6) Superimposed load
The superimposed load on the quay consists of the dead load of the structure and live loads, such as fish cargoes and other cargo handling equipment and vehicles.

The load of cargo handling equipment traveling on the quay is the total weight or the maximum wheel load taking the wheel interval and number of wheels into account.

The wheel load is taken from the Specification for Road Bridge with Commentary, for example T-14.

The surcharge in ordinary condition is determined with due consideration to the kind, type of packing and quantity of the cargo to be handled, method of handling and period of loading.

7) Design wave

(i) Maximum wave height, period and wave direction

The predominant direction of deepwater wave is from south to southwest, but north west direction waves are recorded in 1.3% occurrence rate.(Table 2-1-5) So, waves at each site are examined using both directions.

Waves at each site are generated from the swell with regularity throughout the year and the predominant wave periods are estimated between 14-16 sec judging from the wave observation at Manta.

(ii) Design wave height

Deep water wave:
Following dimensions of deep water wave are adopted in order to determine the design wave.

Wave direction	Wave height Ho(m)	Wave period T(sec)	Wave length Lo(m)
WSW	4.0	15	351
NW	3.0	15	351

Design wave height:
At first, equivalent deep water wave height (H') is analyzed using the wave refraction diagram and then design wave height at planned depth is calculated based on the shoring effect. The calculation process are shown in Table 3-6-4(1),(2),(3),(4). The design wave heights (H) at each site are determined as follows.

Site	Manta	San Mateo	Machalilla	Pto.Lopez
Planned depth	-3.0m	-5.0m	-7.0m	-7.0m
Wave height	3.7m	4.2m	3.4m	4.0m

In the case of Manta Alternative(1), the planned fishing port are sheltered by the existing breakwater and waves coming from deep water area are diffracted. So, its design wave height becomes smaller than others and determined as follows.(ref. Table 3-6-4(5)) Fig. 4-5-3 shows the diffraction diagram.

Manta: H=2.2m h=3m

8) Design tide level
The design tide level was determined on the basis of analysis of existing water level observation records by ESPOL.

Maximum design tide level (MHWS): +2.96m
Minimum design tide level (MLWS): +0.00m

9) Allowable stresses
Concrete: Design strength 210kg/cm²
Reinforcing bars: Allowable tensile unit stress 1,400kg/cm²

10) Unit weight of materials

Reinforced concrete:	2.45
Concrete:	2.30
Stone:	2.60
Sand, gravel, cobble (Dry):	1.80
Sand, gravel, cobble (Wet):	2.00

11) Safety factor

Item	Normal	Abnormal
Overturning	1.2	1.1
Sliding	1.2	1.0
Circle failure sliding	1.3	-
Straight failure sliding	1.2	-
Bearing capacity for shallow foundation	2.5	-
Bearing capacity for deep foundation	2.5	1.5
Allowable bearing capacity at the toe of structure	50 tons/m2	50 tons/m2

(4) Preliminary Design

1) Design of gravity type quaywall
(Manta, San Mateo)

(i) Design conditions
- Purpose: landing fish catches
- Length of quaywall: ref. the figure
- Planned depth: -3.0m
- Crest level: +3.50m (+3.456 ≒ +3.5)
- Width of apron: 10m, 3%
- Surcharge: 0.50 t/m^2 (in ordinary condition)
  0.25 t/m^2 (in special condition)
- Berthing speed: 0.50 m/sec.
- Arrangement of mooring posts: 5.0m intervals

(ii) Marine condition
- Tidal level: MHWS +2.96 (D.L.)
  MLWS +0.00 (D.L.)
- Residual water level: (2.96 - 0.00) x 2/3 = 1.97
  R.W. R.W.L. = 0 + 1.97 = 2.0m

(iii) Condition of ground
- Bearing layer of base: Sand or sand with gravel
- Seismic coefficient: 0.10
  Apparent seismic coefficient under water

$$= \frac{r}{r - 1} \times \text{design seismic coefficient}$$

$$= \frac{2.0}{2.0 - 1} \times 0.10 = 0.20$$

where, unit weight of soil (day) = 2.0 t/m^3

(iv) Principal dimension of the structure
Designed typical cross section is shown in Fig. 3-6-3.

2) Design of open-type quay with vertical piles
(Pto.Lopez, Machalilla)

(i) Design Conditions
- Purpose: landing fish catches
- Length of quaywall: ref. the figure
- Planned depth: -3.0m (D.L.)
- Crest level: +3.50m
- Width of apron: 10.0m 3%
- Surcharge: 1.0 t/m^2 (in ordinary condition)
  0.5 t/m^2 (in special condition)
- Live load: T-14
- Dimensions of the fishing boat: 40GT Draft 2.20m
- Berthing speed: 0.5m/sec
- Tractive force: 3t
- Arrangement of mooring posts: 5m intervals

(ii) Marine conditions

- Tide level: MHWS +2.96 (D.L.)
  : MLWS +0.00 (D.L.)

(iii) Condition of ground

- Bearing layer of base: Sand, N value is 5.

(iv) Principal dimension of the structure

Designed typical cross section is shown in Fig. 3-6-4.

3) Design of slope structure for fish landing of small boat (Manta, San Mateo, Machalilla, Pto.Lopez)

(i) Design Conditions

- Purpose: landing fish catches
- Length of quaywall: ref. the figure
- Planned depth: -1.0m
- Crest level: 3.5m (D.L.)
- Slope of slipway: 1/8
- Thickness of cobble foundation: 30cm
- Thickness of pavement: 20cm
- Thickness of concrete block: 30cm
  (under water)

(ii) Principal dimension of the structure

Designed typical cross section is shown in Fig. 3-6-5.

4) Design of breakwater(Manta, San Mateo, Machalilla, Pto.Lopez)

(i) Design conditions

- Wave height: shown below
- Water depth: shown below
- Tide level: MHWS +2.96m
- Soil of seabed: sand

Site	Manta	San Mateo	Machalilla	Pto.Lopez
Planned depth	-3.0m	-5.0m	-7.0m	-7.0m
Wave height	3.7m	4.2m	3.4m	4.0m

(ii) Design of structure of breakwater

Design of breakwater is to be carried out considering basically layout, construction conditions, availability of construction materials, etc. Rubble mound breakwater is selected according to technical evaluation.

(iii) Crest elevation

Crest elevation is calculated to add M.H.WS and R_L
where $R_L = 0.8\ H$

Site	Manta	San Mateo	Machalilla	Pto.Lopez
RL	3.0m	3.4m	2.7m	3.2m
Crest elevation	6.0m	6.4m	5.7m	6.2m

(iv) Structure

Side slopes of rubble mound breakwater are as follows;

Slope of sea side: 1 : 1.5

Slope of harbour side: 1 : 1.25

(v) Weight of rubble covering the slope surface of the structure receiving the action of the wave forces can be calculated by using the following formula.

$$W = \frac{\tau_r \, r^3 H^3}{K_D \cot\alpha (\tau_r - r)^3}$$

where
W: Minimum weight of rubbles (t)
r: Unit weight of sea water, 1.03(t/m^3)
τr: Unit weight of rubble in air, 2.6(t/m^3)
α: Angle of the slope to horizontal plane (degree)
H: Wave height (m)
KD: Constant determined by the armoring material and damage rate, 8

Site	Manta	San Mateo	Machalilla	Pto.Lopez
W(ton)	3.0	4.5	2.4	3.9
Planned weight	3ton	5ton	3ton	4ton

(v) Principal dimension of the structure

Designed typical cross section is shown in Fig. 3-6-7,8.

5) Design of training jetty (Manta)

(i) Design conditions

- Tide level: MHWS + 2.96m
- Water depth: -3.0m
- Wave height: 2.2m
- Soil of seabed: sand

(ii) Design of structure

Rubble mound type training jetty is selected according to technical evaluation.

(iii) Crest elevation is calculated to add M.H.W.S and 0.6H.

- Crest elevation:4.3m

(iv) Structure

Side slopes are as follows;

Slope of sea side: 1 : 1.25

Slope of harbour side: 1 : 1.25

(iv) Weight of rubbles covering the slope surface of structure can be calculated by following formula.

$$W = \frac{\tau_r \, r^3 H^3}{K_D \cot\alpha (\tau_r - r)^3}$$

where W: Minimum weight of rubbles (t)
r: Unit weight of sea water, 1.03(t/m^3)
τr: Unit weight of rubble in air, 2.6(t/m^3)
α: Angle of the slope to horizontal plane (degree)
H: Wave height at the design depth, 2.2(m)
KD: Constant determined by the armoring material and damage rate, 8

Weight of rubbles is determined as 1 ton.

(v) Principal dimension of the structure
Designed typical cross section is shown in Fig. 3-6-9.

3.6.2 Cost Estimate

(1) Main Facilities

The construction costs of the main facilities for master plans initialized Manta, Puerto Lopez, San Mateo and Machalilla are as follows;

(Exchange rate is assumed: 910 S/. per US$)

(Unit: Million Yen)

	Basic facility	Land reclamation including temporary revetments	Total
1) Manta	3,114	419	3,533
2) Puerto Lopez	2,254	84	2,338
3) San Mateo	2,714	155	2,869
4) Machalilla	1,943	73	2,016

(2) Functional Facilities

The construction costs of the functional facilities such as ice making, ice storage, etc., are estimated as follows;

1) Manta 553 (Million Yen)

2) Puerto Lopez 345 (Million Yen)

3) San Mateo 440 (Million Yen)

4) Machalilla 341 (Million Yen)

(3) Total Costs of Preliminary Estimate

Total costs of preliminary estimate including main and functional facilities are as followings;

1) Manta 4,086 (Million Yen)

2) Puerto Lopez 2,683 (Million Yen)

3) San Mateo 3,309 (Million Yen)

4) Machalilla 2,357 (Million Yen)

CHAPTER 3 TEXT FIGURES
TEXT TABLES

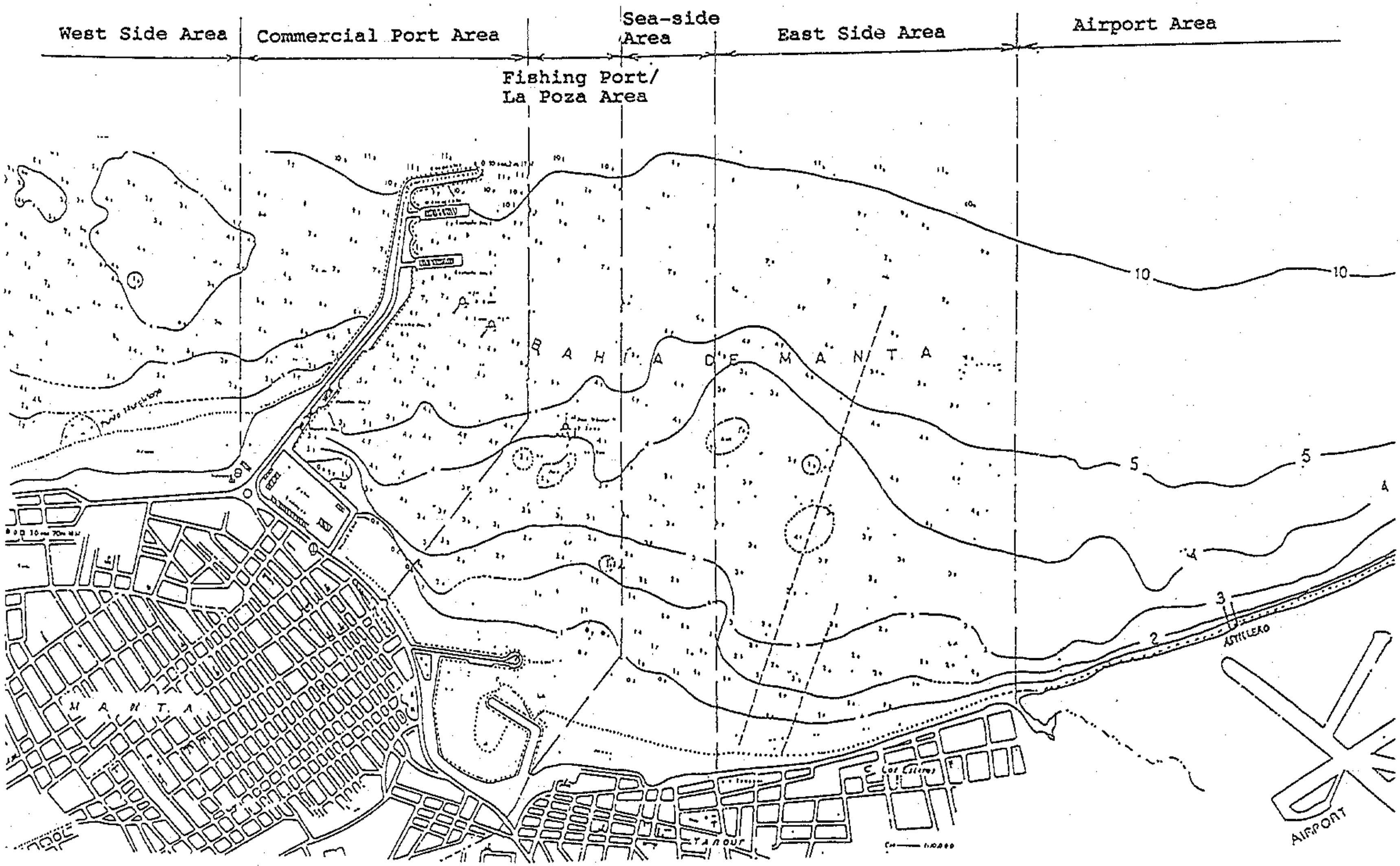
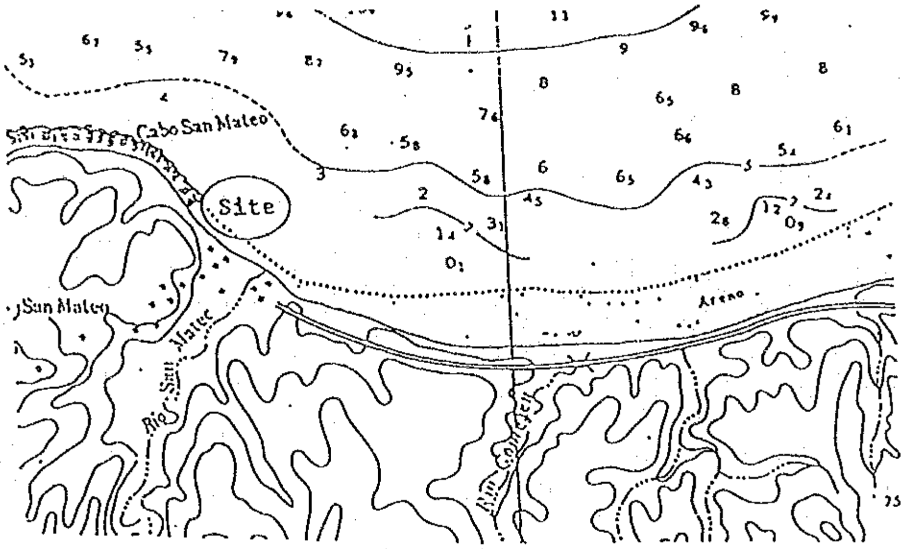
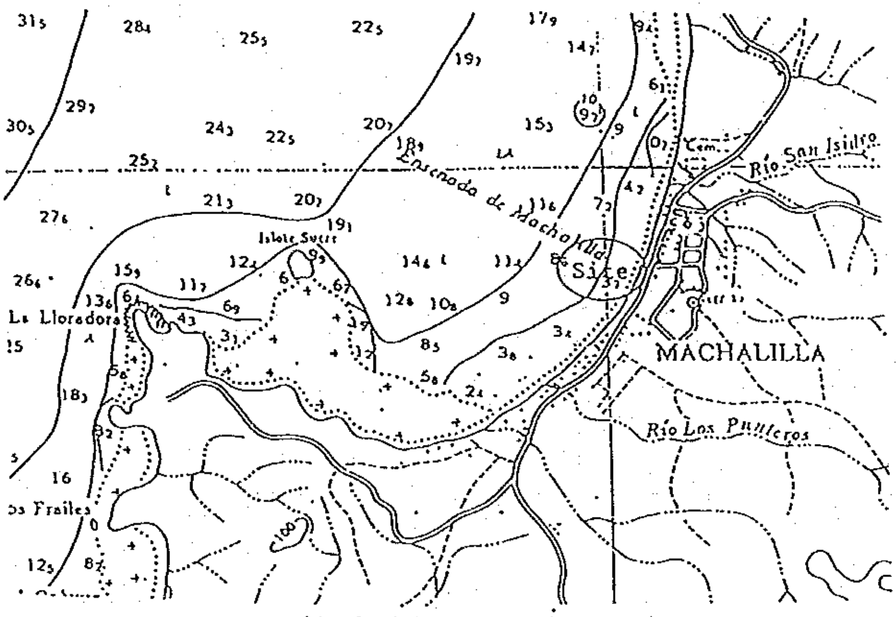


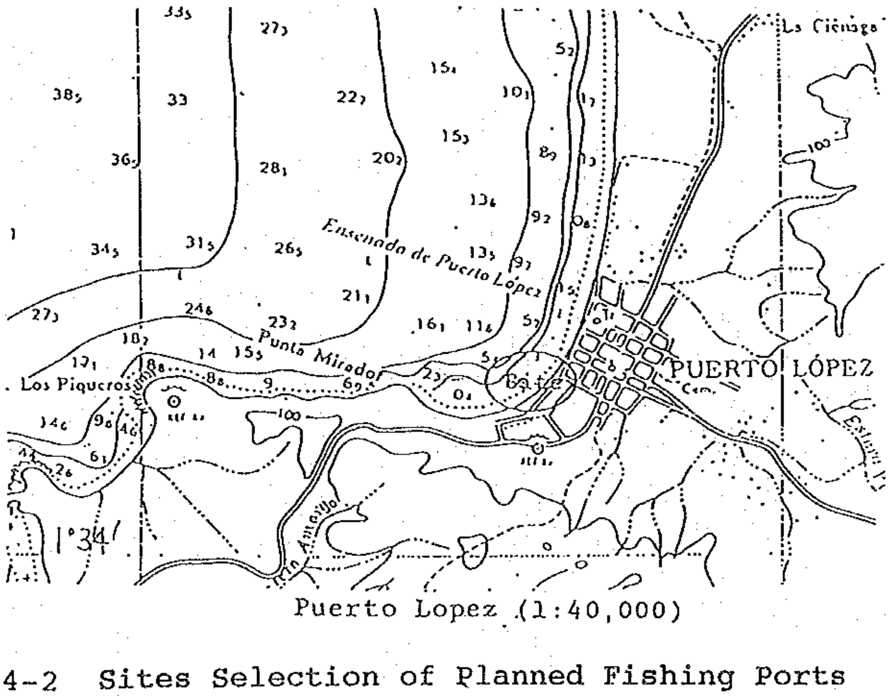
Fig.3-4-1 Zoning of Beach at Manta



San Mateo (1:25,000)



