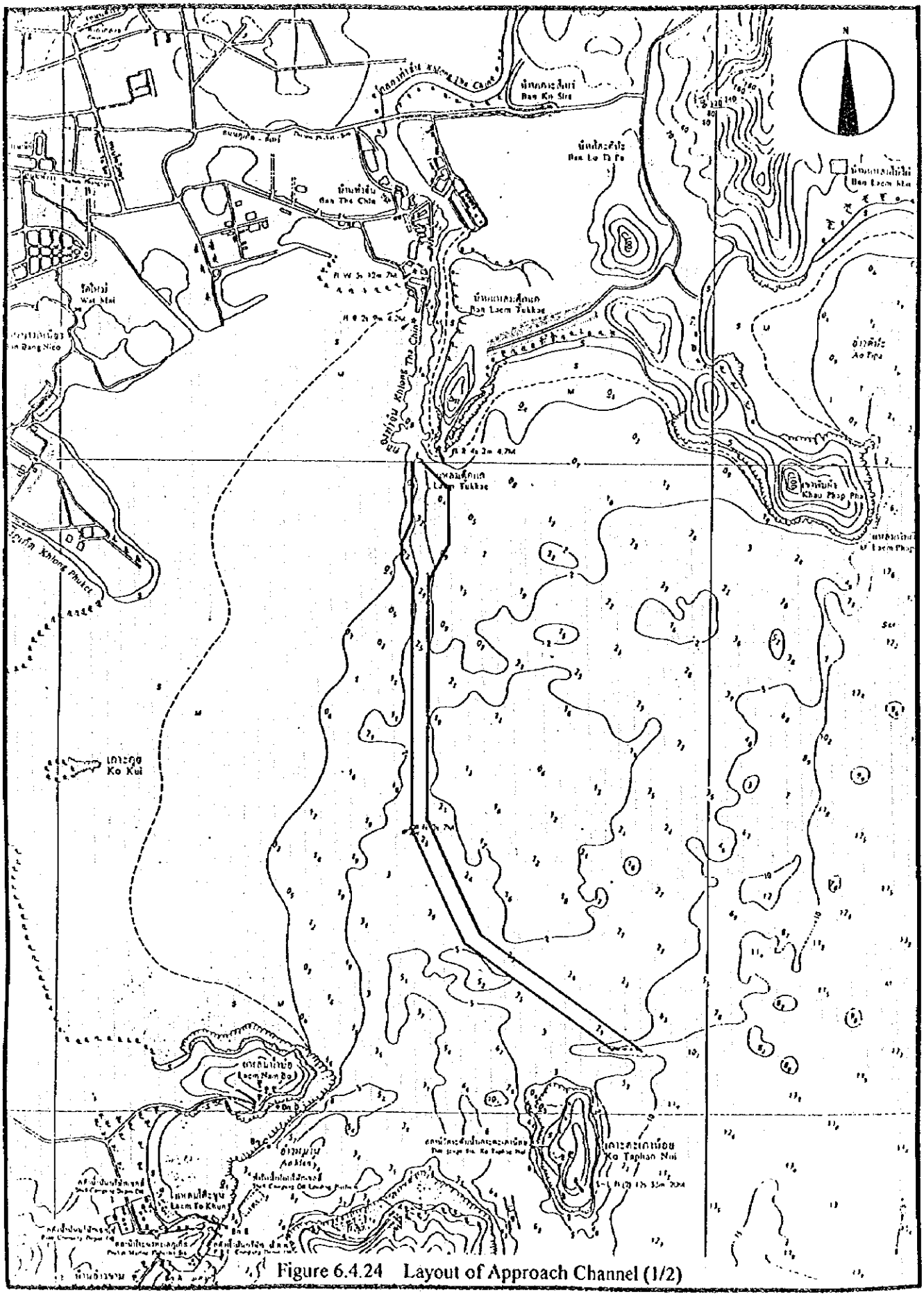


Figure 6.4.24 Layout of Approach Channel (1/2)

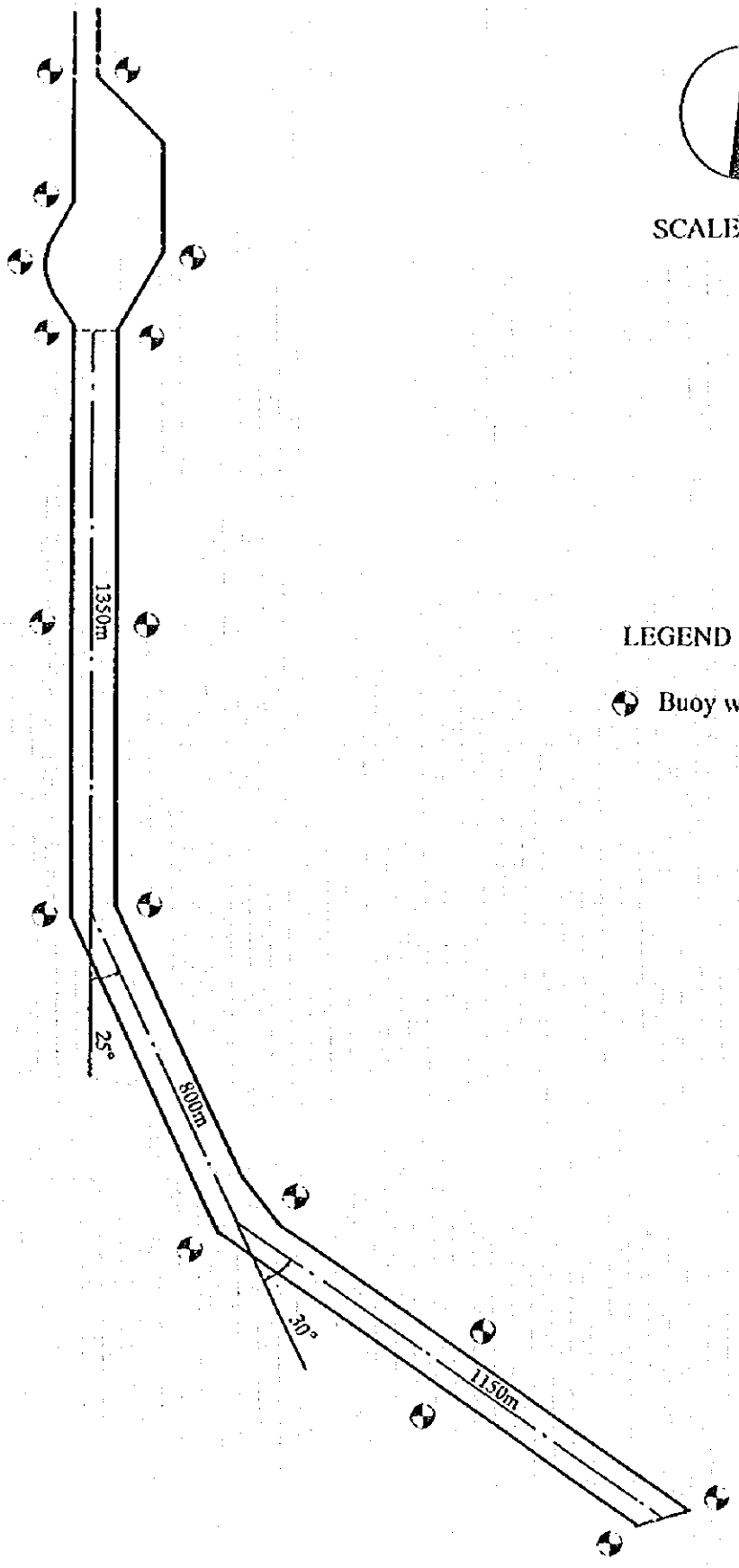


Figure 6.4.25 Layout of Approach Channel (2/2)