Machalilla (1:40,000)



Puerto Lopez (1:40,000)

Fig.3-4-2 Sites Selection of Planned Fishing Ports

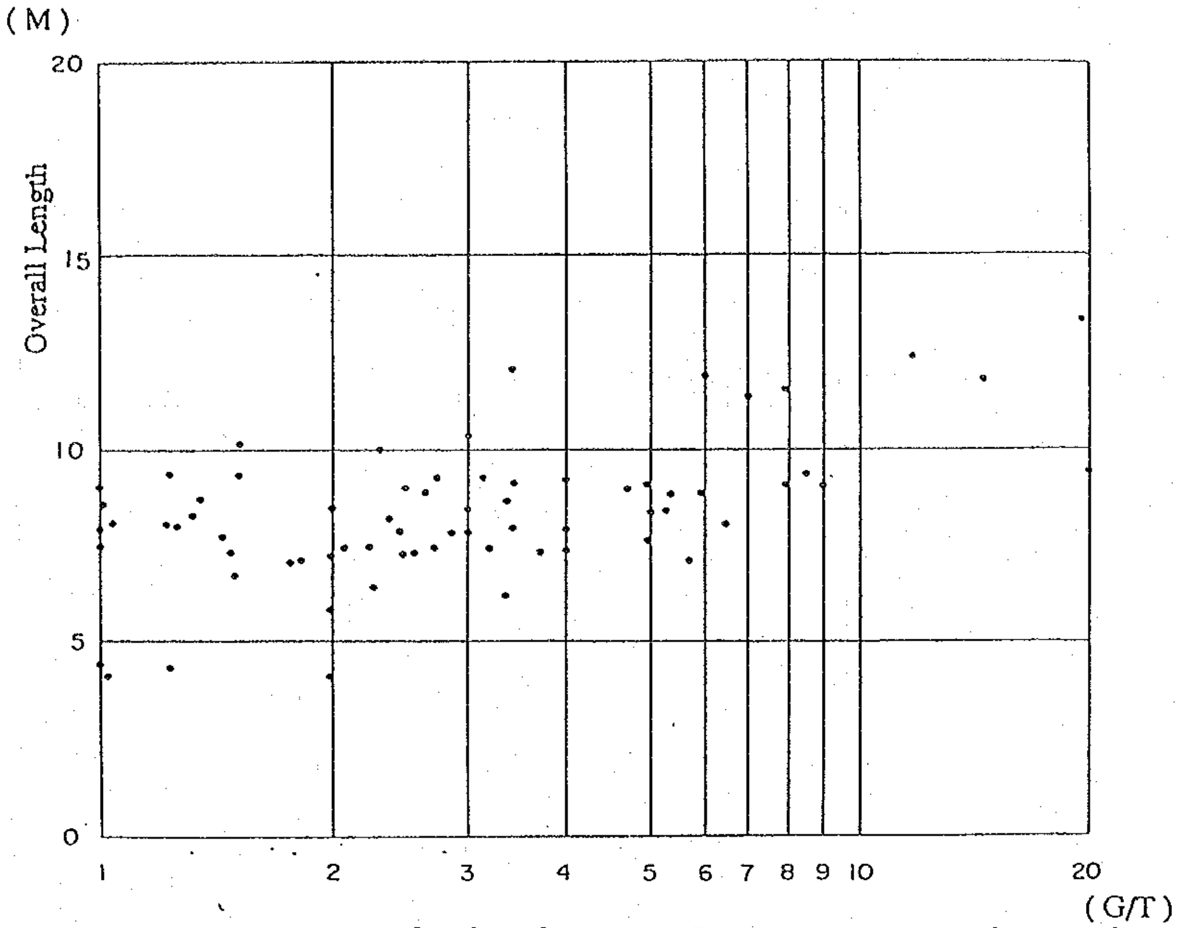


Fig.3-4-3 Correlation between Gross Tonnage and Length

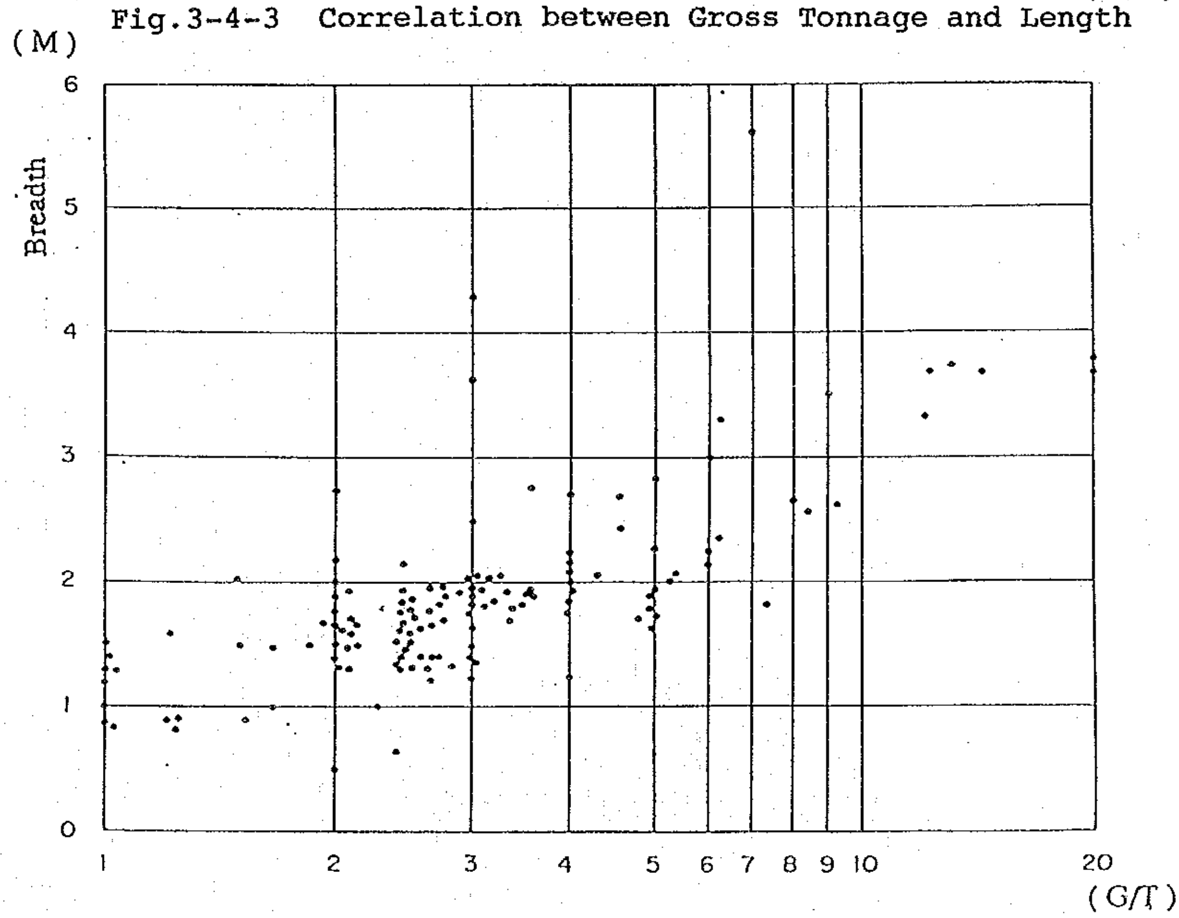
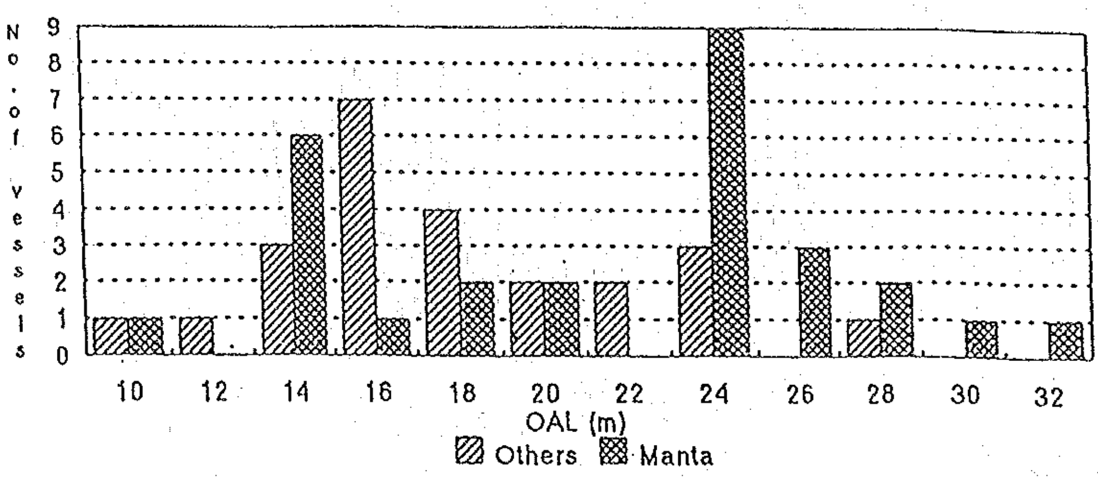
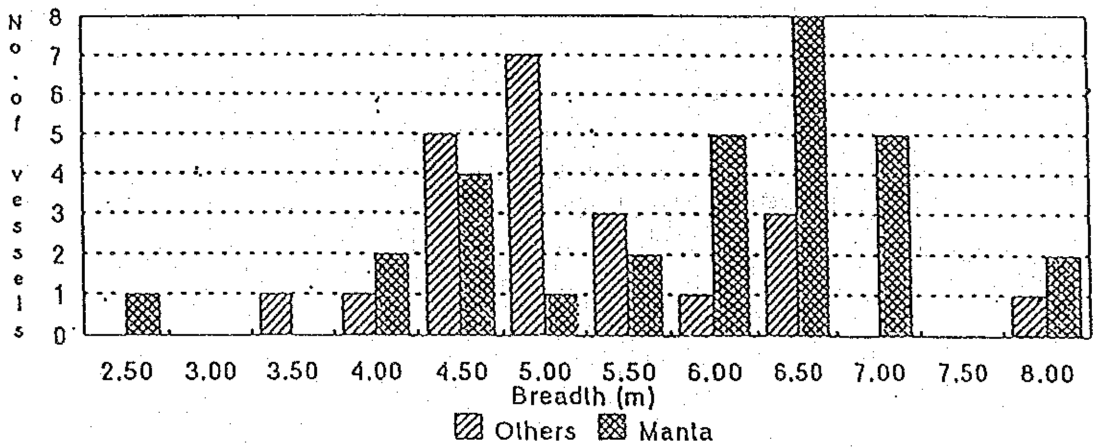


Fig.3-4-4 Correlation between Gross Tonnage and Width

(1) Overall Length



(2) Breadth



(3) Depth

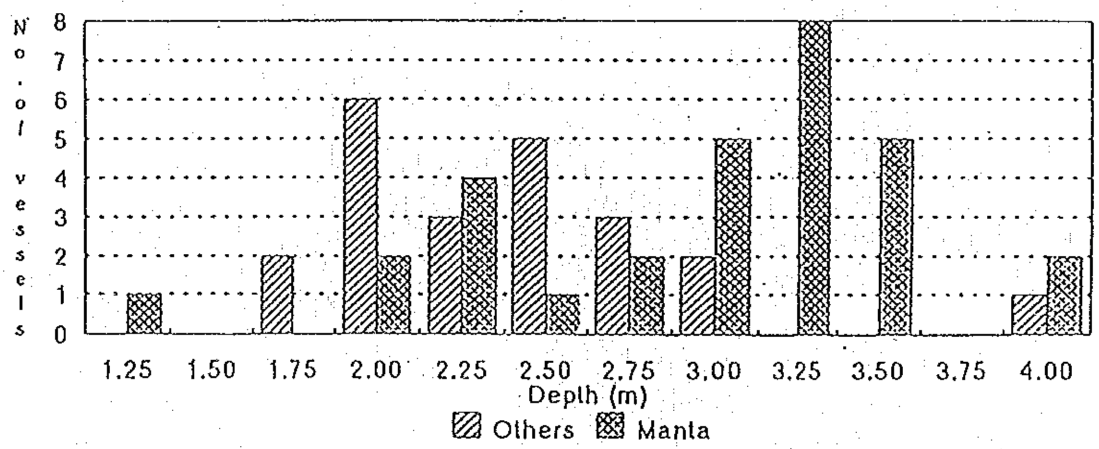


Fig.3-4-5 Histogram for Main Dimensions of Fishing Boats

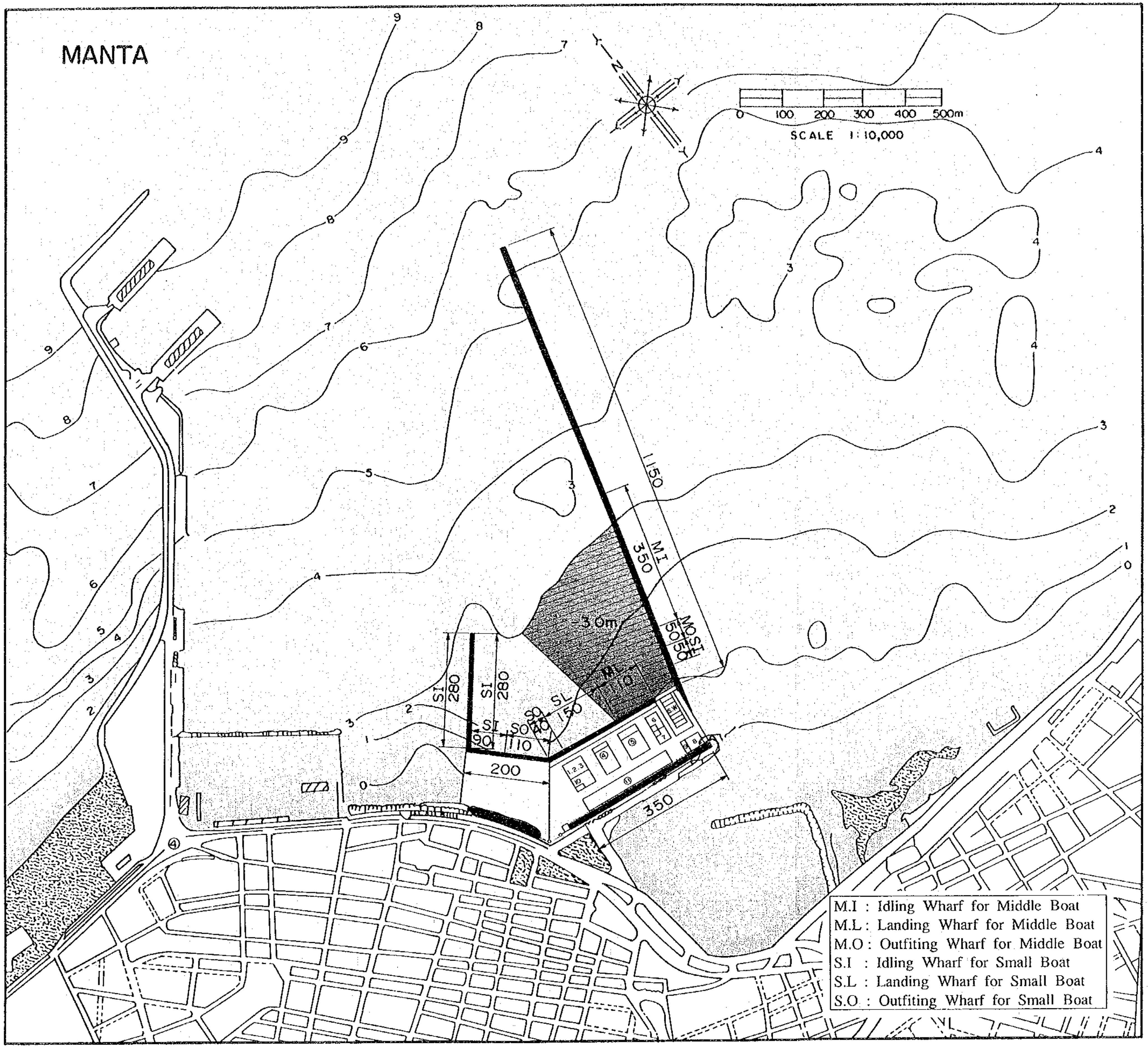


Fig.3-5-1(1) Master Plan (Manta)