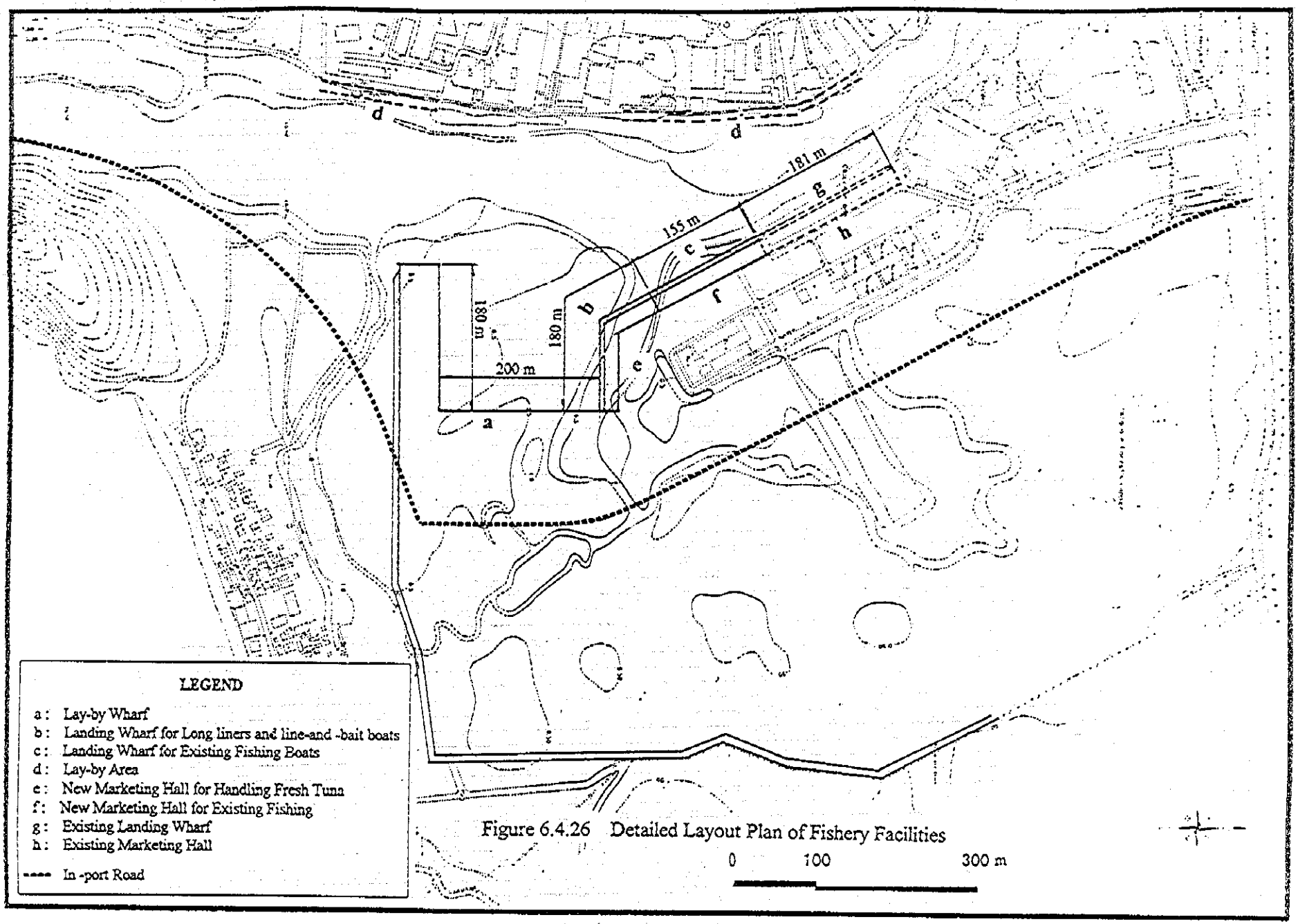


Figure 6.4.26 Detailed Layout Plan of Fishery Facilities

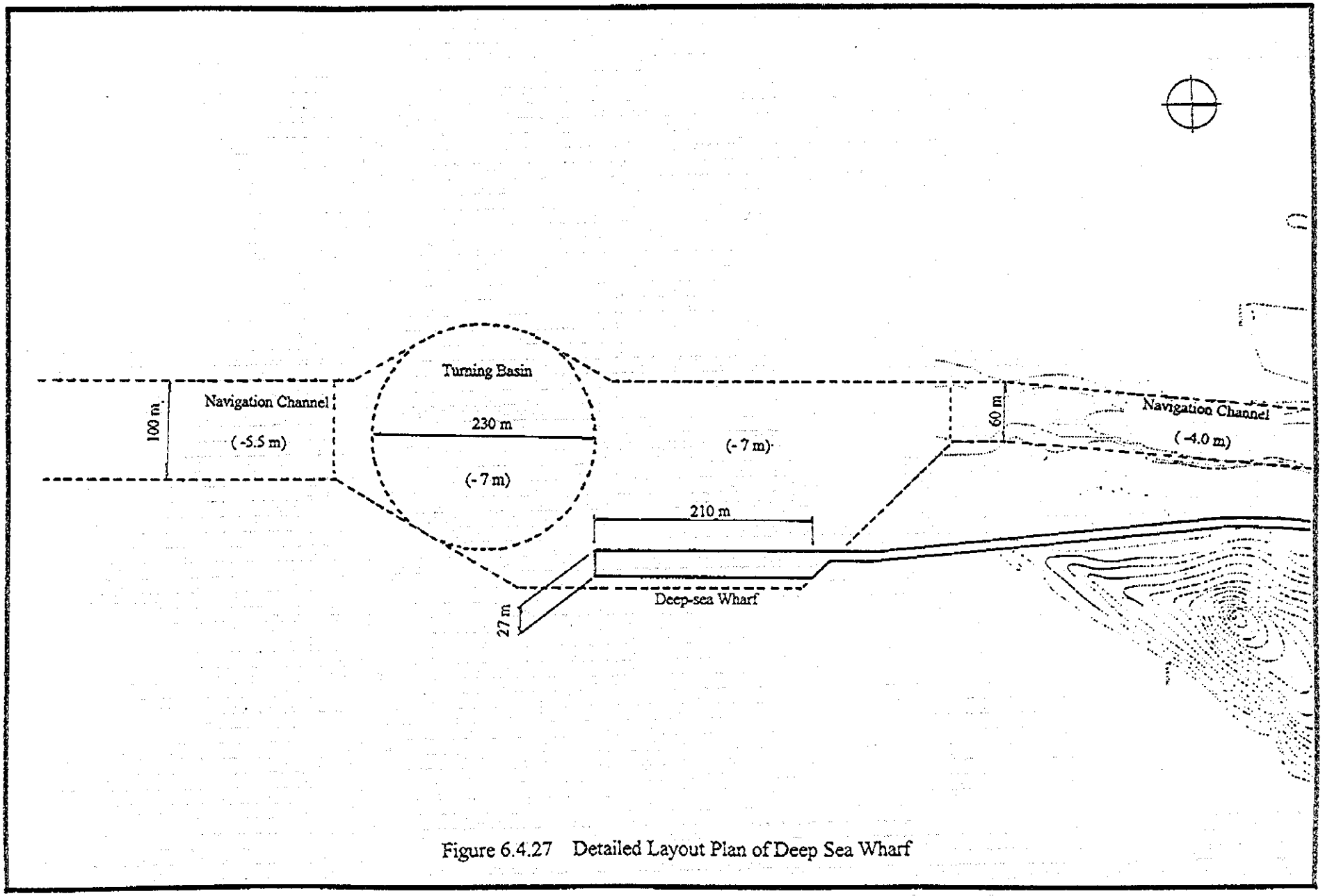


Figure 6.4.27 Detailed Layout Plan of Deep Sea Wharf

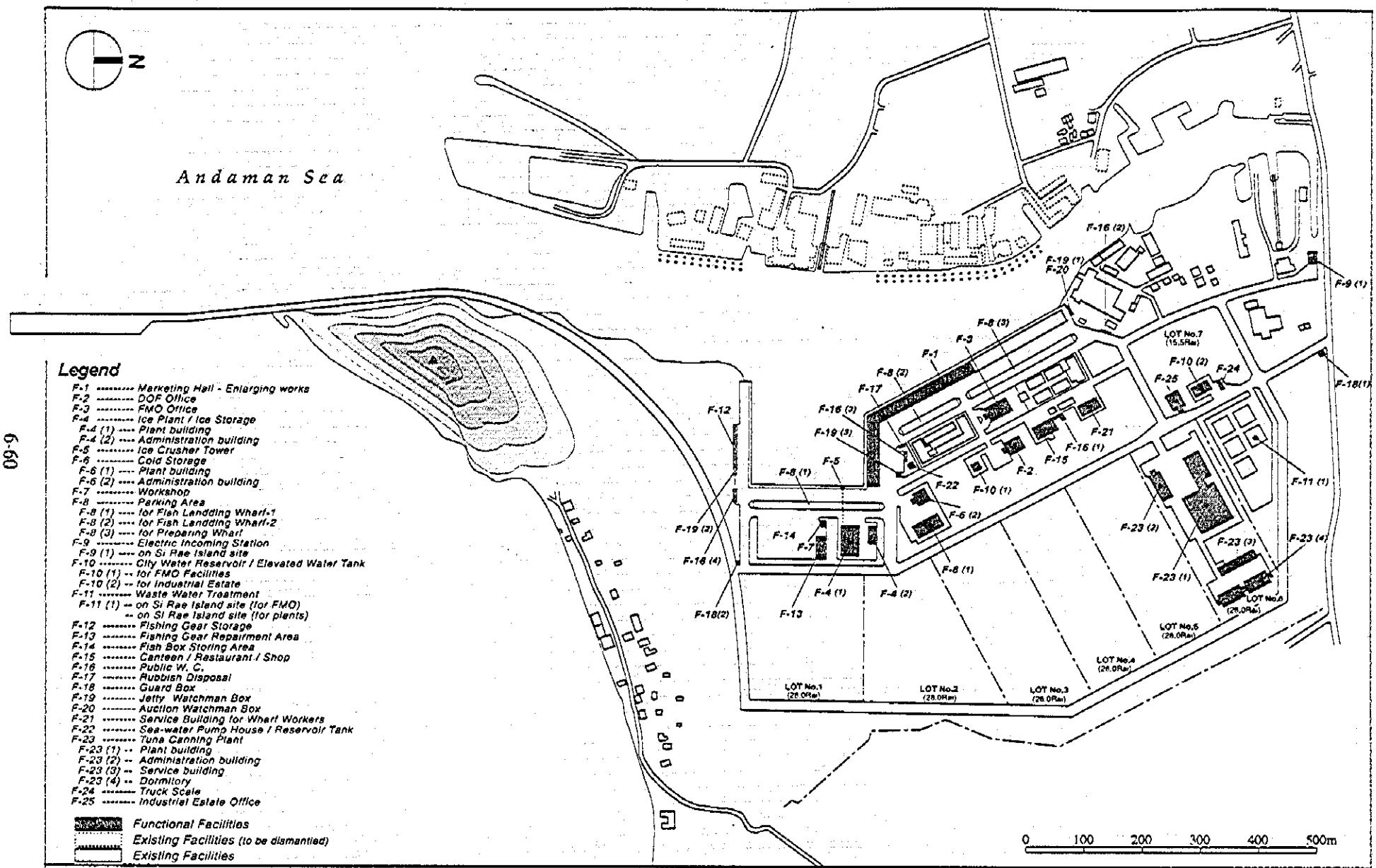


Figure 6.4.28 Detailed Layout Plan of Phuket Port

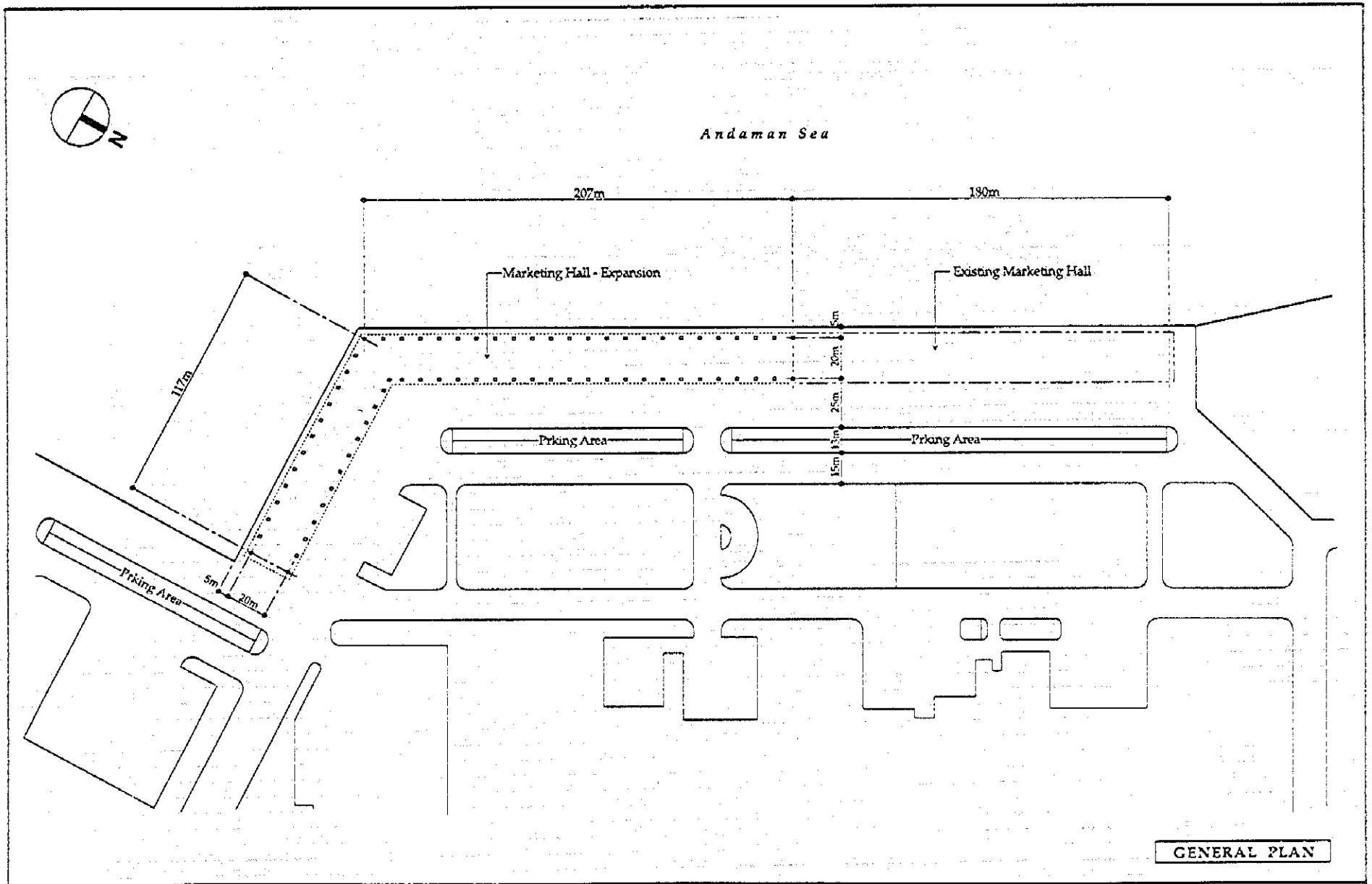