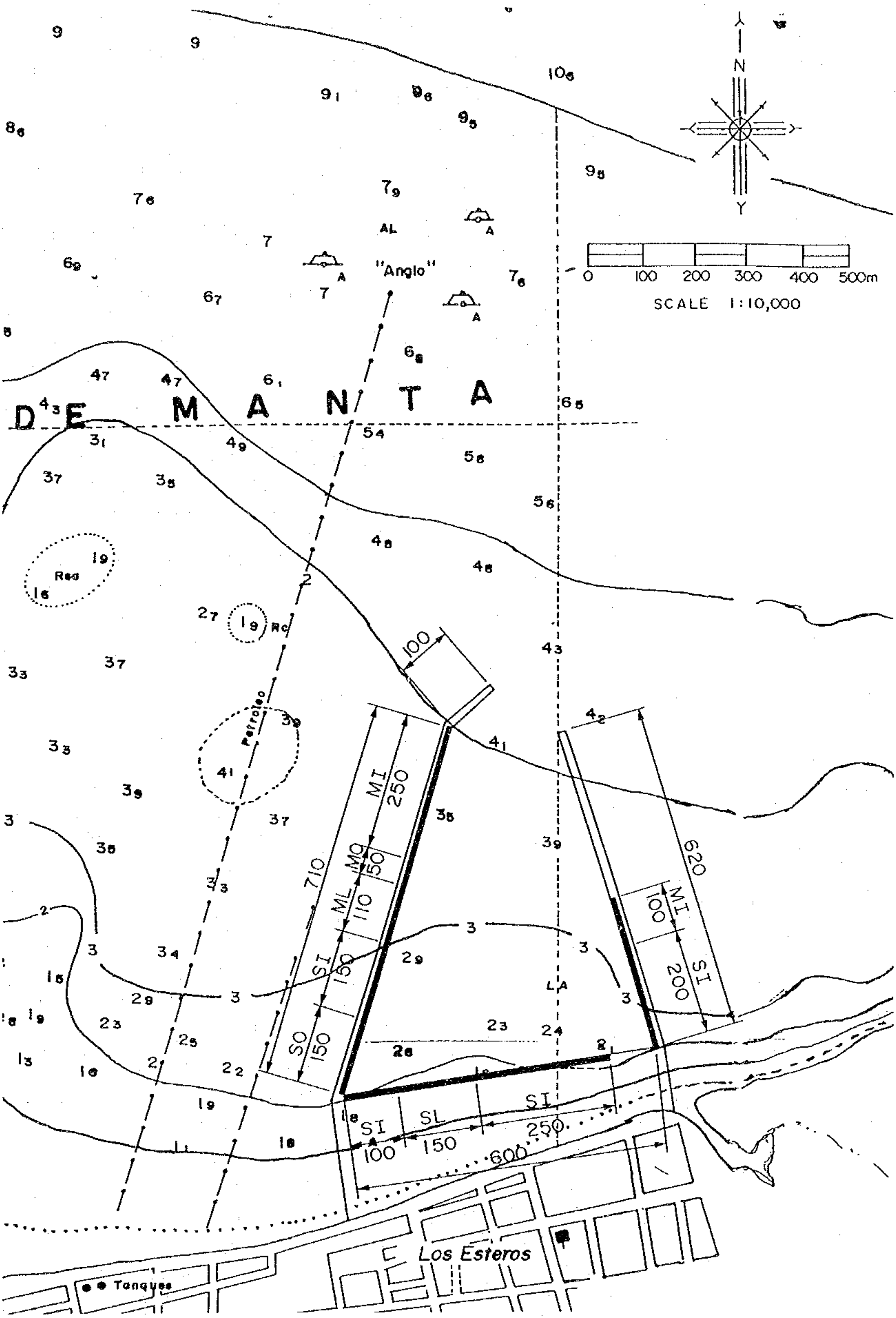


Fig.3-5-1(2) Master Plan (Manta)

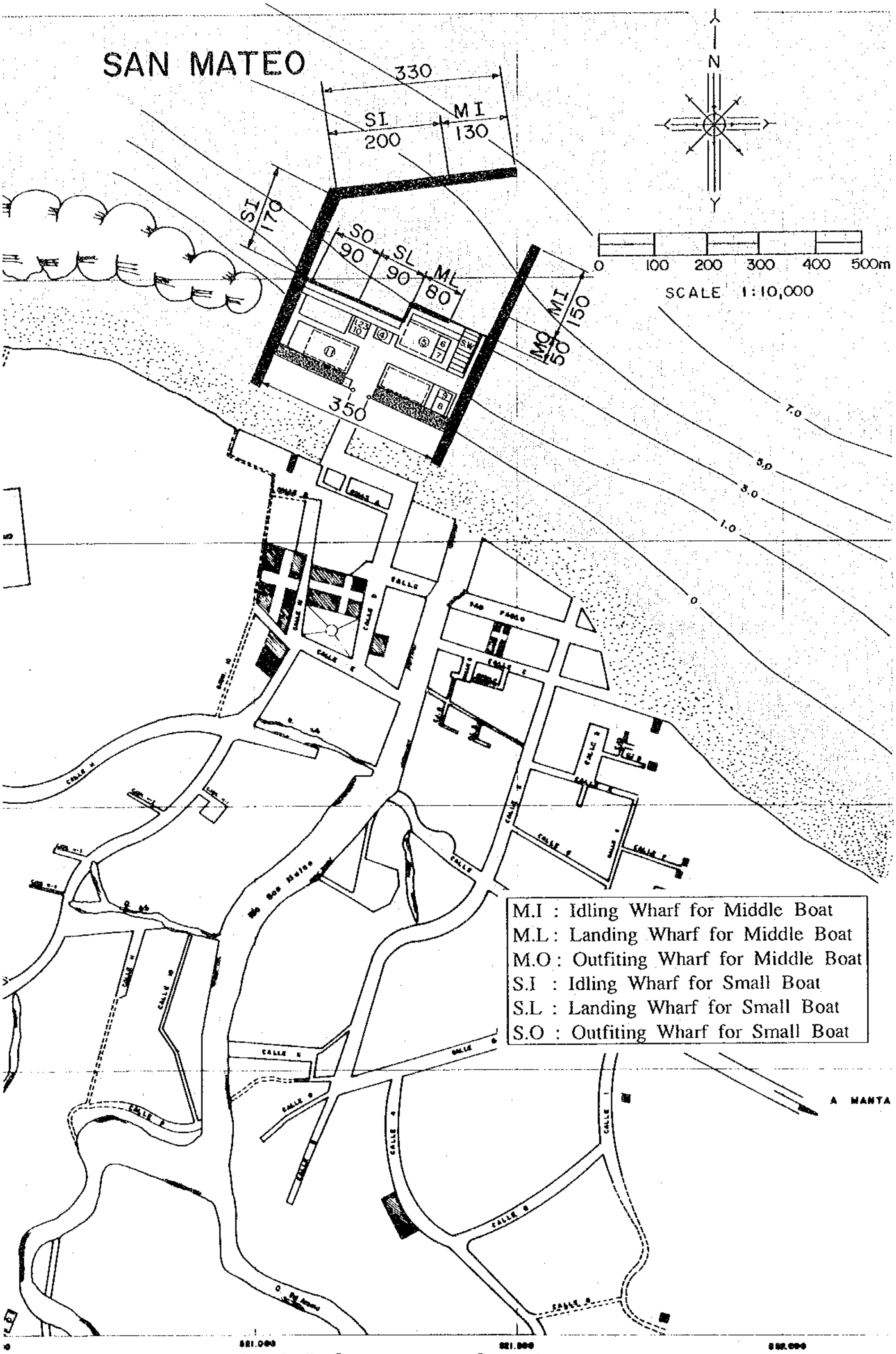


Fig.3-5-2 Master Plan (San Mateo)

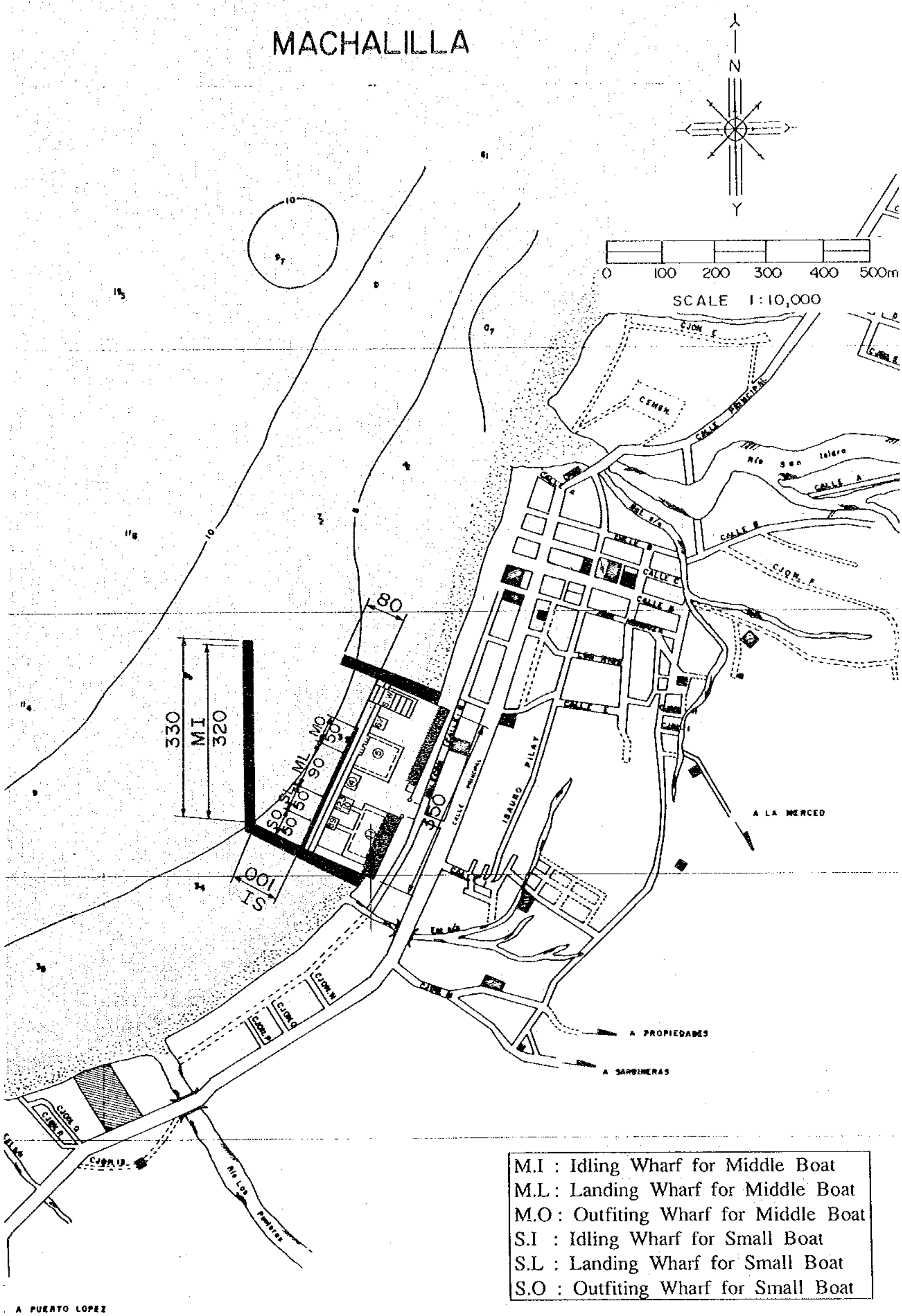


Fig.3-5-3 Master Plan (Machalilla)

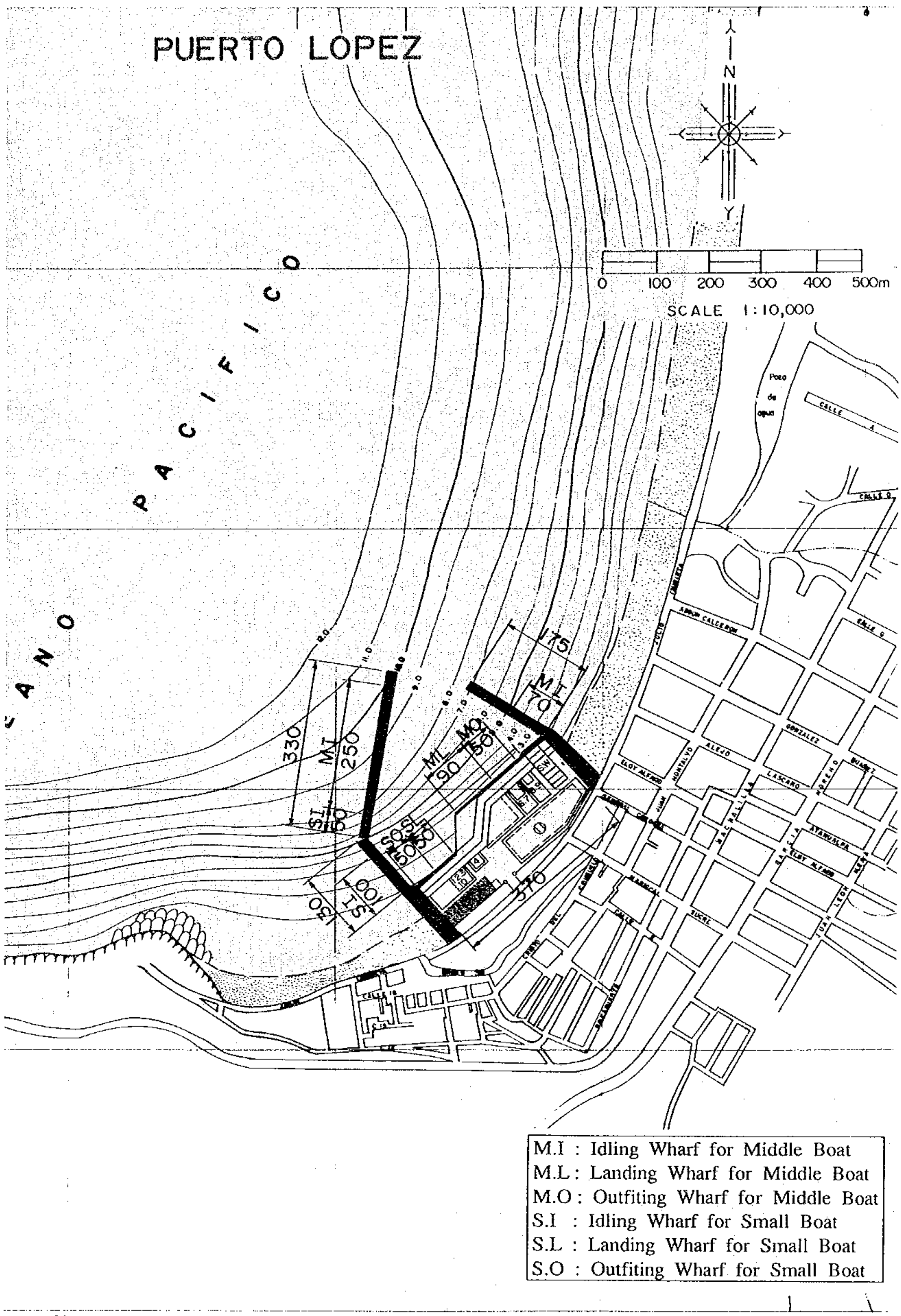


Fig.3-5-4 Master Plan (Pto.Lopez)

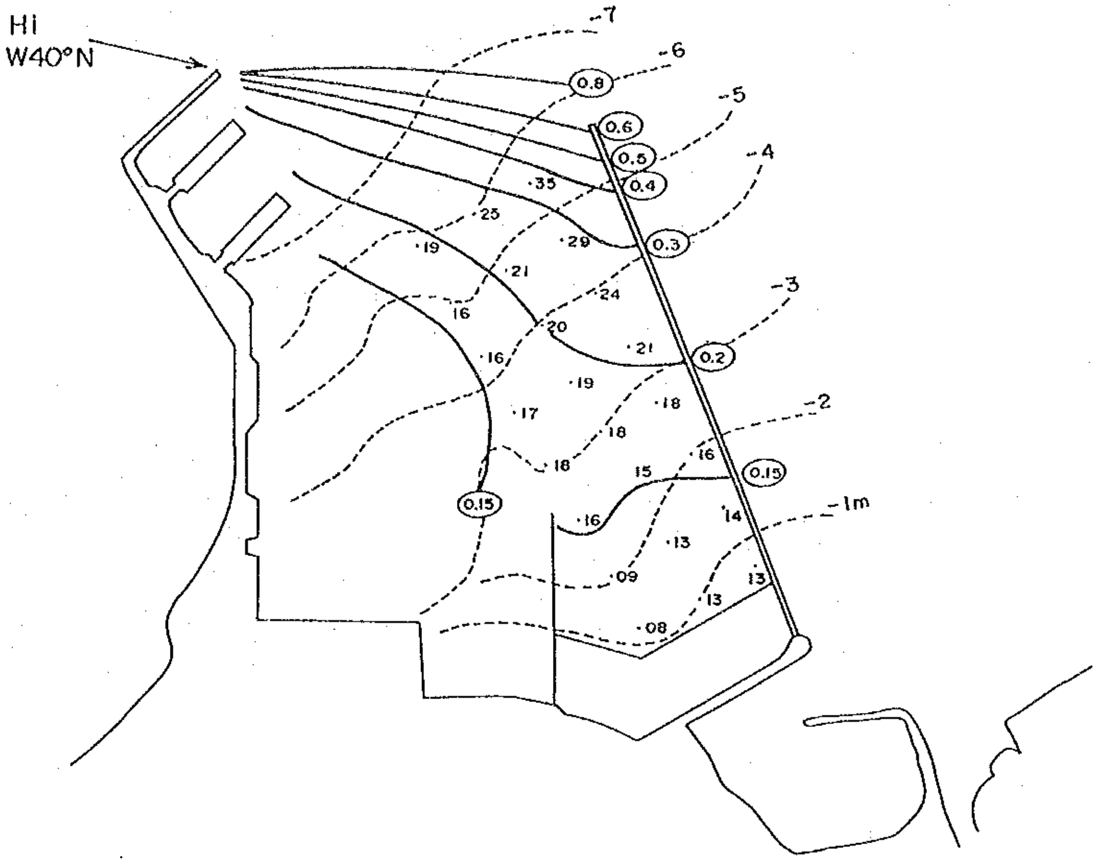


Fig.3-5-5 (1) Degrees of Calmness (Manta)

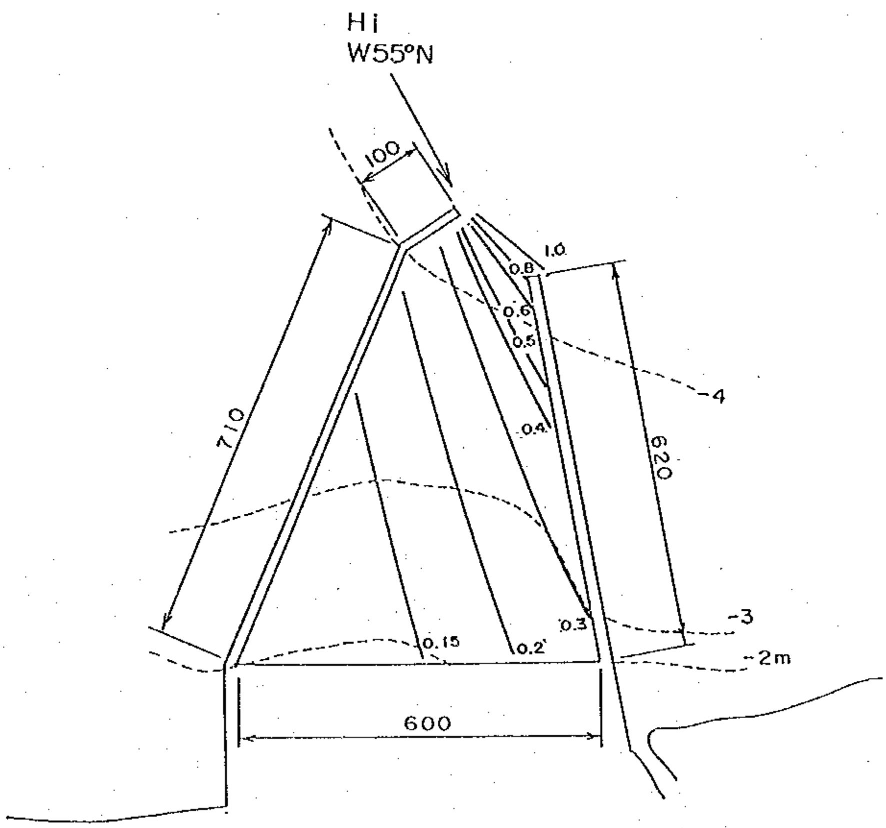


Fig.3-5-5 (2) Degrees of Calmness (Manta)

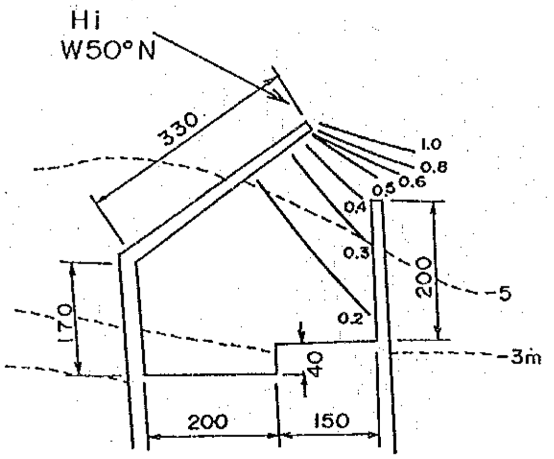


Fig.3-5-6 Degrees of Calmness
(San Mateo)

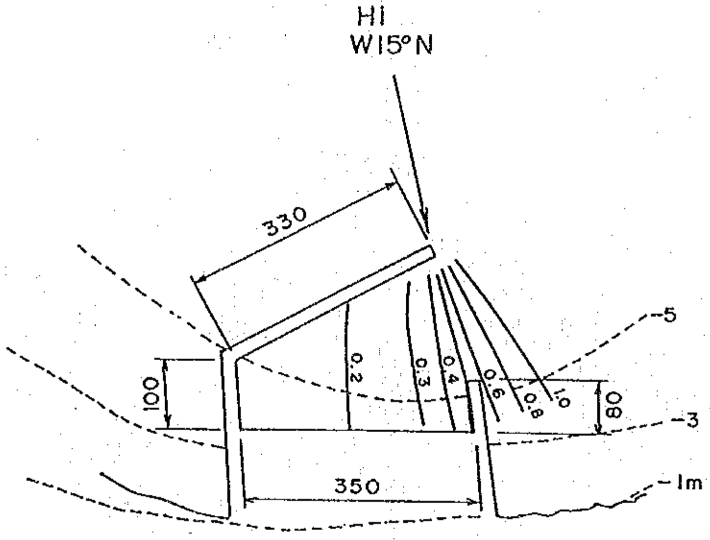


Fig.3-5-7 Degrees of Calmness
(Machalilla)

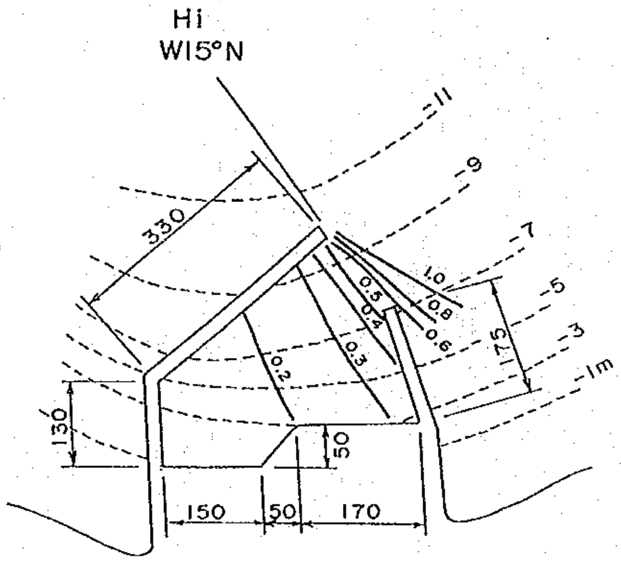


Fig.3-5-8 Degrees of Calmness
(Pto.Lopez)

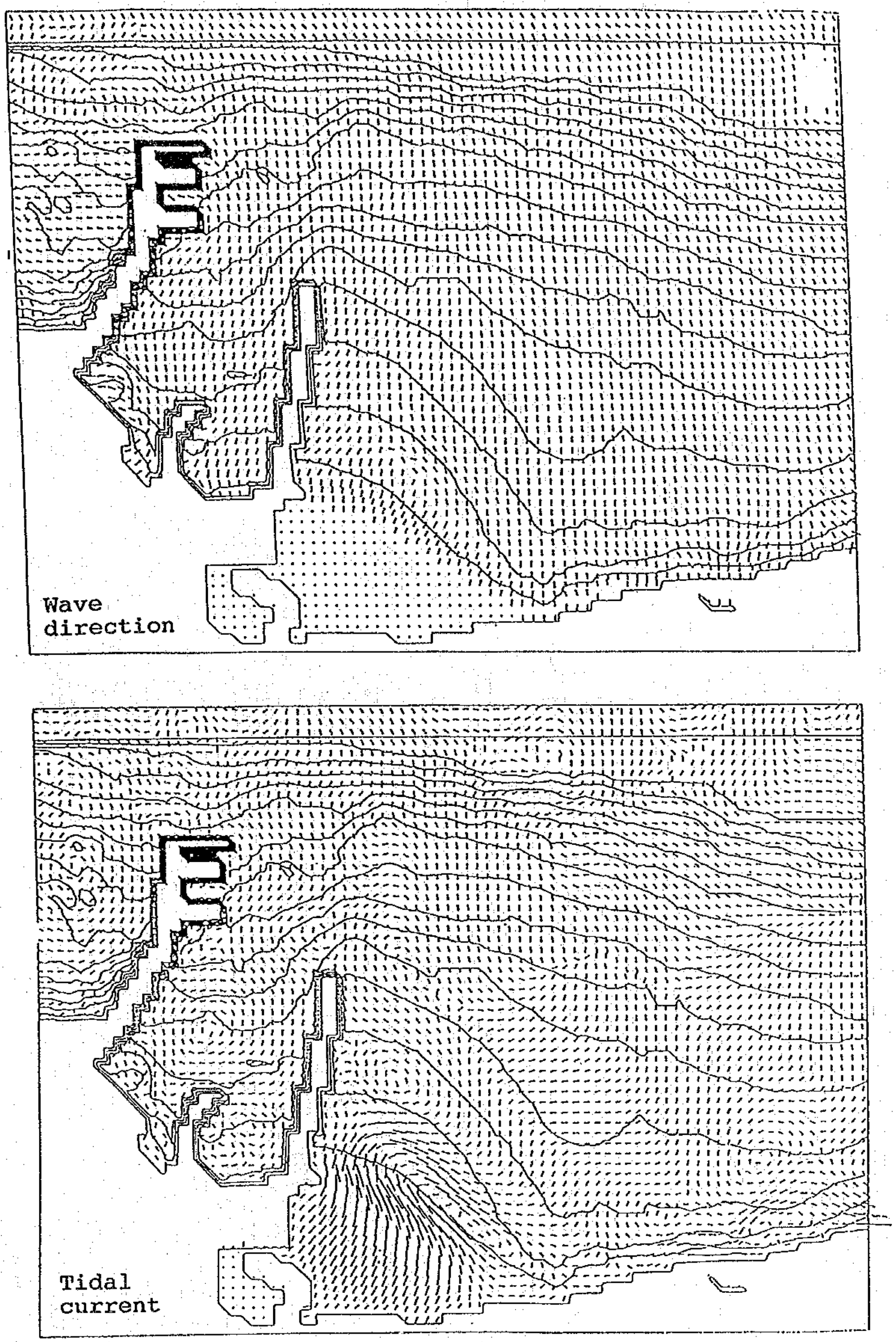


Fig.3-5-9 Wave Direction and Current (Manta, Alternative-1)

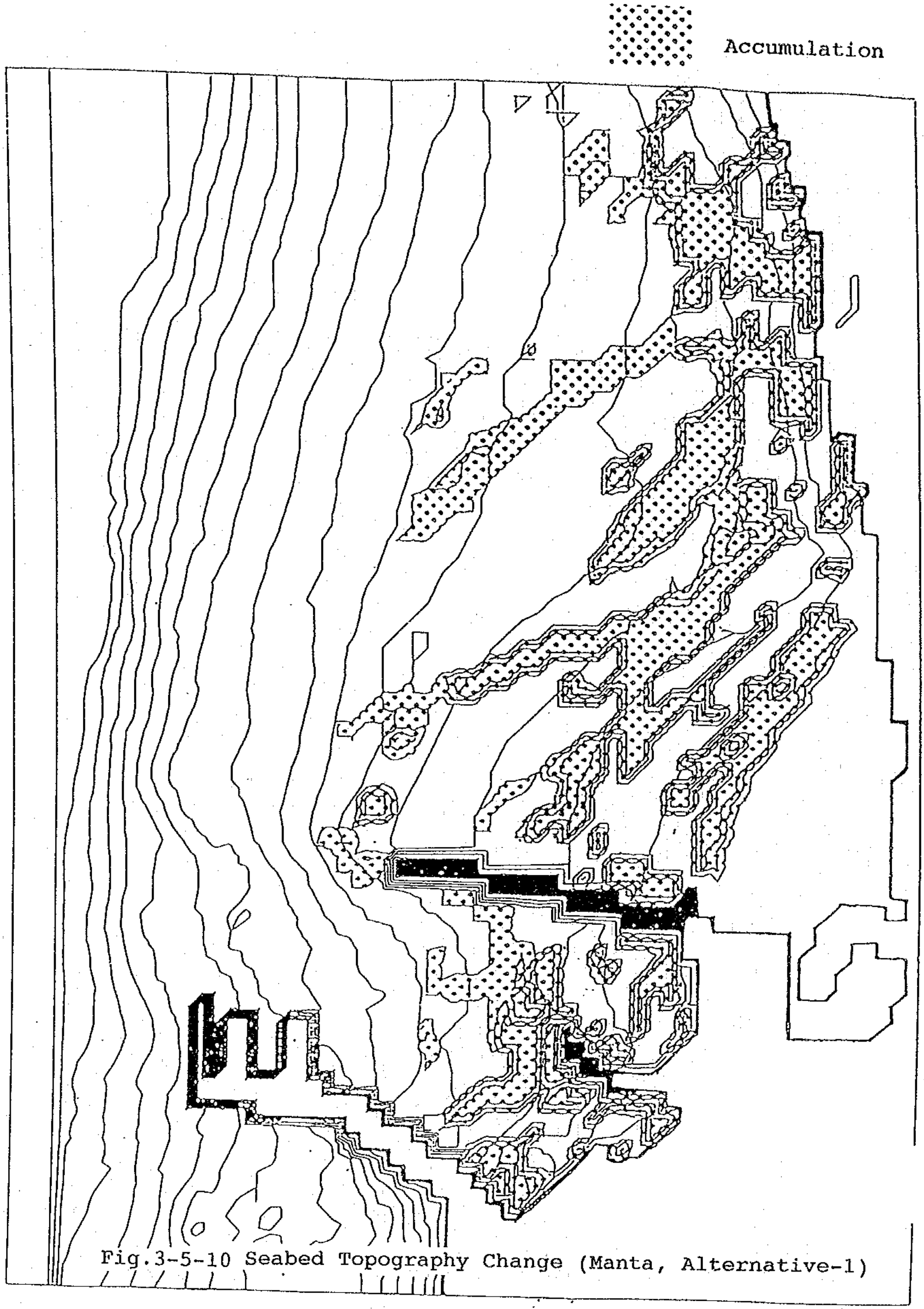
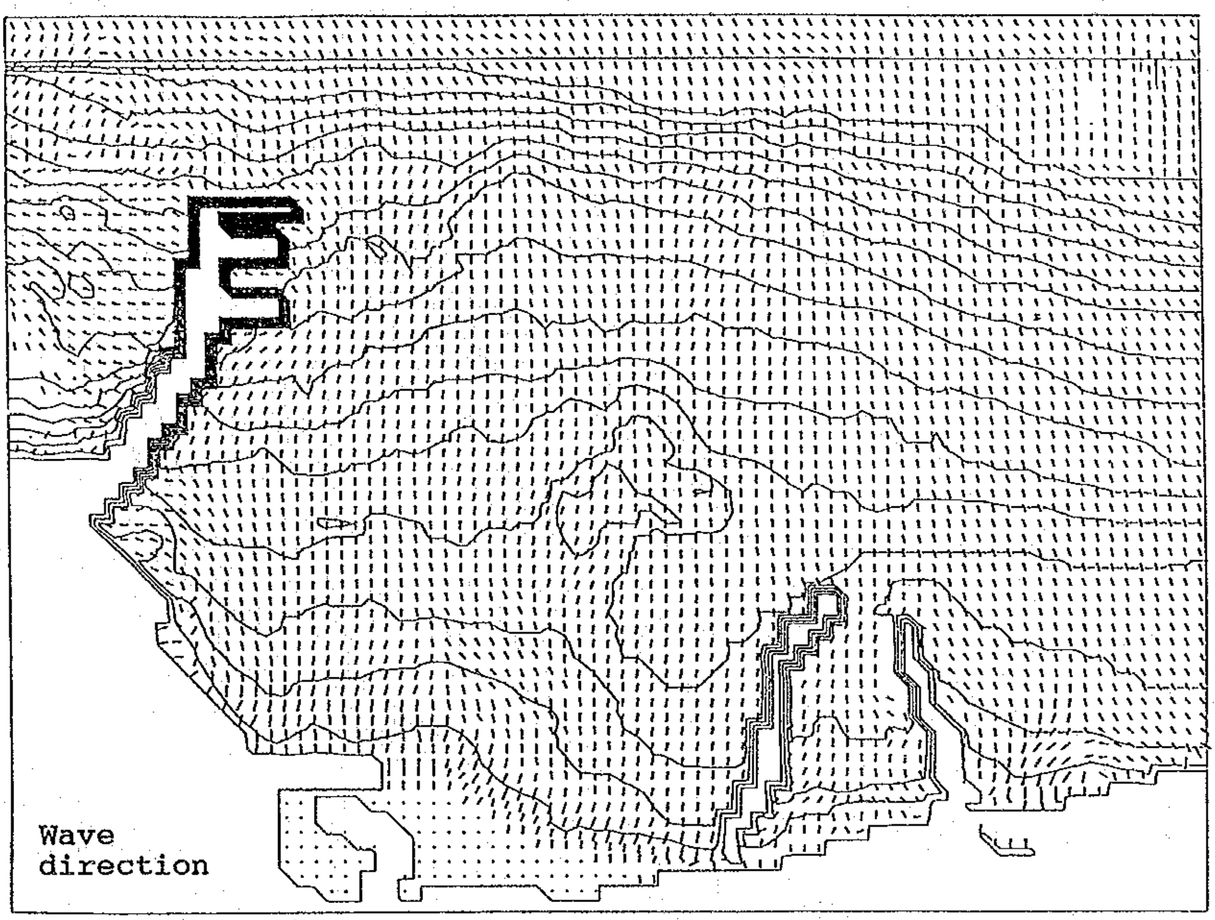


Fig.3-5-10 Seabed Topography Change (Manta, Alternative-1)



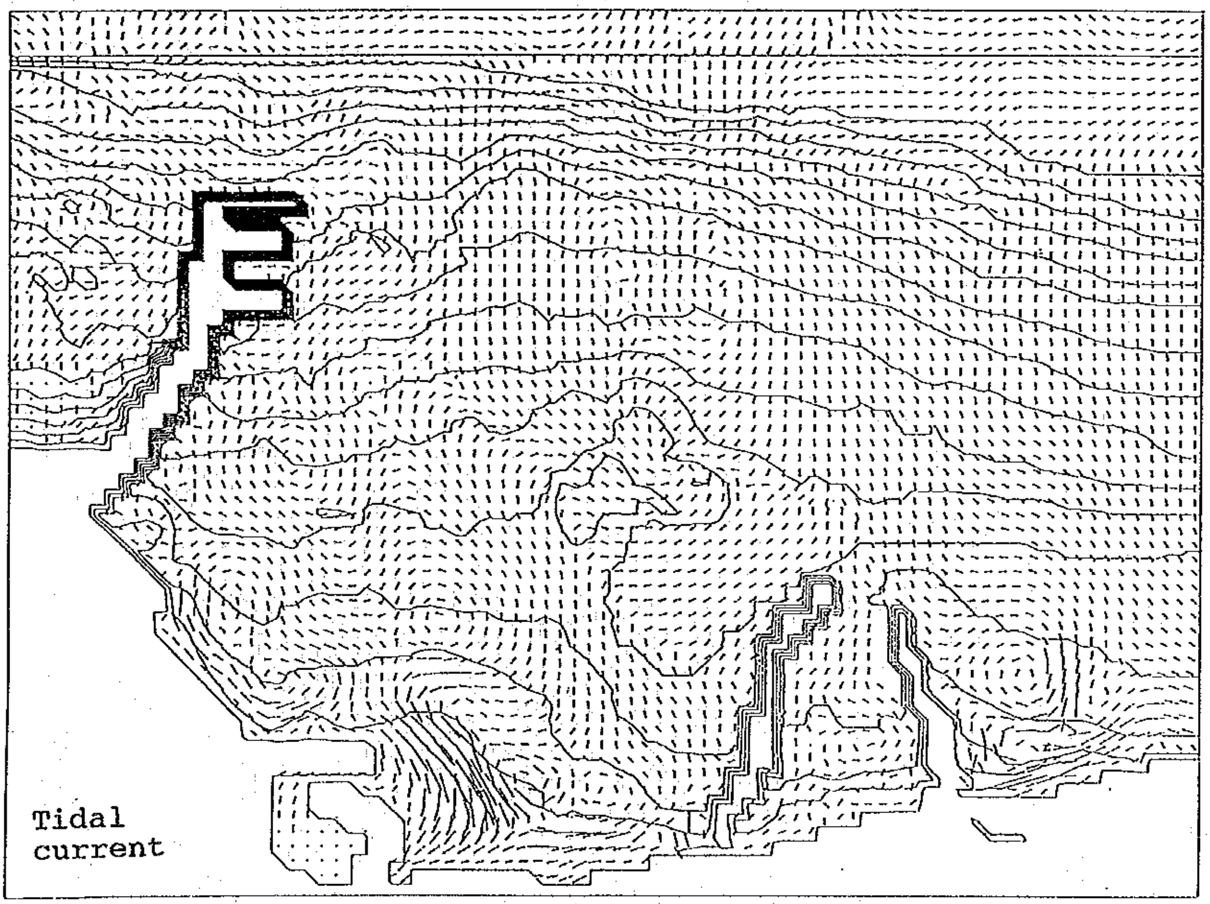


Fig.3-5-11 Wave Direction and Current (Manta, Alternative-2)