Figure. 6.4.29 (1) Marketing Hall - Expansion Plan General Plan Scale = 1 : 2.500

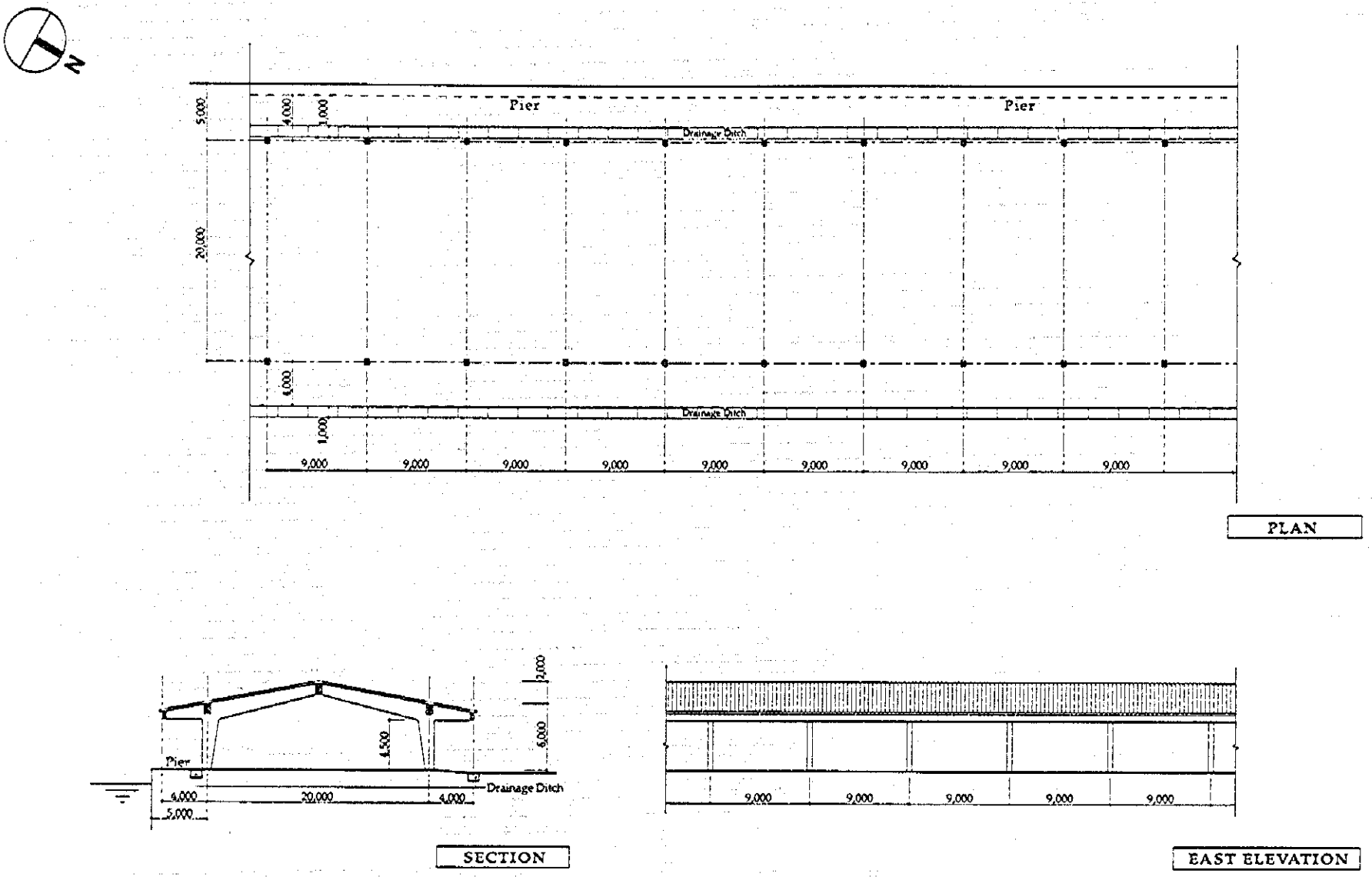


Figure. 6.4.29 (2) Marketing Hall - Expansion Plan Plan, Section, Elevation Scale = 1 : 500

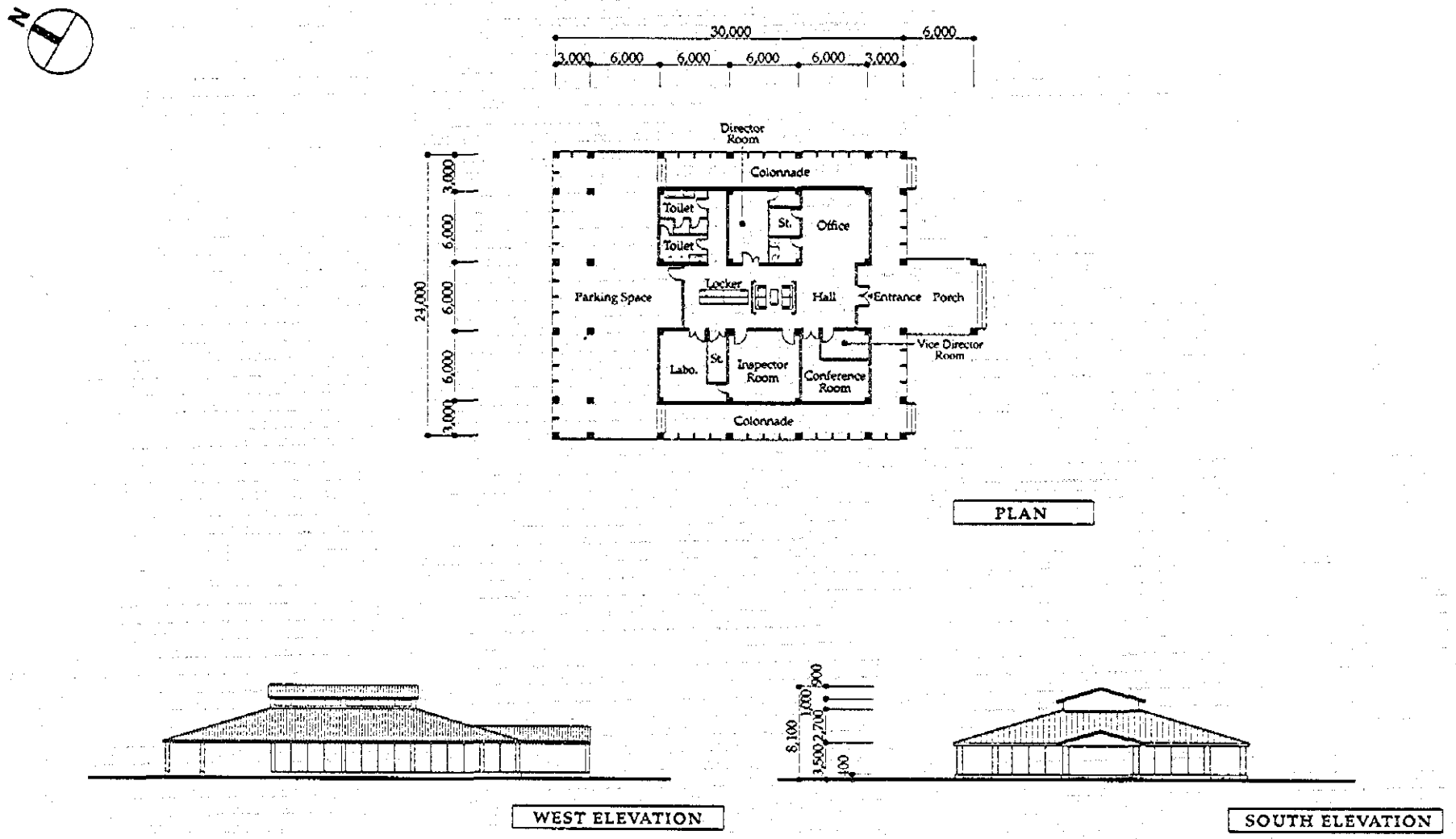
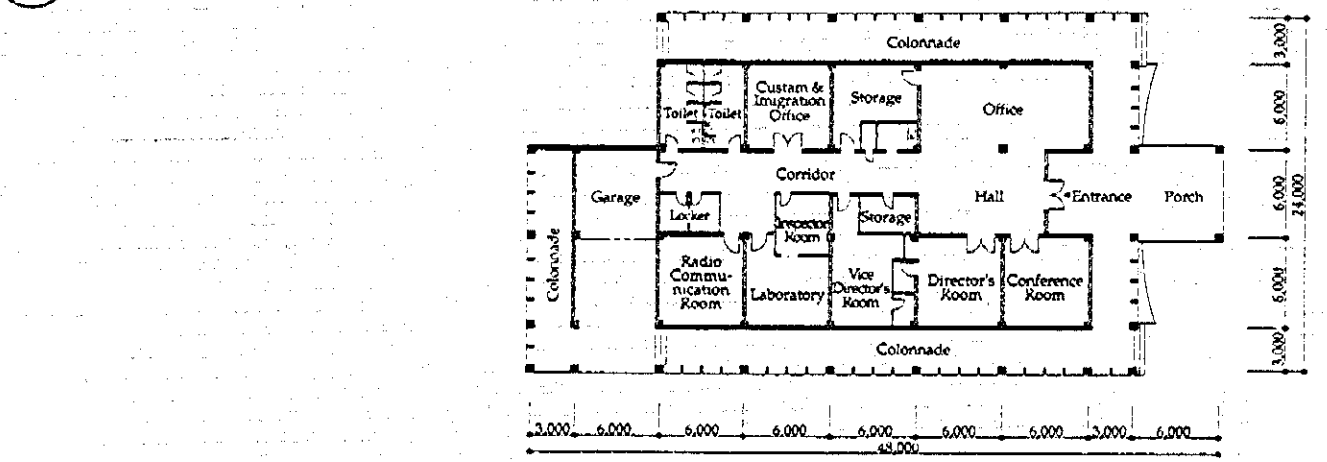
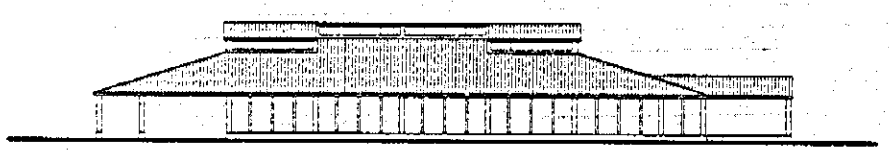


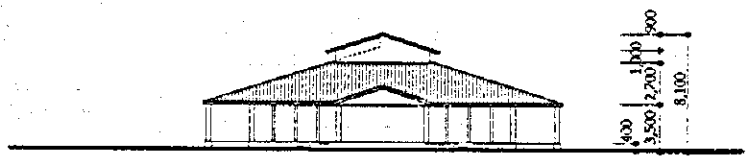
Figure. 6.4.30 DOF Office Plan, Elevation Scale = 1 : 500



PLAN



WEST ELEVATION



SOUTH ELEVATION

Figure. 6.4.31 FMO Office ..... Plan, Elevation

Scale = 1 : 500

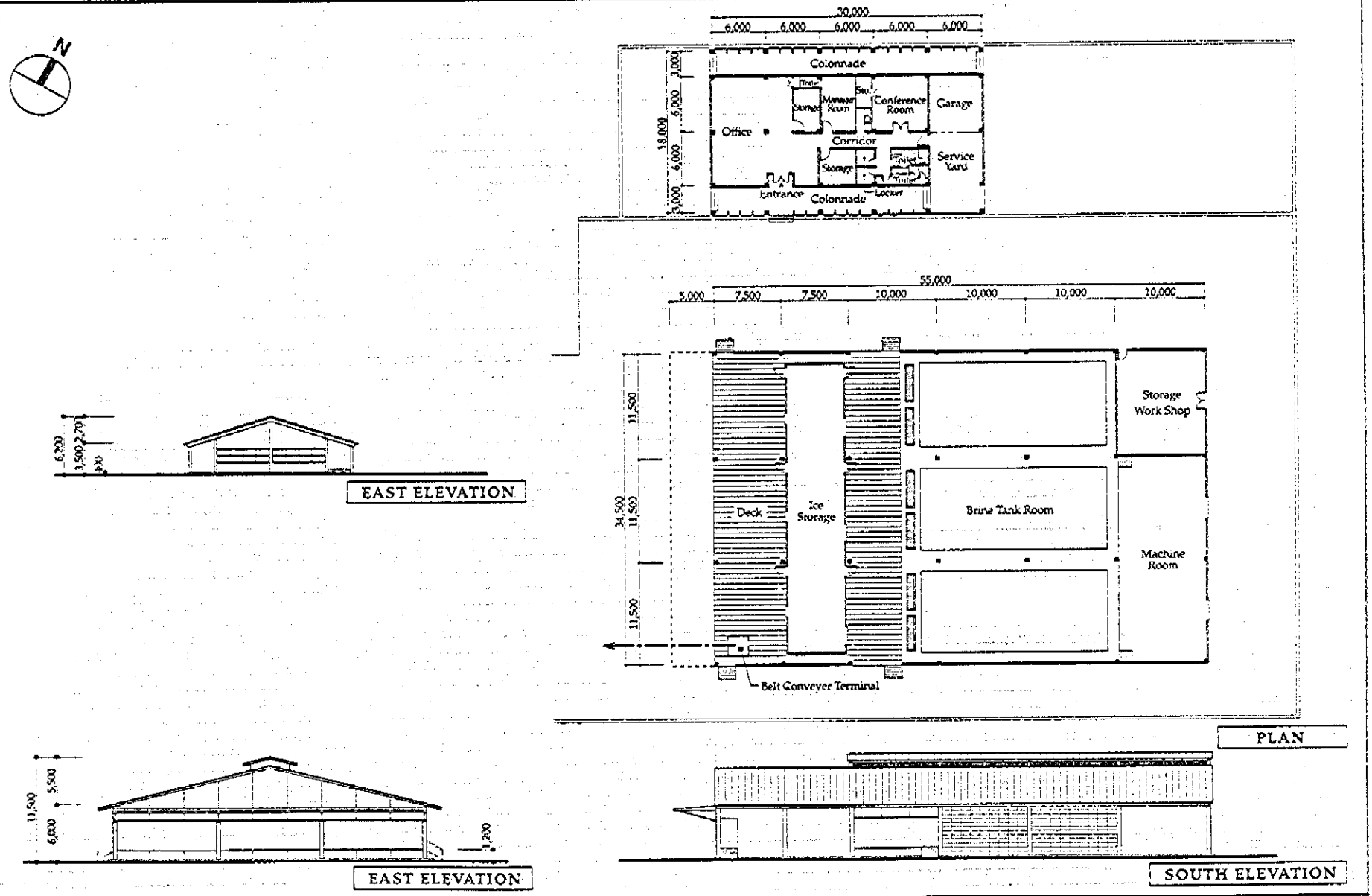


Figure. 6.4.32 Ice Plant Plan, Elevation Scale = 1 : 600

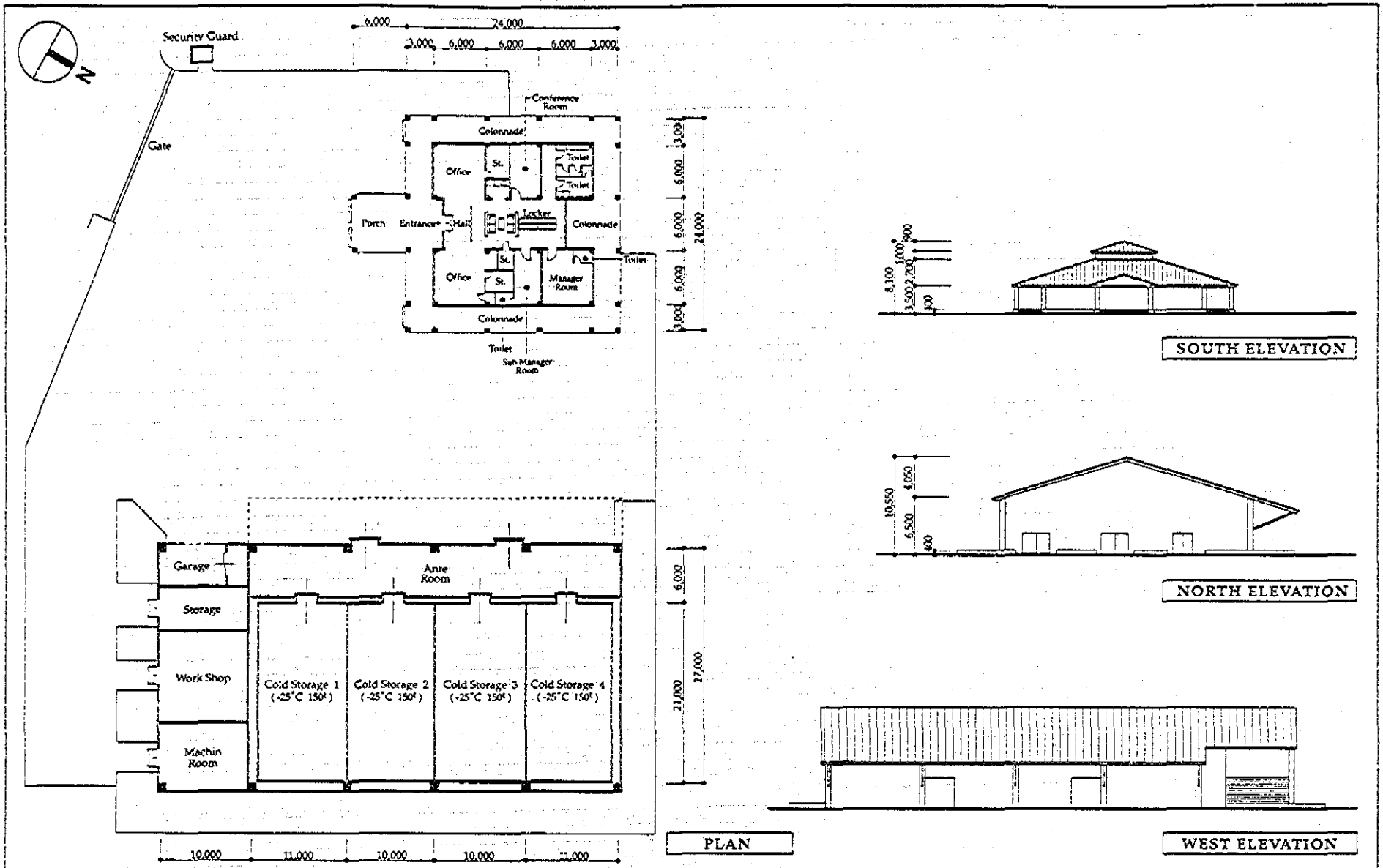


Figure. 6.4.33 Cold Strage Plan, Elevation Scale = 1 : 600