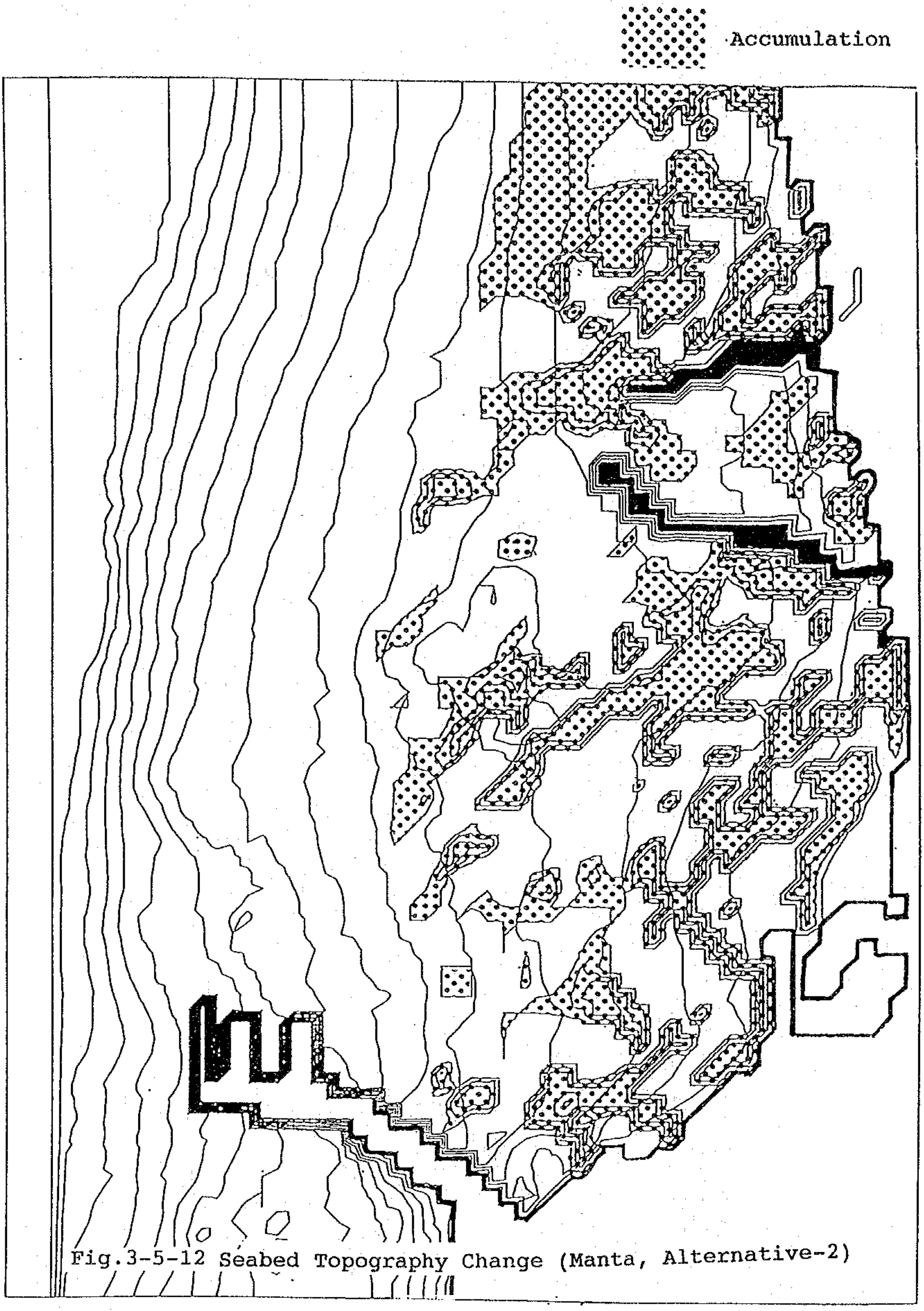
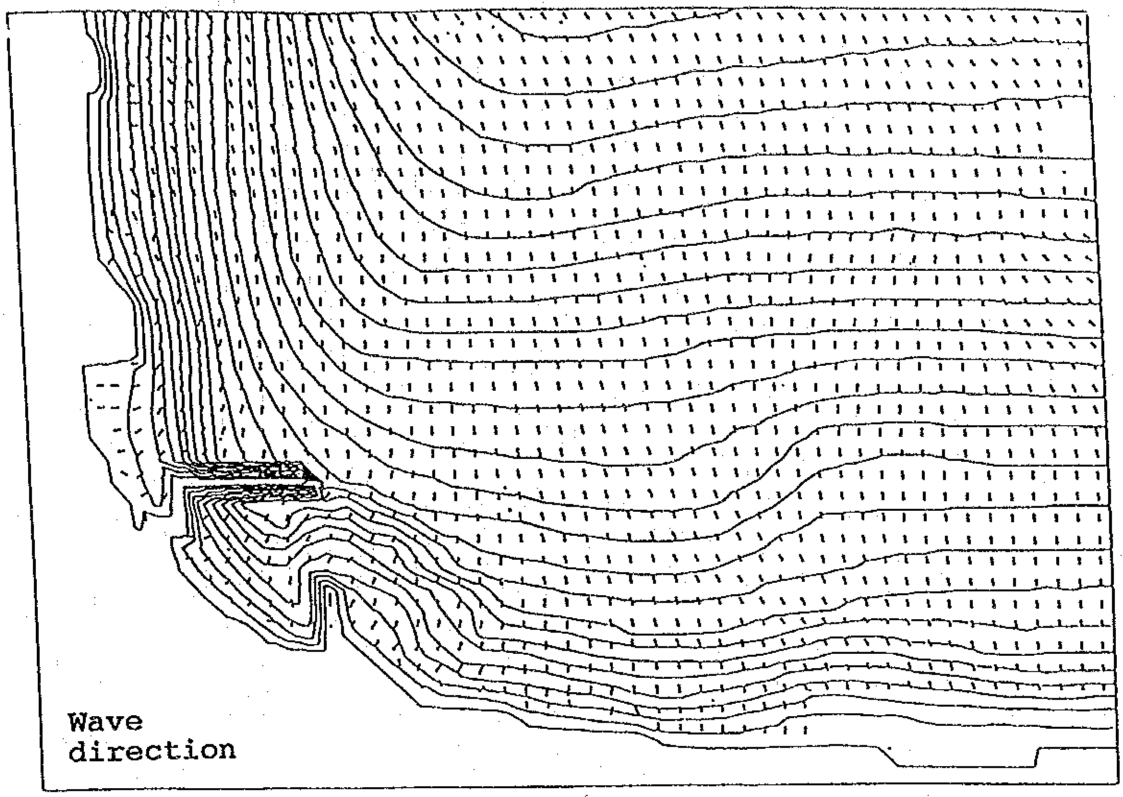


Fig.3-5-12 Seabed Topography Change (Manta, Alternative-2)



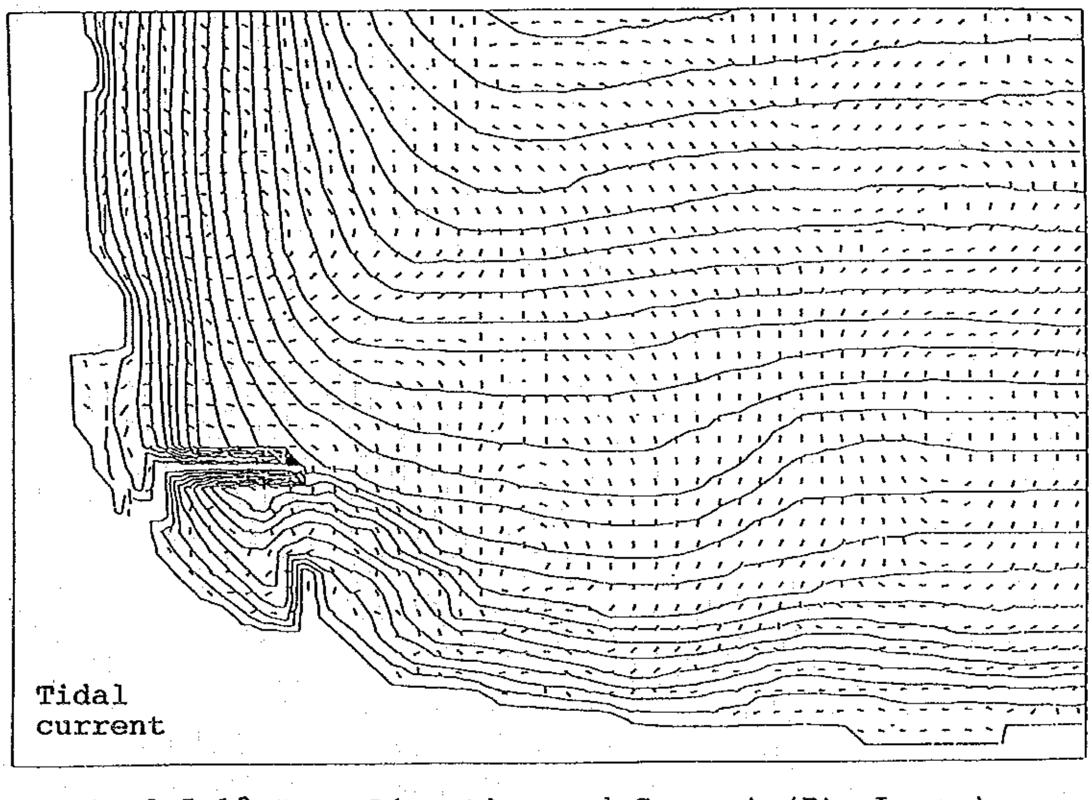


Fig.3-5-13 Wave Direction and Current (Pto.Lopez)

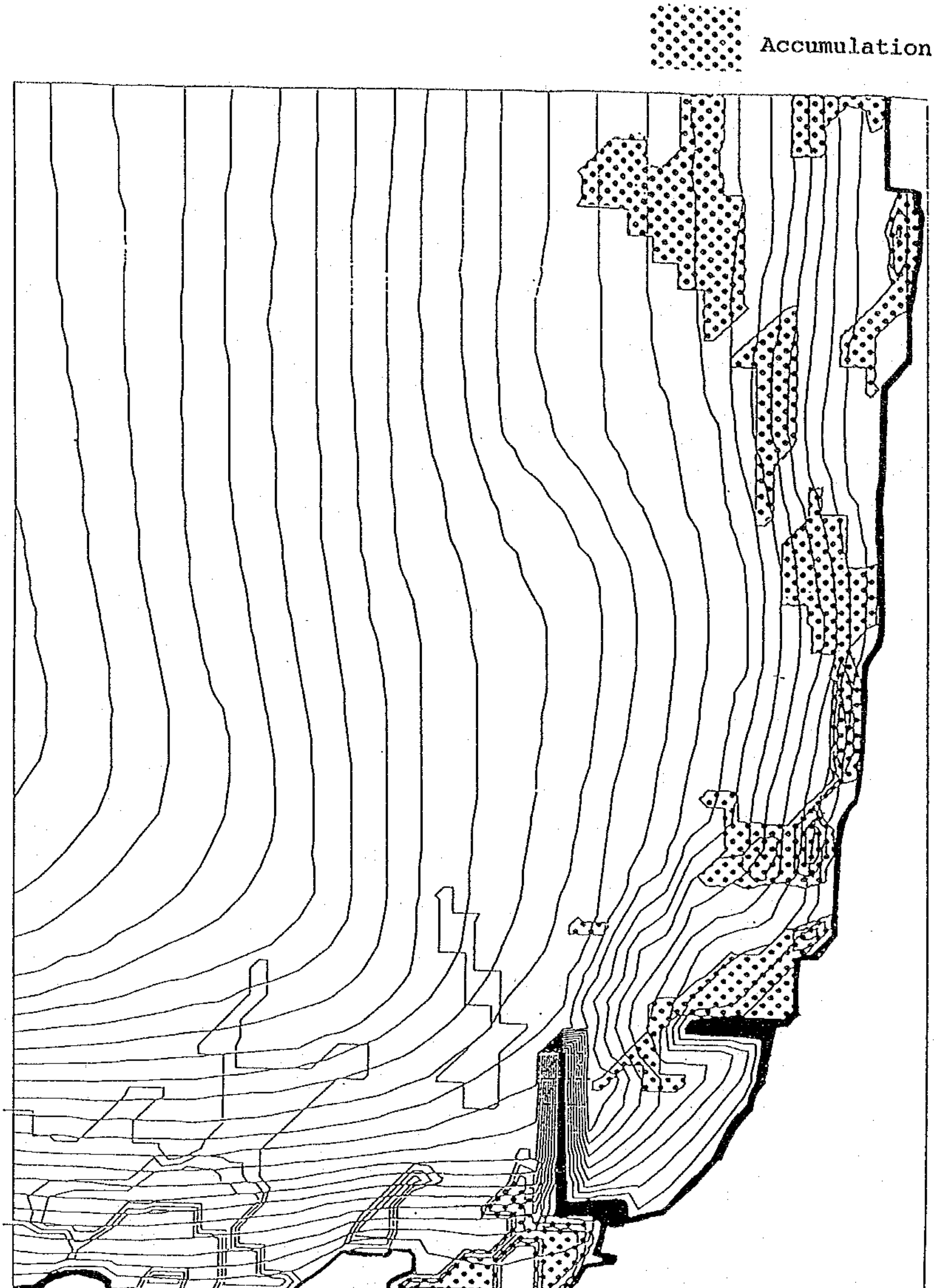


Fig.3-5-14 Seabed Topography Change (Pto.Lopez)