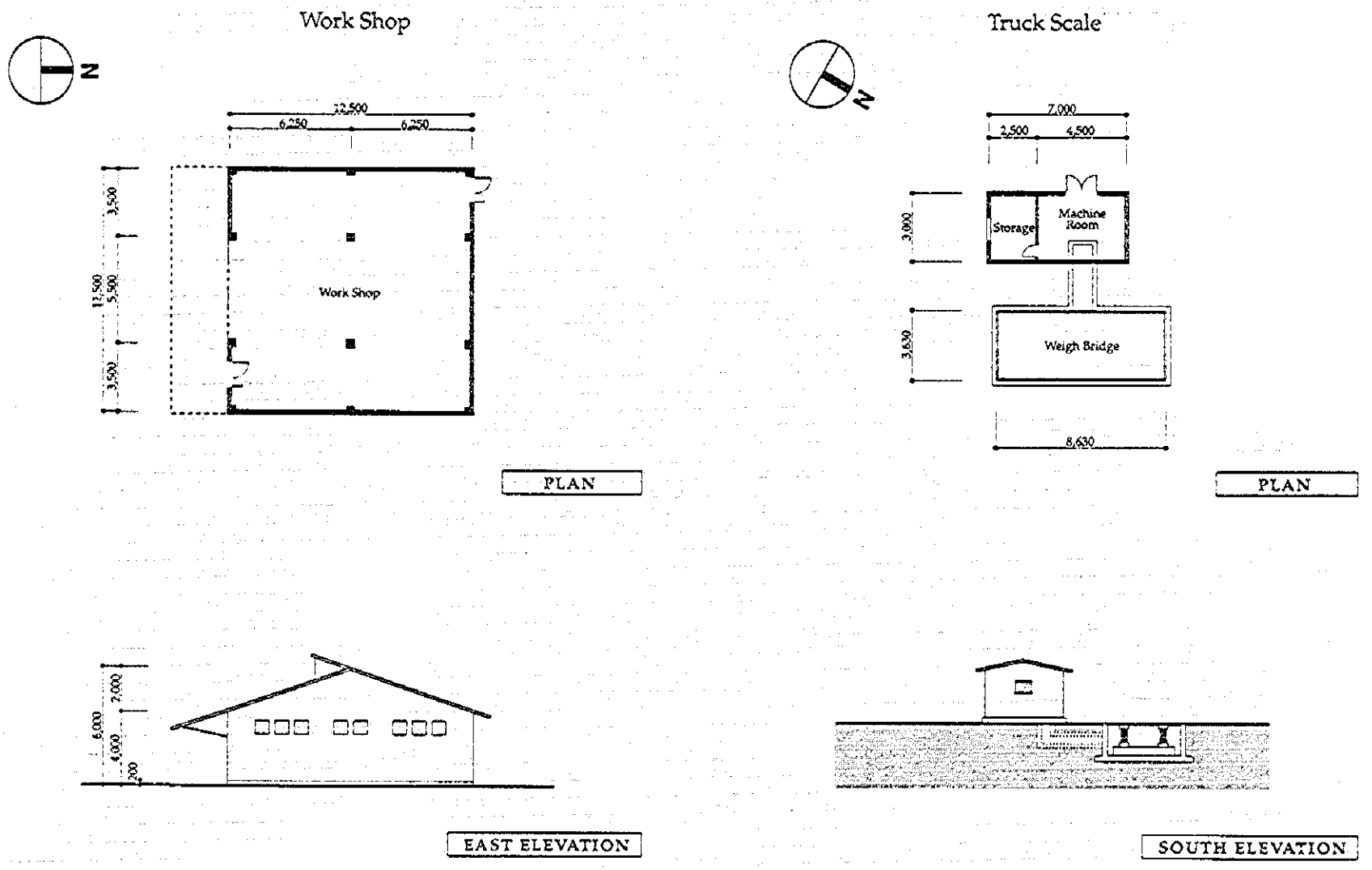


Figure. 6.4.34 Work Shop, Truck Scale Plan, Elevation Scale = 1 : 300

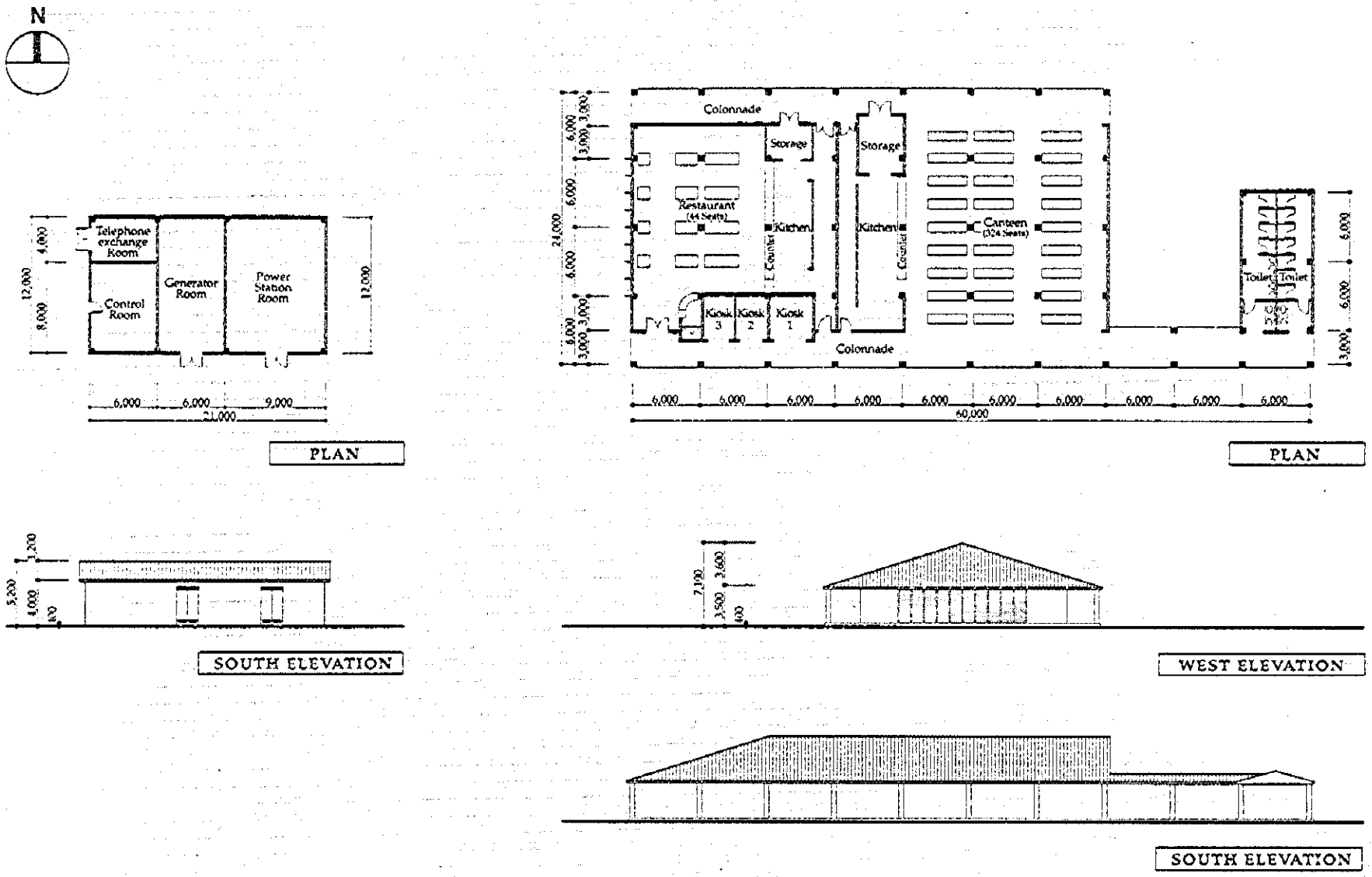


Figure. 6.4.35 Electric Incoming Station Canteen / Restaurant / Shop Plan, Elevation Scale = 1 : 500

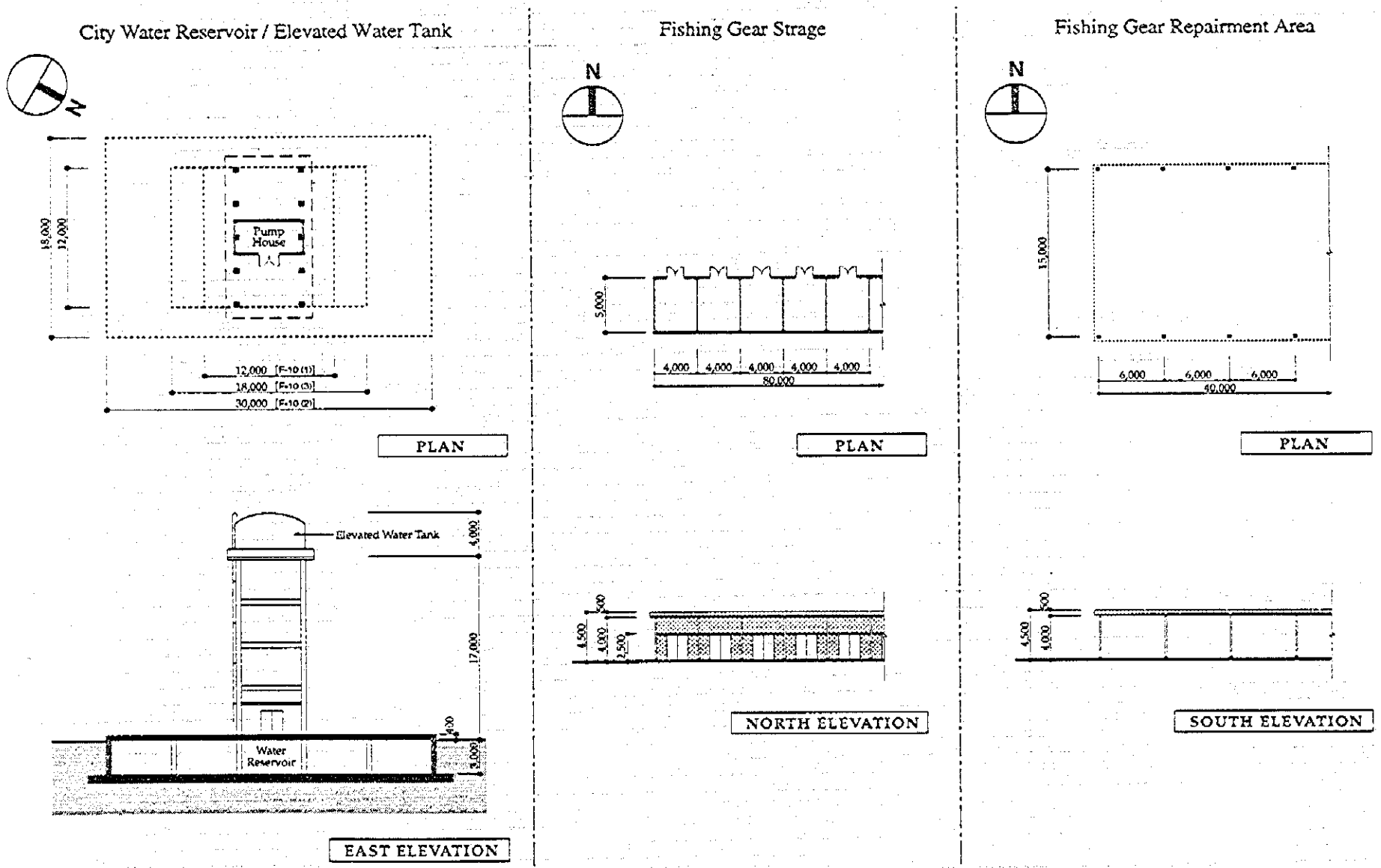


Figure. 6.4.36 City Water Reservoir / Elevated Water Tank, Fishing Gear Storage, Fishing Gear Repairment Area Plan, Elevation Scale = 1 : 500