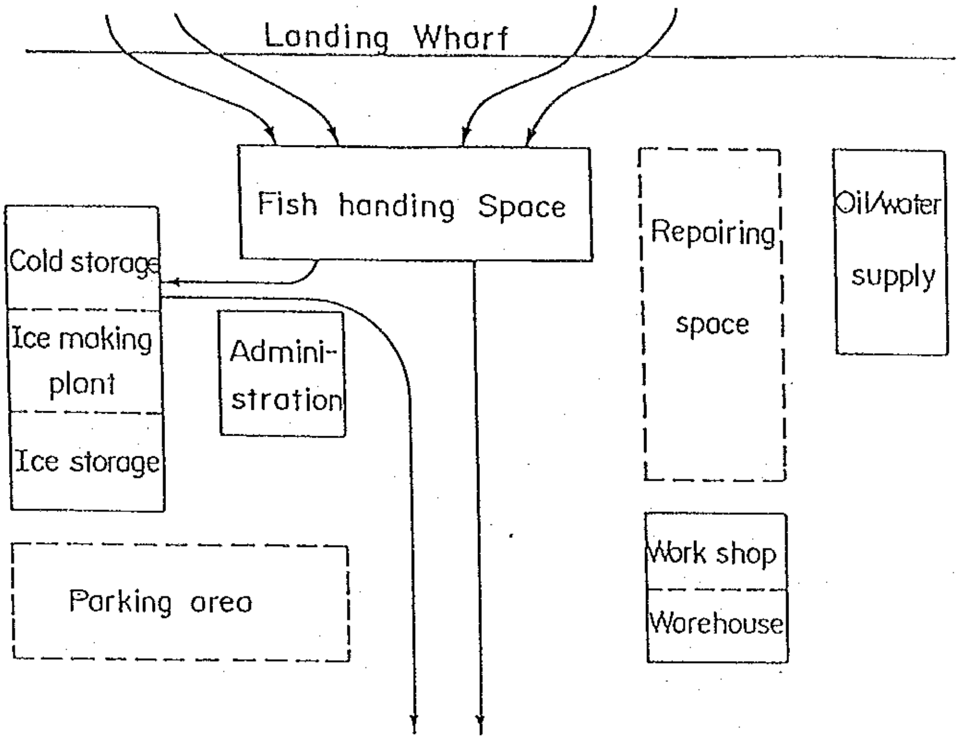


Fig.3-5-15 Model Layout Plan for Facilities

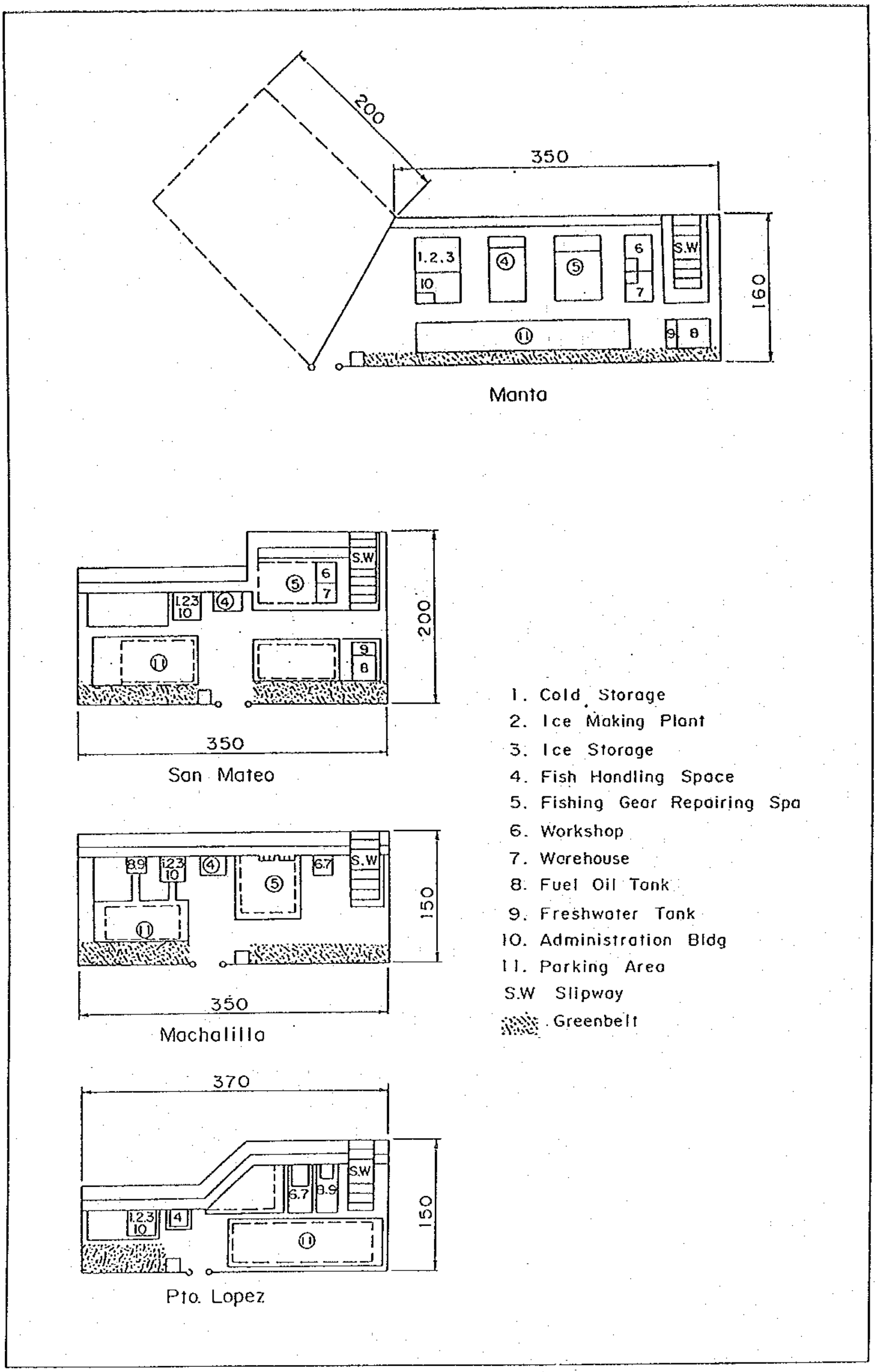


Fig.3-5-16 Layout Plan for Functional Facilities

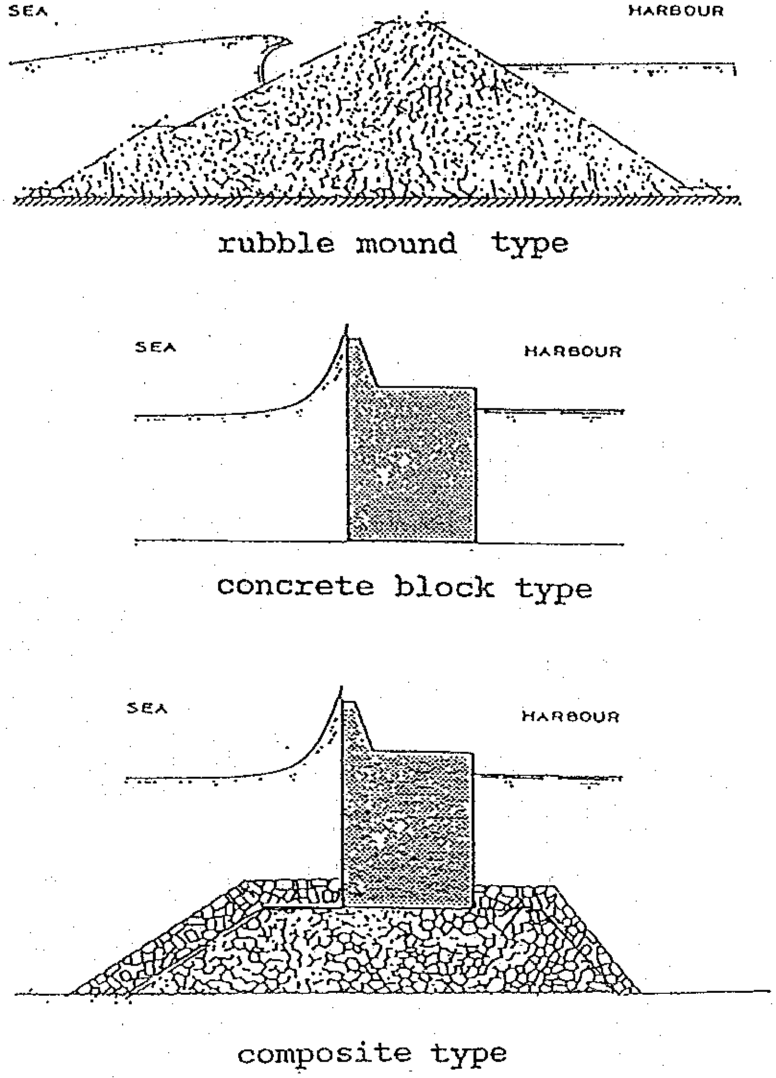
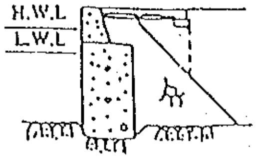
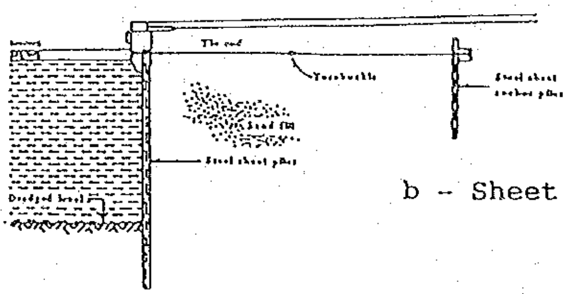


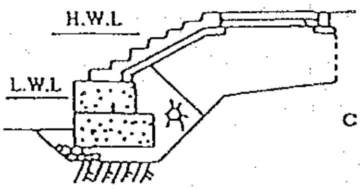
Fig.3-6-1 Model Types of Breakwater



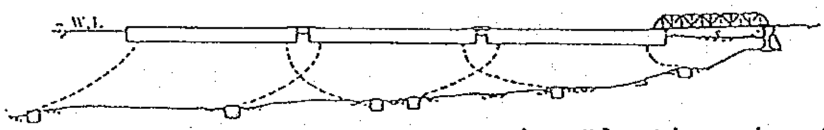
a - Gravity type quaywall



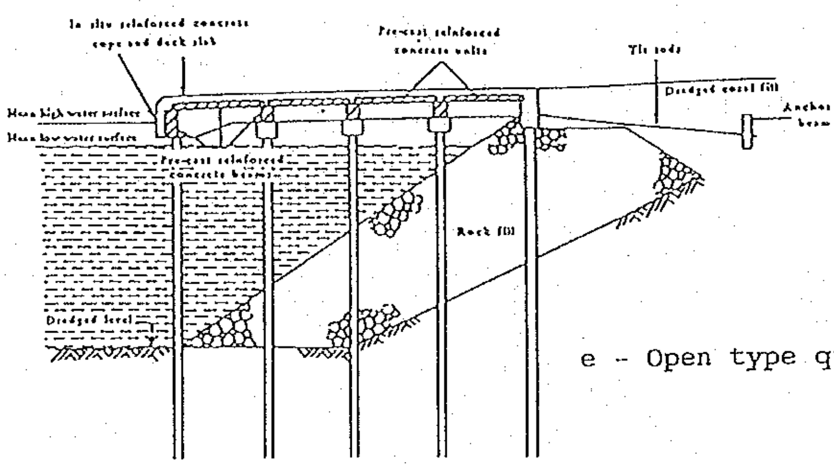
b - Sheet pile type quaywall



c - Stair type



d - Floating pier type quaywall



e - Open type quaywall

Fig.3-6-2 Model Types of Quay

Fig.3-6-3 Typical Cross Section of Gravity Type Quay

(MANTA, SAN MATEO)

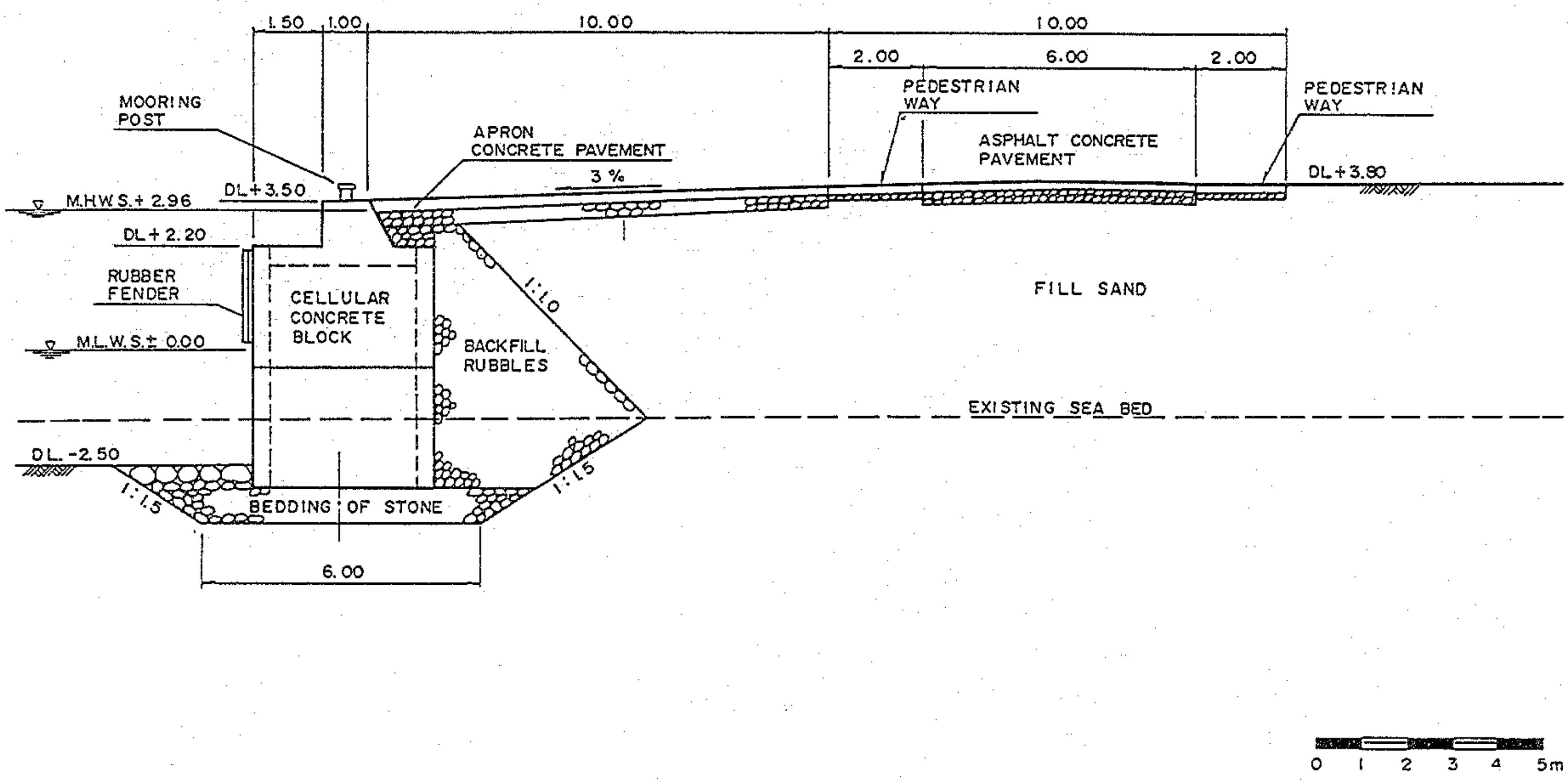


Fig.3-6-4 Typical Cross Section of Open Type Quay

(PUERTO LOPEZ, MACHALILLA)

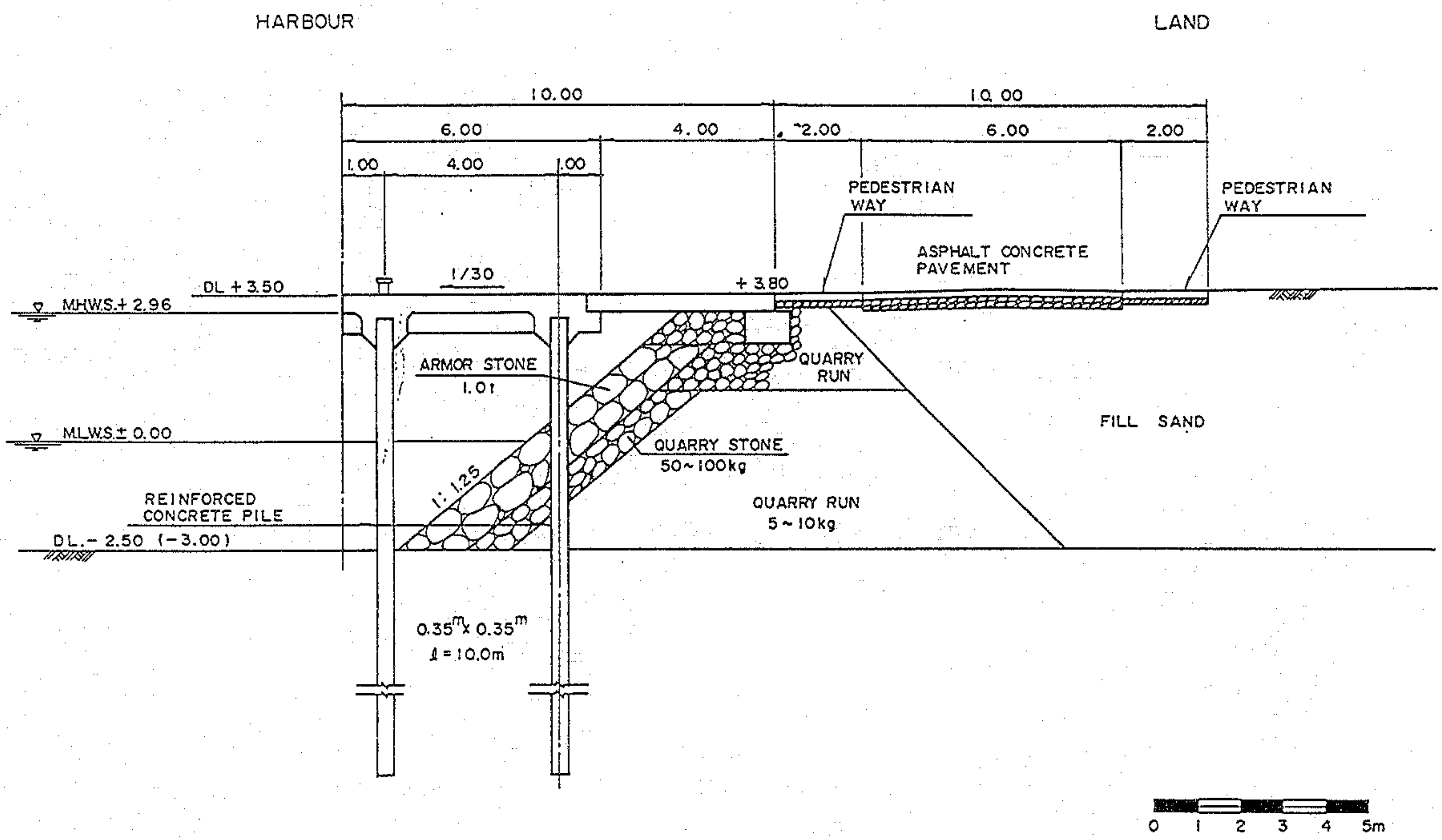


Fig.3-6-5 Typical Cross Section of Slope Type Quay
(MANTA, SAN MATEO, MACHALILLA, PUERTO LOPEZ)

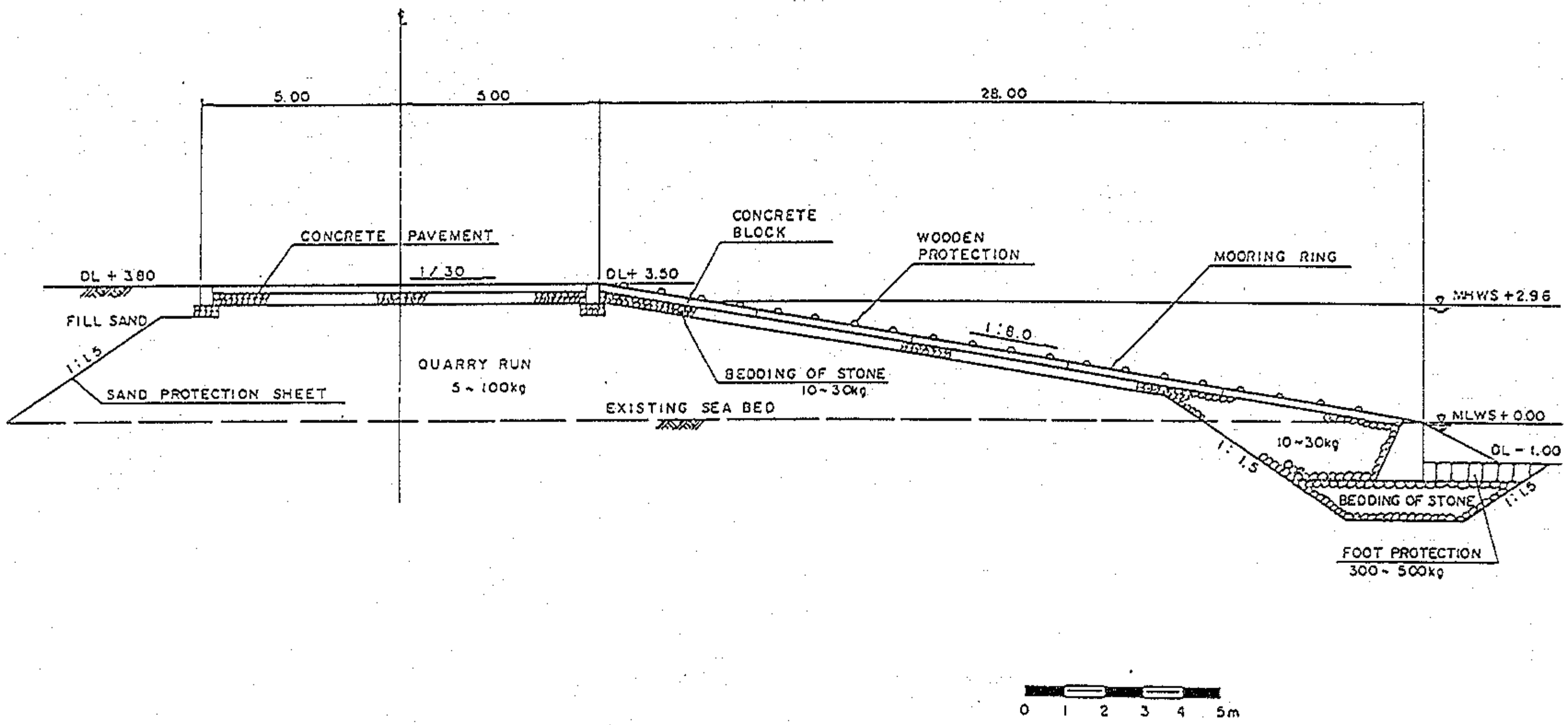


Fig.3-6-6 Typical Cross Section of Gravity Type Quay

(MANTA, SAN MATEO, MACHALILLA, PUERTO LOPEZ)