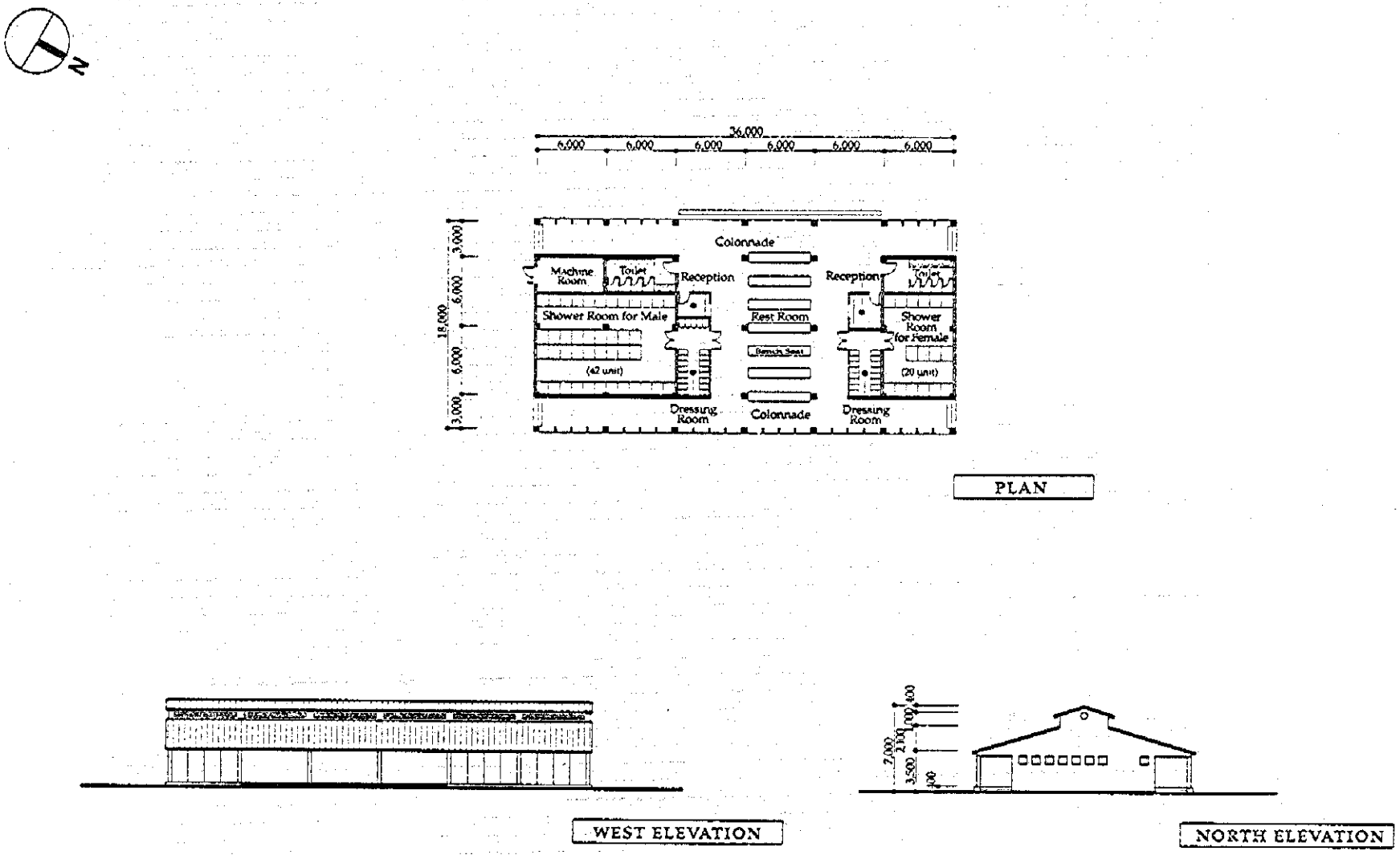


Figure. 6.4.37 Service Building for Wharf Workers Plan, Elevation Scale = 1 : 500

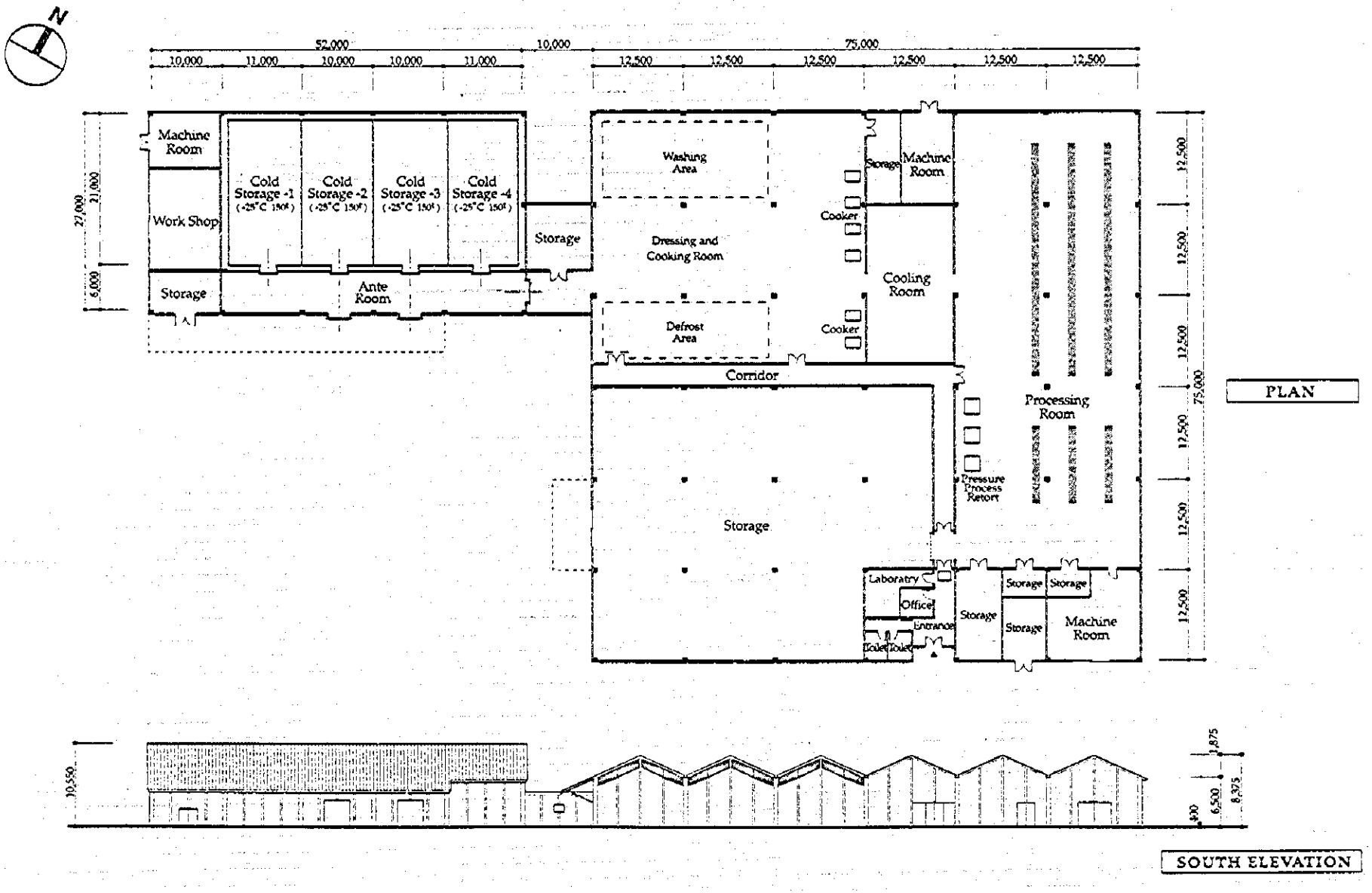


Figure. 6.4.38 Tuna Canning Plant - Plant Building Plan, Elevation Scale = 1 : 750