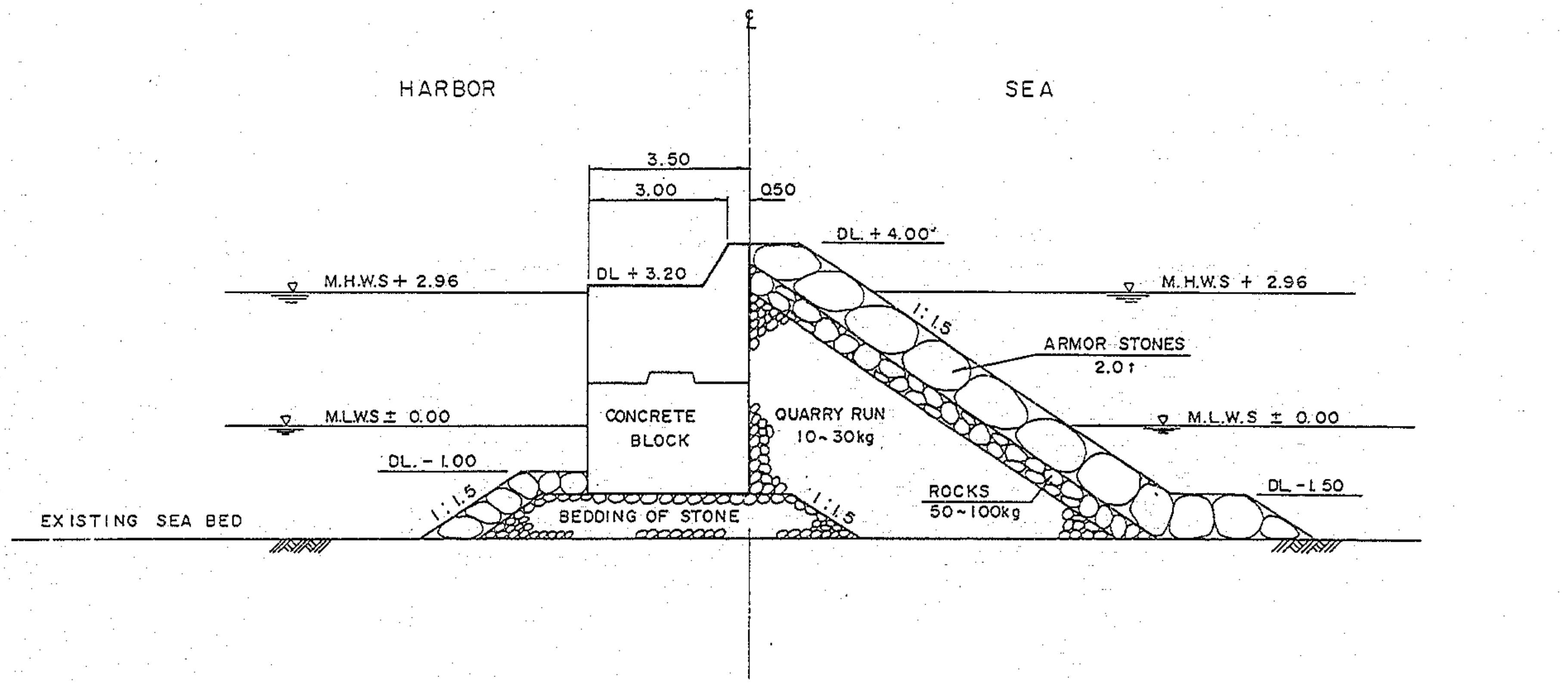


Fig.3-6-7 Typical Cross Section of Breakwater(1)

MANTA (MACHALILLA)

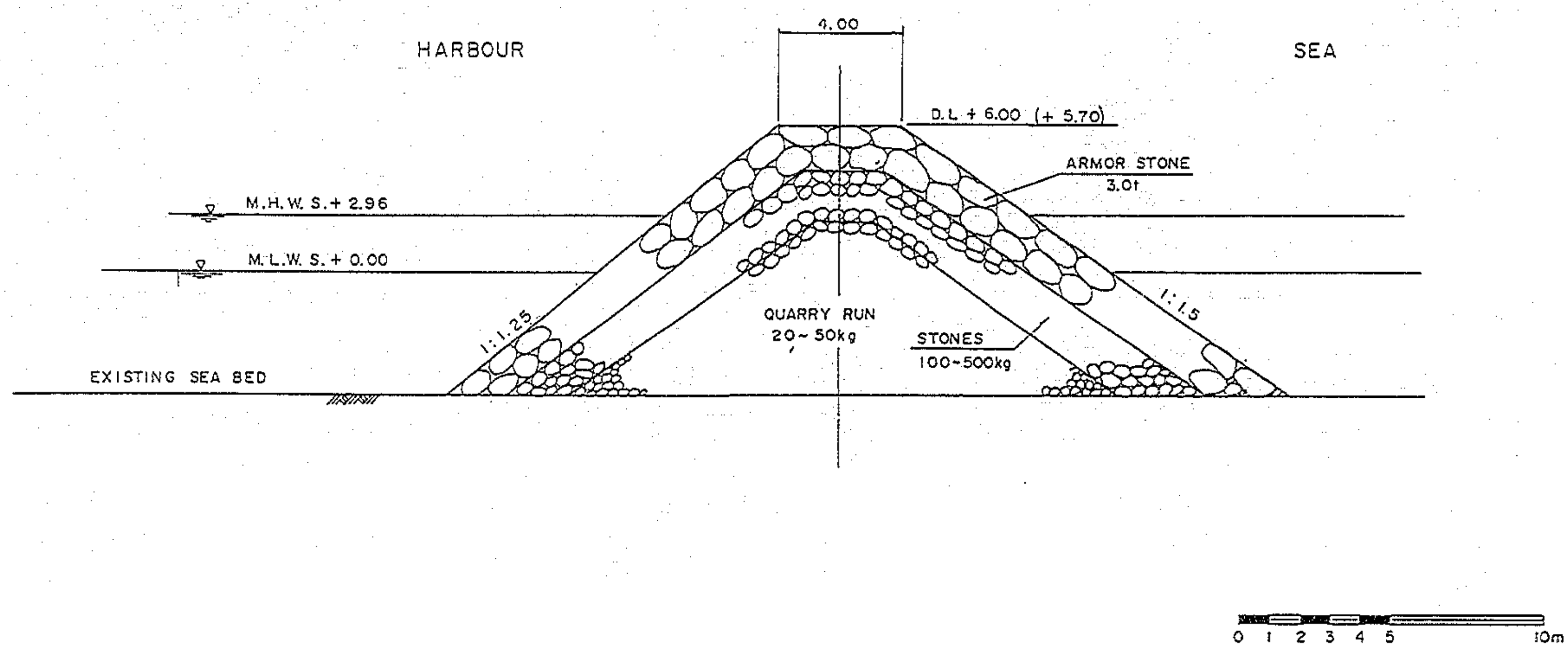


Fig.3-6-8 Typical Cross Section of Breakwater(2)

PUERTO LOPEZ (SAN MATEO)

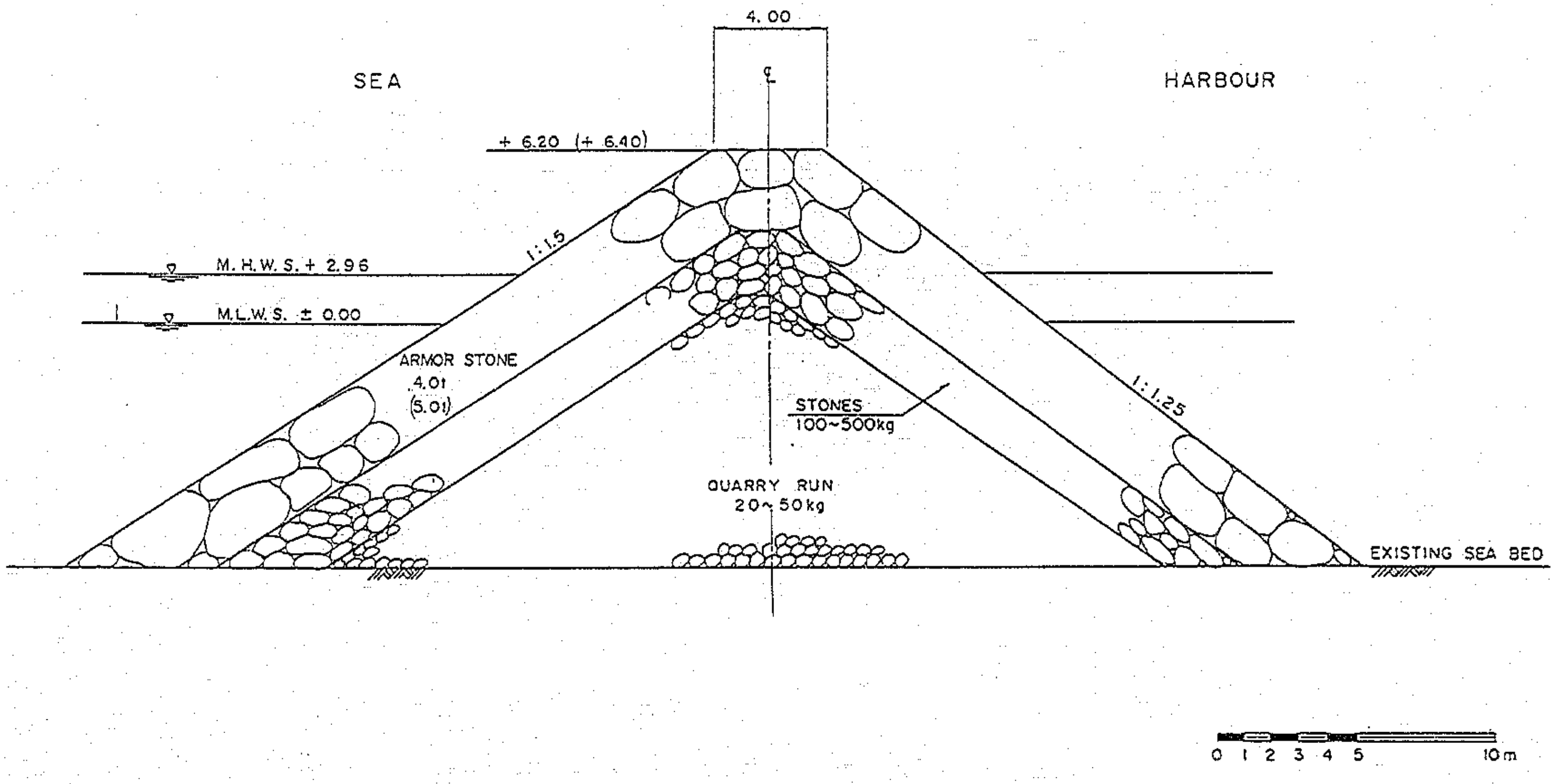


Fig.3-6-9 Typical Cross Section of Training Jetty

(MANTA)

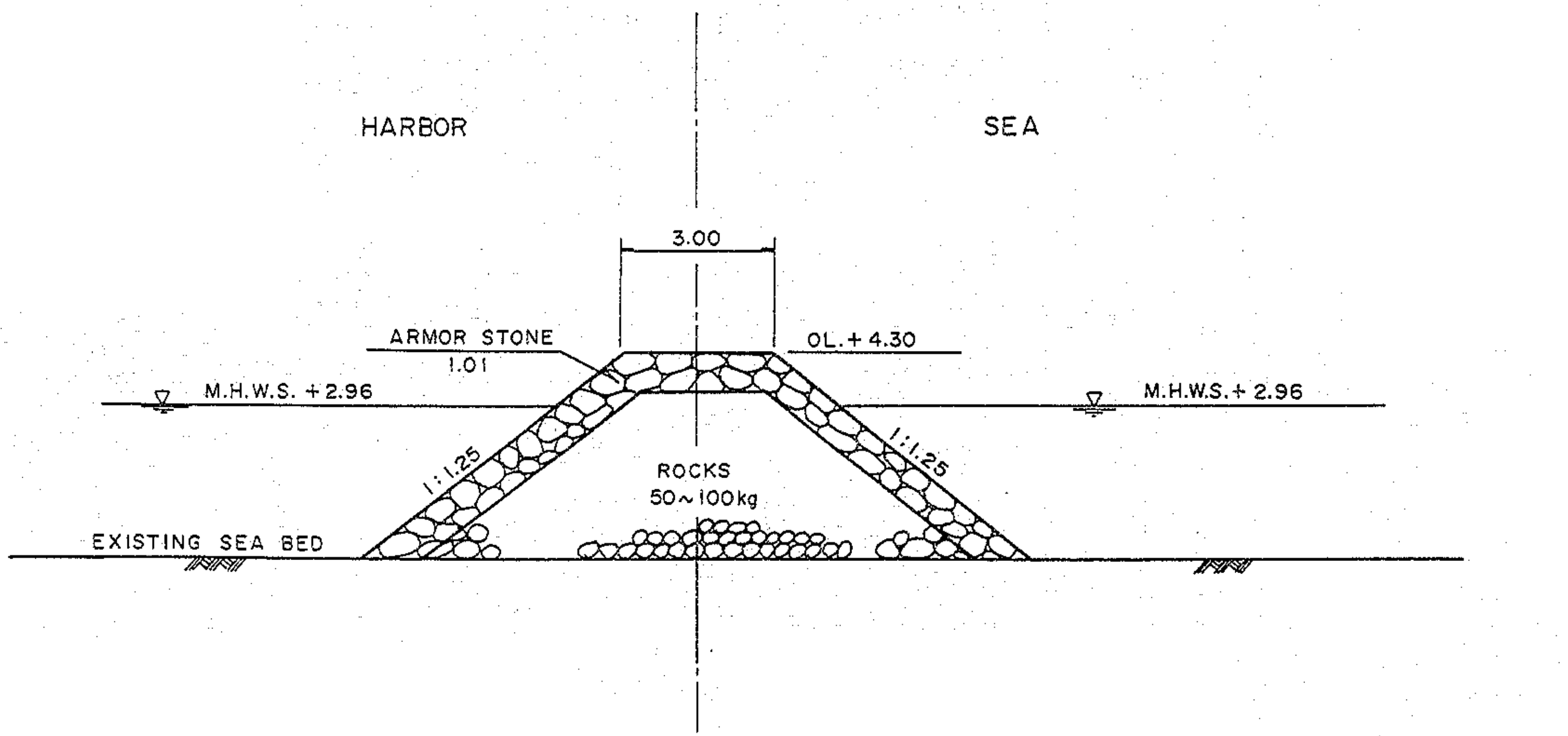


Table 3-4-7(1) Scale Outline of the Planned Facilities (1)
The Year of 2005

Descriptions	Manta	Puerto López
1. Landing Volumes		
Demersal fish and large pelagic fish:	36 Mt/day	12 Mt/day
Lanchas :	341	71
Long liners :	25	23
Purse seiners :	25	22
2. Facilities Plan		
Cold storage(0°C)	240 cu.m	120 cu.m
(-30°C)	340 cu.m	-
Blast Freezer	12 Mt/day	-
Building area	300 sq.m	70 sq.m
Ice making plant	70 Mt/day	20 Mt/day
Building area	400 sq.m	150 sq.m
Ice storage	420 cu.m	120 cu.m
Building area (including a platform)	700 sq.m	200 sq.m
Fish handling space	400 sq.m	200 sq.m
Fishing gear repairing space	1000 sq.m	1000 sq.m
Warehouse	100 sq.m	100 sq.m
Workshop	100 sq.m	100 sq.m
Fuel oil tank:		
Gasoline	150 Kltrs	30 Kltrs
Diesel oil	190 Kltrs	180 Kltrs
Building area	150 sq.m	80 sq.m
Freshwater tank	15 Kltrs	10 Kltrs
Building area	20 sq.m	20 sq.m
Administration Bld.	150 sq.m	150 sq.m
Parking space	40 vehicles 600 sq.m	20 vehicles 300 sq.m
Total	4000 sq.m	2500 sq.m

Table 3-4-7(2) Scale Outline of the Planned Facilities (2)
The Year of 2005

Descriptions	Machalilla	San Mateo
1. Landing Volumes		
Demersal fish and large pelagic fish:	11 Mt/day	21 Mt/day
Lanchas :	53	183
Long liners :	23	20
Purse seiners :	22	20
2. Facilities Plan		
Cold storage	110 cu.m	210 cu.m
Building area	70 sq.m	100 sq.m
Ice making plant	20 Mt/day	40 Mt/day
Building area	150 sq.m	250 sq.m
Ice storage	120 cu.m	240 cu.m
Building area (including a platform)	200 sq.m	400 sq.m
Fish handling space	200 sq.m	300 sq.m
Fishing gear repairing space	1000 sq.m	1000 sq.m
Warehouse	100 sq.m	100 sq.m
Workshop	100 sq.m	100 sq.m
Fuel oil tank:		
Gasoline	20 Kltrs	80 Kltrs
Diesel oil	180 Kltrs	160 Kltrs
Building area	80 sq.m	100 sq.m
Freshwater tank	5 Kltrs	10 Kltrs
Building area	10 sq.m	20 sq.m
Administration Bld.	150 sq.m	150 sq.m
Parking space	20 vehicles 300 sq.m	20 vehicles 300 sq.m
Total	2500 sq.m	3000 sq.m

Table 3-6-1 Technical Comparison of Alternative Breakwater Types

No. Item	Type: Sloping of rubble mound	Concrete upright	Composite
* 1 Experiences at site	+++	+	++
* 2 Difficulty of material procurement	+++	+	++
3 Difficulty of construction	+++	+	++
* 4 Construction period	+++	++	+
5 Adaption of base ground	+++	+	+++
6 Number of complicated works	+++	++	+
7 Temporary facilities required	+++	++	+
* 8 Difficulty of maintenance	+++	+	++
9 Number of construction equipment	+++	++	+
10 Necessity for work boats	++	+	+
11 Necessity for land equipment	++	++	++
12 Resistant against wave force	++	+	+++
13 Occurrence of reflective wave	+++	+	++
14 Probability of erosion of foundation	++	+	+++
15 Suitable for sand ground	+++	+	++
16 Quantities of materials	++	+++	+
17 Suitable for shallow sea	+++	++	+
* 18 High or low, construction cost	+++	+	++
Comprehensive evaluation	+++	+	++

Note: Ranking of evaluation

+++ : Excellent
++ : Ordinary
+ : Some problems

cf. * Marks mean special item for evaluation.