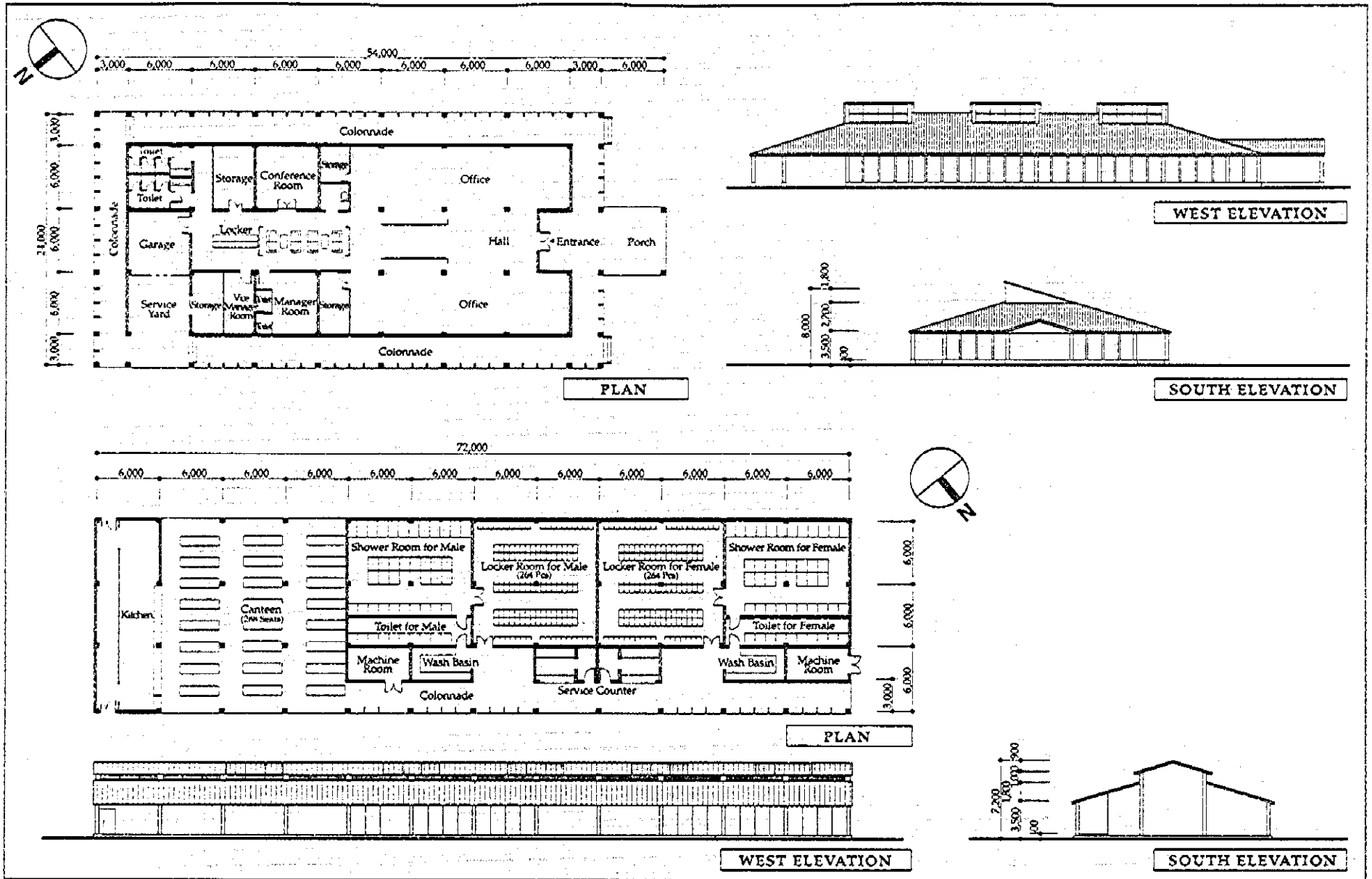


Figure. 6.4.39 Plant's Administration Building - Service Building Plan, Elevation Scale = 1 : 500

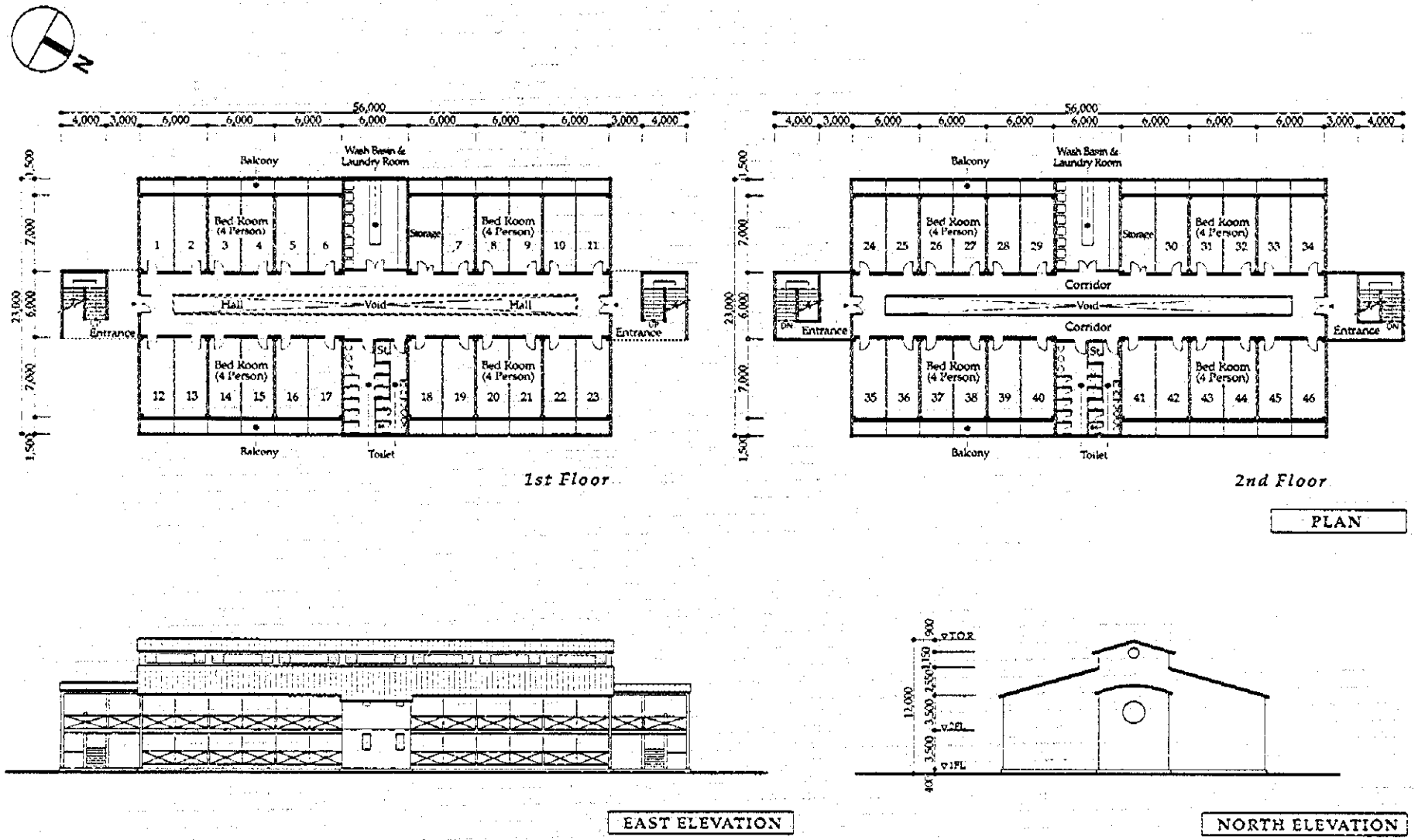


Figure. 6.4.40 Tuna Canning Plant - Dormitory Plan, Elevation Scale = 1 : 500

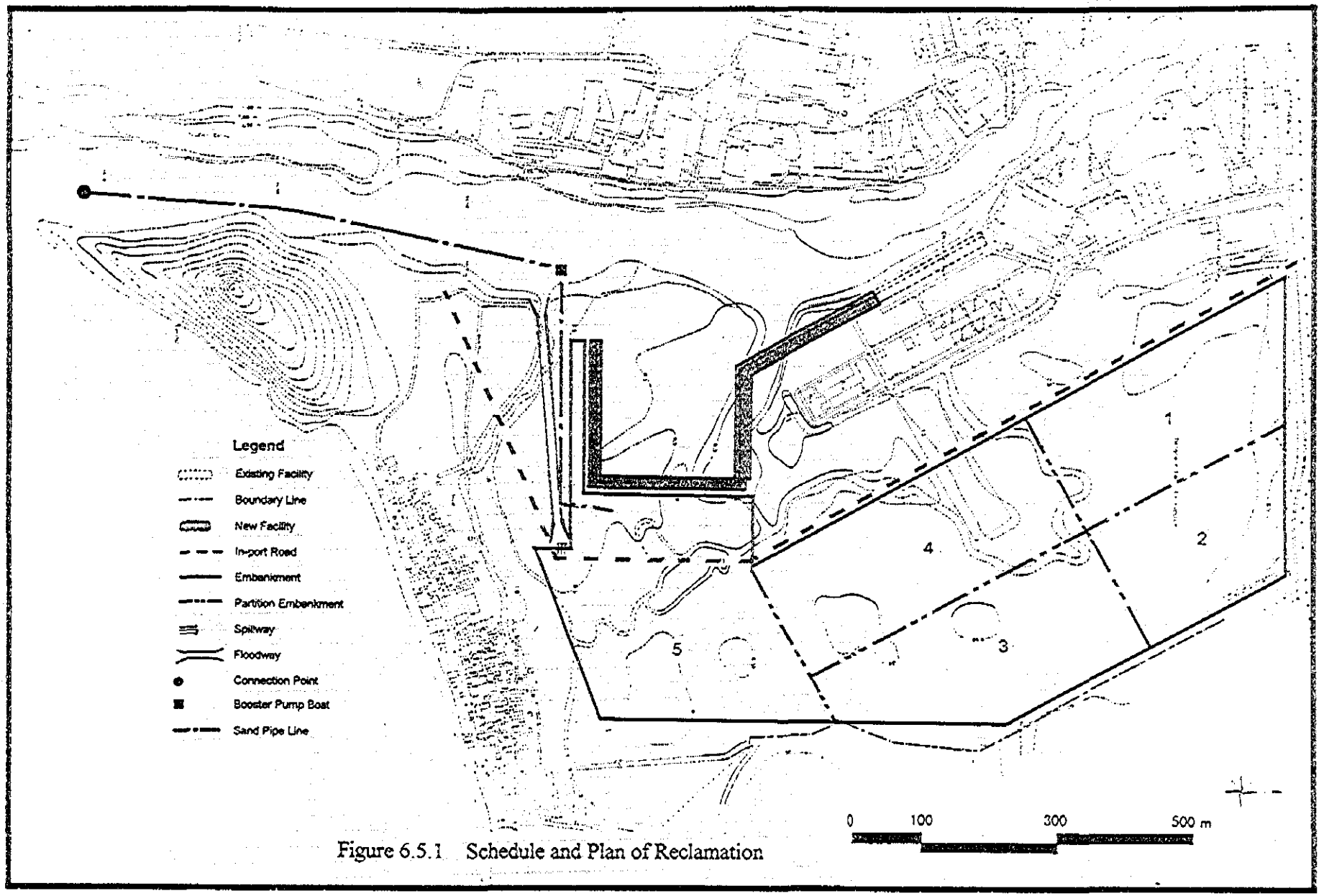


Figure 6.5.1 Schedule and Plan of Reclamation

Table 6.4.1 Floor Area, Foundation and Structure of Functional Facilities in Short-term Development Plan

	Functional Facilities	Number of Bldg.	Number of Story	Total Floor Area (sq.m)	Type of Foundation	Structure	Remarks
1	Marketing Hall - Enlarging works	1	1	6,240	Pilling	R.C.	Folklift
2	DOF Office	1	1	414	Pilling	R.C.	Food inspection equipment
3	FMO Office	1	1	558	Pilling	R.C.	Radio communication system
4	Ice Plant / Ice Storage						
	4.1 Plant building	1	1	1,265	Pilling	Steel	Brine tank, Overhead crane
	4.2 Administration building	1	1	360	Pilling	Steel	
	4.3 Ice Crusher Tower	1	1	-	Pilling	Steel	Ice crusher, Shooter
5	Cold Storage						
	5.1 Plant building	1	1	1,404	Pilling	Steel	
	5.2 Administration building	1	1	324	Pilling	Steel	
6	Workshop	1	1	156	Pilling	Steel	Repair tools
7	Electric Incoming Station						
	7.1 On Si Rae Island Site	1	1	252	Pilling	R.C.	
8	City Water Reservoir / Elevated Water Tank						
	8.1 for FMO's facilities in Si Rae Island Site	-	-	144	Pilling	R.C.	Water pump
9	Waste Water Treatment						
	9.1 for FMO's facilities in Si Rae Island Site			(Total)	Pilling		
10	Fishing Gear Storage	1	1	400	Spread	Steel	
11	Fishing Gear Repairment Area	1	1	600	Spread	Steel	
12	Fish Box Storing Area	-	-	6,350	-	-	
13	Canteen / Restaurant / Shop	1	1	1,008	Pilling	R.C.	
14	Public W. C.	4	1	72 x 4	Pilling	R.C.	
15	Rubbish Disposal	-	-	50	Spread	R.C.	
16	Guard Box	2	1	6.25 x 2	Spread	R.C.	
17	Jetty Watchman Box	3	1	6.25 x 3	Spread	R.C.	
18	Auction Watchman Box	1	1	19	Pilling	R.C.	
19	Service Building for Wharf Workers	1	1	432	Pilling	R.C.	
20	Sea-water Pump House / Reservoir Tank	-	-	100	Pilling	R.C.	Water pump
21	Truck Scale	1	1	25	Pilling	R.C.	Scale

Table 6.4.2 Floor Area, Foundation and Structure of Processing Plant Facilities in Short-term Development Plan

	Functional Facilities	Number of Bldg.	Number of Story	Total Floor Area (sq.m)	Type of Foundation	Structure	Remarks
1	City Water Reservoir / Elevated Water Tank						
	1.1 for Industrial Estate in Si Rae Island Site	-	-	540	Pilling	R.C.	Water pump
2	Waste Water Treatment						
	2.1 for Industrial Estate in Si Rae Island Site	-	-	5,000	-	-	Airation Pump
3	Tuna Canning Plant						
	3.1 Plant building	6	1	7,174 x 6	Pilling	Steel	Processing machine, Cold storage
	3.2 Administration building	6	1	738 x 6	Pilling	R.C.	
	3.3 Service building	6	1	1,296 x 6	Pilling	R.C.	
	3.4 Dormitory	12	2	2,744 x 12	Pilling	R.C.	

Table 6.5.1 Implementation Schedule

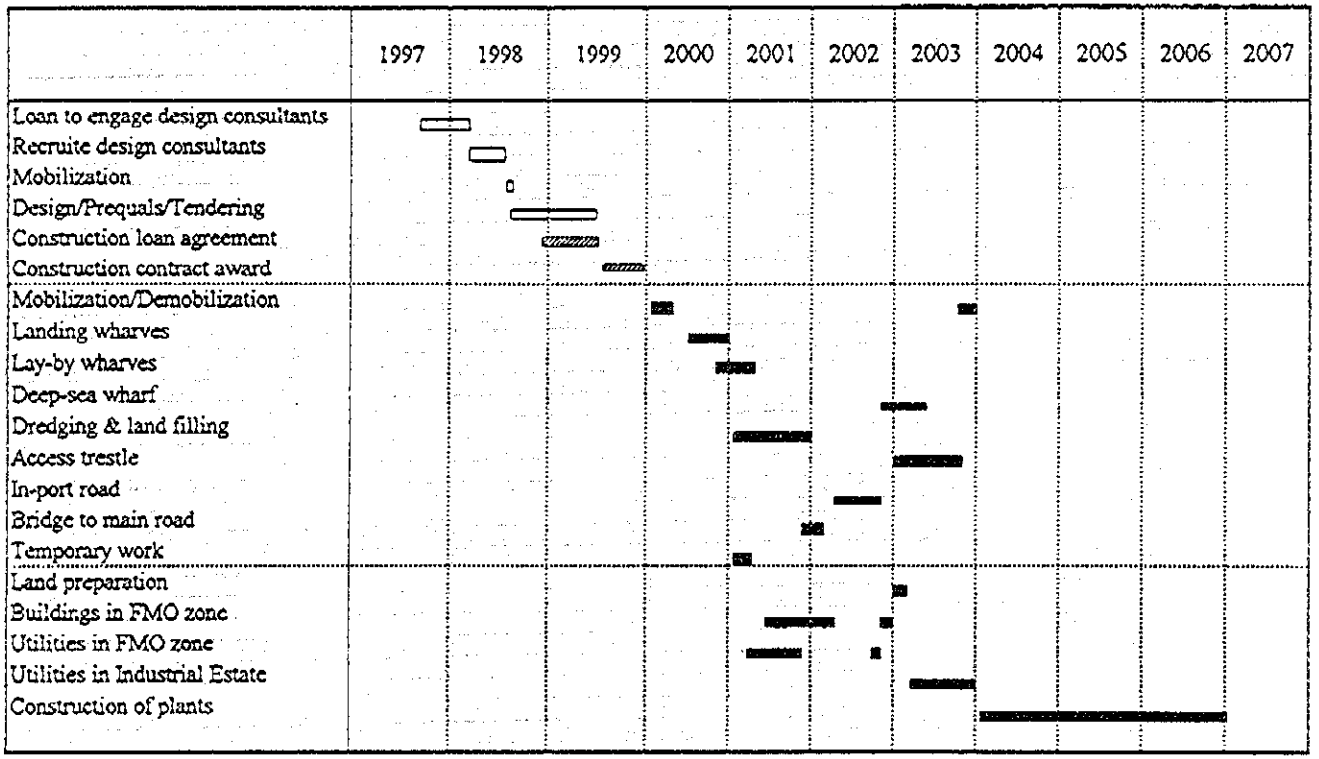


Table 6.5.2 Construction Cost

	Item	Quantity	Total Cost	Foreign Currency	(Unit: ,000 Baht) Local Currency
1	Landing Wharf for Existing Fishing Boats and Long liners	335 m	83,750	40,200	43,550
2	Lay-by Wharf	380 m	90,250	42,418	47,833
3	Deep-sea Wharf	210 m	111,563	78,094	33,469
4	Access Trestle	700 m	113,750	45,500	68,250
5	Dredging	1,800,000 m^3	450,000	360,000	90,000
6	In-port Road	1,600 m	27,000	0	27,000
7	Bridge to City Road	15 m	3,375	0	3,375
8	Aids to Navigation	Lump sum	20,740	18,715	2,025
9	Temorary Jetty	Lump sum	4,800	0	4,800
10	Mobilization/Demobilization	Lump sum	31,250	29,688	1,562
	Total		936,478	614,614	321,864
11	Detailed Design and Engineering Investigation		93,648	60,871	32,777
12	Contengency		83,916	48,932	34,984
	GRAND TOTAL (excluing VAT)		1,114,042	724,417	389,625
	VAT 7%		77,983	50,709	27,274

Table. 6.5.3 Construction Cost of Fishing Port Facilities (Short Term Plan)

I. Fishing Port Functional Facilities and External/Infrastructure — unit : 1,000Baht

	Item	Unit	Qty	Total floor area of 1 lot (sqm)	Total floor area (sqm)	Total Cost	Foreign Currency	Local Currency
Public 1. Fishing Port Functional Facilities								
1	Marketing Hall - Enlarging works	Lot	1	6,240.00	6,240.00	37,995	0	37,995
2	DOF Office	Lot	1	414.00	414.00	23,941	16,560	7,381
3	FMO Office	Lot	1	558.00	558.00	11,637	2,530	9,107
4	Ice Plant / Ice Storage / Ice Crusher Tower	Lot	1	2,258.00	2,258.00	123,004	75,739	47,265
5	Cold Storage	Lot	1	1,704.00	1,704.00	45,014	19,550	25,464
6	Workshop	Lot	1	156.00	156.00	10,938	8,947	1,991
7	Electric Power Station	Lot	1	252.00	252.00	2,217	0	2,217
8	City Water Reservoir / Elevated Water Tank	Lot	1	-	-	8,863	0	8,863
9	Waste Water Treatment	Lot	1	-	-	11,995	0	11,995
10	Fishing Gear Storage	Lot	1	400.00	400.00	2,706	0	2,706
11	Fishing Gear Re-ailment Area	Lot	1	600.00	600.00	4,600	0	4,600
12	Canteen / Restaurant / Shop	Lot	1	1,008.00	1,008.00	12,076	0	12,076
13	Others	-	-	-	-	13,690	368	13,322
	Sub-total					308,506	123,694	184,872
14	Detailed Design and Engineering Service					13,416		
15	Overhead and Profit					18,782		
	Total - 1					340,704		
Public 2. External Works and Infrastructure								
1	External Works and Infrastructure					145,098	0	145,098
	Sub-Total					145,098	0	145,098
2	Detailed Design and Engineering Service					6,309		
3	Overhead and Profit					8,832		
	Total - 2					160,240		
Total - I						501,003		

II. Industrial Estate in Si Rae Island — unit : 1,000Baht

	Item	Unit	Qty	Total floor area of 1 lot (sqm)	Total floor area (sqm)	Total Cost	Foreign Currency	Local Currency
Public 1. Facilities								
1	City Water Reservoir / Elevated Water Tank	Lot	1	-	-	16,057	0	16,057
2	Waste Water Treatment	Lot	1	-	-	70,380	0	70,380
3	Estate Office	Lot	1	414.00	414.00	6,403	0	6,403
	Sub-Total					92,840	0	92,840
4	Detailed Design and Engineering Service					4,036		
5	Overhead and Profit					5,651		
	Total - 1					102,527		
Public 2. External Works and Infrastructure								
1	External Works and Infrastructure					180,835	0	180,835
2	Detailed Design and Engineering Service					7,862		
3	Overhead and Profit					11,007		
	Total - 2					199,704		
Private. Processing Factory								
1	Tuna Canning Plants and related facilities	Lot	6	14,696.00	89,176.00	1,000,856	31,671	969,185
	Sub-Total					1,000,856	31,671	969,185
2	Detailed Design and Engineering Service					43,515		
3	Overhead and Profit					60,922		
	Total - 3					1,105,293		
Total - II						1,407,525		
Grand Total (excluding VAT)						1,908,528		