Table 3-6-2 Technical Comparison of Alternative Quay Types

No.	Item (Type)	Concrete gravity	Sheet pile	Concrete stair	Steel pontoon	RC pile quay
* 1	Experience at site	+	+	+	++	+++
2	Conformity to fishing port position	++	+	+	+	++
3	Efficiency of fish catch handling	++	++	+++	+++	++
* 4	Difficulty in material procurement	++	+	++	++	+++
5	Procurement of construction equipment	++	+	++	++	+++
6	Procurement of work boats	++	+	+	+	+++
7	Difficulty of quality control	++	+	+	+++	++
* 8	Construction period	+	++	+	+++	++
* 9	Maintenance after completion of construction	+++	+	+++	+	+++
10	Measures against corrosion	+++	+	+++	+	+++
11	Suitability for base ground	+++	+	+++	+++	++
12	Resistance to horizontal loads	+++	+++	+++	+	+++
13	Occurrence of reflection wave	+	+	+	++	+++
14	Difficulty in layout of related facilities	+++	+++	++	+	++
15	Effects of differential settlement	+	++	+	++	++
16	Amount and complication of works	+++	+	+++	++	++
*17	Construction cost	++	++	+++	++	++
	Comprehensive evaluation	++	+	+++	+	++

Note: Ranking of evaluation

+++ : Excellent
++ : Ordinary
+ : Some problems

cf. * Marks mean special item for evaluation.

Table 3 − 6 − 4 (1) Design Wave

Direction of Deepwater Wave: WSW
Tide Level: MHWS +2.96 m
: MLWS +0.00 m

Site	Manta (D.L −3.0 m i=1/100)		San Mateo (D.L −5.0 m i=1/100)	
H_o(m)	4.0		4.0	
T (sec)	15.0		15.0	
L_o(m)	351.0		351.0	
K_r	0.395		0.6	
H_o' (m)	1.6		2.4	
H_o'/L_o	0.005		0.007	
Planned depth				
Tide Level	MHWS	MLWS	MHWS	MLWS
h (m)	6.0	3.0	8.0	5.0
h/H_o'	3.75	1.88	3.33	2.08
H/H_o'	1.37	1.57	1.31	1.67
H (m)	2.2	2.5	3.1	4.0
In front of the planned depth (5H)				
h (m)	6.2	3.2	8.2	5.2
h/H_o'	3.88	2.0	3.42	2.17
H/H_o'	1.36	1.62	1.30	1.65
H (m)	2.1	2.6	3.1	4.0
Peak				
H/H_o'	1.80		-	
H (m)	2.80		-	

Table 3－6－4 (2) Design Wave

Direction of Deepwater Wave: WSW
Tide Level: MHWS ＋2.96 m
: MLWS ＋0.00 m

Site	Machalilla (D.L －7.0m i＝1/50)		Pto.Lopez (D.L －7.0m i＝1/50)	
H_o(m)	4.0		4.0	
T (sec)	15.0		15.0	
L_o(m)	351.0		351.0	
K_r	0.577		0.707	
H_o' (m)	2.3		2.8	
H_o'/L_o	0.007		0.008	
Planned depth				
Tide Level	MHWS	MLWS	MHWS	MLWS
h (m)	10.0	7.0	10.0	7.0
h/H_o'	4.35*	3.04	3.57	2.5
H/H_o'	Ks, 1.25	1.37	1.21	1.43
H (m)	2.9	3.2	3.4	4.0
In front of the planned depth(5H)				
h (m)	10.5	7.5	10.5	7.5
h/H_o'	4.57**	3.26	3.75	2.68
H/H_o'	Ks, 1.15	1.32	1.20	1.40
H (m)	2.6	3.0	3.4	3.9
Peak				
H/H_o'	-		-	
H (m)	-		-	

* h/L0 = 0.028
** h/L0 = 0.030
Ks : Shoaling coefficient

Table 3－6－4 (3) Design Wave

Direction of Deepwater Wave: NW
Tide Level: MHWS ＋2.96 m
: MLWS ＋0.00 m

Site	Manta (D.L －3.0 m i＝1/100)		San Mateo (D.L －5.0 m i＝1/100)	
H_0(m)	3.0		3.0	
T (sec)	15.0		15.0	
L_0(m)	351.0		351.0	
K_r	0.725		0.877	
H_0' (m)	2.2		2.6	
H_0'/L_0	0.006		0.007	
Planned depth				
Tide Level	MHWS	MLWS	MHWS	MLWS
h (m)	6.0	3.0	8.0	5.0
h/H_0'	2.75	1.38	3.04	1.90
H/H_0'	1.54	1.10	1.39	1.53
H (m)	3.4	2.4	3.6	4.0
In front of the planned depth(5H)				
h (m)	6.2	3.2	8.2	5.2
h/H_0'	2.84	1.47	3.12	1,98
H/H_0'	1.51	1.20	1.30	1.60
H (m)	3.3	2.6	3.4	4.2
Peak				
H/H_0'	1.7		1.6	
H (m)	3.7		4.2	

Table 3－6－4 (4) Design Wave

Direction of Deepwater Wave: NW
Tide Level: MHWS ＋2.96 m
: MLWS ＋0.00 m

Site	Machalilla (D.L －7.0m i＝1/50)		Pto.Lopez (D.L －7.0m i＝1/50)	
H_o(m)	3.0		3.0	
T (sec)	15.0		15.0	
L_o(m)	351.0		351.0	
K_r	0.803		0.767	
H_o' (m)	2.4		2.3	
H_o'/L_o	0.007		0.007	
Planned depth				
Tide Level	MHWS	MLWS	MHWS	MLWS
h (m)	10.0	7.0	10.0	7.0
h/H_o'	4.17*	2.92	4.35*	3.04
H/H_o'	Ks, 1.25	1.40	Ks, 1.25	1.38
H (m)	3.0	3.4	2.9	3.2
In front of the planned depth(5H)				
h (m)	10.5	7.5	10.5	7.5
h/H_o'	4.38**	3.13	4.57**	3.26
H/H_o'	Ks, 1.15	1.35	Ks, 1.15	1.32
H (m)	2.8	3.3	2.6	3.0
Peak				
H/H_o'	-		-	
H (m)	-		-	

* h/L0 = 0.028
** h/L0 = 0.030
Ks : Shoaling coefficient

Table 3 – 6 – 4 (5) Design Wave

Tide Level: MHWS +2.96 m
: MLWS +0.00 m

Site	Manta (D.L −3.0m i=1/100)		Manta (D.L −5.0m i=1/100)	
Direction	WSW		NW	
H_o(m)	4.0		3.0	
T (sec)	15.0		15.0	
L_o(m)	351.0		351.0	
K_r, Kd	0.395, 0.2		0.725, 0.6	
H_o' (m)	0.3		1.3	
H_o'/L_o	0.0009		0.004	
Planned depth				
Tide Level	MHWS	MLWS	MHWS	MLWS
h (m)	6.0	3.0	6.0	3.0
h/H_o'	20 *	10 *	4.62*	2.31
H/H_o'	Ks, 1.35	Ks, 1.45	Ks, 1.25	1.73
H (m)	0.4	0.4	1.6	2.2
In front of the planned depth(5H)				
h (m)	6.2	3.2	6.2	3.2
h/H_o'	21 *	11 *	4.69*	2.38
H/H_o'	Ks, 1.25	Ks, 1.45	Ks, 1.25	1.71
H (m)	0.4	0.4	1.6	2.2
Peak				
H/H_o'	-		-	
H (m)	-		-	

* h/L0 = 0.017
** h/L0 = 0.009
Ks : Shoaling Coefficient

CHAPTER 4 FORMULATION OF THE PRIORITY PLAN

CHAPTER 4 FORMULATION OF THE PRIORITY PLAN

4.1 Selection of the Priority Site

A priority site of which the completion is scheduled for 1995 was selected among the possible sites listed in the Master Plans and feasibility study for the priority site was conducted.

(1) Basic Principles in Determining Priority Site
Selection of the priority site is based on the following basic principles:

1) Considering the current problems of the artisanal fishery, the planned fishing port should be constructed urgently. The target year for the completion of the projects is set as 1995.

2) It is necessary to take account of the current situation of the artisanal fishery activities and to select a site that make the use of the existing infrastructures possible, so that the planned fishing port can immediately play the role of a center for the growth of the artisanal fishery.

3) The planned fishing port should facilitate the small scale fishing boats as many as possible.

4) The planned fishing port should also be designed to serve the middle scale fishing boats in order to maximize the investment efficiency.

5) The planned fishing port should contribute to the promotion of the fishery in neighboring fishing villages through the distribution of the fish catches and the establishment of the fish markets.

(2) Determination of the Priority Site
The priority site is determined as follows:

1) Manta is selected among the proposed master plans as a site covering the northern part of the study area. Manta is the center for commerce and one of the consumer markets. Located between Jaramijo and San Mateo, Manta can facilitate also as a base for the middle fishing boats operating in these three areas.

2) Pto.Lopez is selected among the proposed master plans as a site covering the southern part of the study area. Since Pto.Lopez is connected with consumer markets via Machalilla and Pto.Cayo, these three areas can make a common market by united efforts. Pto.Lopez can serve also as a base for middle fishing boats of Pto.Lopez and Machalilla.
Pto.Lopez has a high fishing port potential, as shown in the following Table.

Therefore, the priority site is selected as a result of the comparison of the above two sites.

The artisanal fishery is an important industry in both Manta and Pto.Lopez. However, since Manta has a larger population adding a high concentration of manufacturing and other industries, the share of the number of people engaged in the artisanal fishery in Pto.Lopez to the entire working population is therefore higher than in Manta. The ratio of the numbers of the artisanal fishermen in Manta to the working population is 3%, whereas Pto.Lopez is about 25%. However, the absolute numbers of the artisanal fishermen in Manta is 700, whereas Pto.Lopez is 500.

The number of small boats involved in the artisanal fishery in Manta is 341, about five times more than in Pto.Lopez where the number is 71.

The middle scale fishing boats has been already introduced at Manta and Pto.Lopez, and is expected to increase in the future. At present, some privately owned, middle fishing boats in Manta land their catches from Manta commercial port, using the port's fishery product handling facilities. Others, however, inevitably use the beach because of the limited capacity of the handling facilities, thus losing the advantages of middle scale boats.

Pto. Lopez has no port facilities. Under the present conditions, both sites have limits on the use of middle boats.

With respect to ease of distribution of catches from small-scale fishery to domestic and export markets, Manta is already serving as the distribution center for three fishing villages in the northern area and four in the central area, and Manta is also one of the major domestic markets itself. Therefore, fishing port development at Manta will contribute to the improvement of product quality, the stable supply of catches, and the planned shipment.

The Ecuadorian Government supports CPA's activities as part of its efforts to improve the living environment of fishermen, and plans to assist CPA in rationalizing distribution through fishing port development. CPAs have been already organized at Manta and Pto.Lopez, and especially the CPAs at Pto.Lopez are active.

For the construction of the fishing port in Manta, it is necessary to take countermeasures in order to prevent the port from shoaling caused by sedimentation discharge generated from rivers. However, the existing breakwater of the commercial port shelters the planned site in Manta, thereby the targeted calmness at the site can be maintained without additional breakwaters.

Pto. Lopez also has the problem of sedimentation, but there is no need for countermeasures because an appropriate site can be selected. To achieve the target level of calmness, however, breakwaters will be necessary.

As shown in Appendix 3.3, the rough estimate of the construction cost of fishing port in Manta is greater than in Pto.Lopez, but the cost per fishing boat (equivalent small fishing boat) for the Manta site is lower.

When evaluated in terms of the site conditions, the fishing situation and the construction conditions, both Manta and Pto. Lopez have advantages and disadvantages.

However, since this project aims at contributing to the regional development through the fishery development, the site selection should preferably be consistent with the national policy for the regional development.

As mentioned above, Manta already has a concentration of industries and a considerable level of the infrastructures. These favorable conditions are expected to contribute to the achievement of immediate effect to the regional development.

On the other hand, Puerto Lopez is in the south Manabi which is one of the less developed areas in Manabi. Hence, by implementing the development of the artisanal fishery, which is a major local industry, the promotion of the regional development and well-balanced land development can be expected.

The characteristics of the two sites as mentioned above have been discussed and reviewed by between Japan and Ecuador sides. In 1991, Manta started various public works, such as the flood control mainly intended for La Poza (existing fishing port area), the countermeasures against the sedimentation, the river works for the environmental improvement, the construction of by-pass roads for easing traffic congestion in the coastal areas, and expansion of drinking water supply, in addition to projects concerning existing infrastructures. Therefore, it was agreed that the Manta fishing port should be given a higher priority as a major project affecting the regional development.

Evaluation Items	Manta,	Pto.Lopez
(a) Oceanography	B	A
(b) Available Space	A	A
(c) Accessibility	A	A
(d) Utilities	A	B
(e) Artisanal Fisherman	A	A
(f) Fishing Boat	A	A
(g) Market	A	B
(h) Activity of Cooperatives	B	A
(i) Construction Cost	B	B
(l) Maintenance	A	B

4.2 Fisheries at Manta

4.2.1 Fishing Boats Fisheries at Manta

(1) Small Fishing Boats

As the owner's address has been given in the application for the fishing permit since the bigining of 1991, it has been easier to locate the small fishing boats. UNEPE classifies these fishing permit records by the districts of the inspector's office, and inputs data to an electronic data base system. At the time of the study, the data up to the end of May,1991 were available. According to the data by UNEPE, at the inspector's office in Manta, 579 small boats have applied for the artisanal fishing permit in 1991 during such term. It is also indicated that, among these boats, the owners of 521 boats have their address in Manta and the owners of other 58 boats have their address in other districts.

When considering the survey resluts by Fallows, et al. (1990) and the results of the field study by the team, the above number, 521 boats, on Manta does apparently not reflect the actual situation, which seems to be caused, for an example, by the reason that the address of the boat owner does not correspond to the district where his or her boat is operated. It is considered therefore that the survey results by Fallows (1990), like the case of the Master Plan, should be based on when evaluating the number of the small boats at Manta for the Highest Priority Plan.

Meanwhile, the transformation of hull materials from wood to FRP has been progressed most at Manta together with San Mateo, and as a result of it, the stronger similarity of hull size is presently observed at the both districts. From the frequency distribution of the major particulars, if dividing the boats by the place of registration, Manta and other districts, it appears that peak of the frequency for both groups is shown on mostly similar position in a histogram. As shown in the next table the frequency itself, however, is larger at Manta than other districts for all of the particulars.

There are around 7 FRP shipyards at Manta and Montecristi, and these shipyards are major source of FRP hull for the south of Manabi Province. Among these shipyards, FIBRACROM Co.,Ltd. has 8 kinds of mold for fishing boats, and ITALFIBRA Co.,Ltd. has likewise 4 kinds. According to ITALFIBRA, in the basis of their building record in 1990, the boats of 7.70m and 7.50m in OAL account for 80 % of the total number of FRP boats that has been built by this company.

Table 4-2-1 Small Fishing Boats: Peak of the Histogram of Main Particulars

Place of Regist-ration	Manta (521 boats)	Others (58 boats)
Overall length		
9m to 7m	85 %	60 %
Breadth		
2m to 1.6m	67	45
Depth		
1m or less	91	66
Gross tonnage		
4GT to 2GT	69	40

Source: UNEPE (1991)
Remark: Percentage means the ratio of frequency to the total number of boats.

Figure 4.2.1-1 shows the histogram of principal particulars of 521 small fishing boats that have been registered by the end of May,1991 for the fishing permit in 1991 at the inspector's office at Manta. By the reason mentioned above, it should be noted that this histogram may include the boats operated in the other districts. However it is considered that this histogram can provide more actual distribution than one from the fishing permit records in 1990 which does not give any information classified by districts.

(2) Middle Fishing Boats

As of July 07,1991, the registration records in the office of captania at Manta holds 142 vessels as a group of "barcos de pesquerias" (B/P: deckked fishing boat of a larger size), which can be presumed, as stated in Chapter 2, to engage presently in the fishery production in the southern half of Manabi Province. Among these 142 vessels and some others which are under document "tramitte (transaction)" for the registration, 90 boats have obtained fishing permit in 1990, among which 20 vessels are of industrial permit as a company owned boat and the rest 70 vessels are of industrial permit for an individual management body. From this situation that a considerable number of the boats is operated without fishing permit, it appears that the registration records by the office of capitania should be used as a basic data to estimate the numbers of active middle fishing boats (P class), which correspond to industrial fishing boats.

According to the registration records, the number of industrial fishing boats in Manta and its vicinity, Jaramijo, are estimated as follows;

Table 4-2-2 Middle Fishing Boats at Manta and Jaramijo as of July in 1991

With/without Fishing Permit	No. of Boats	
1) Total of B/Ps	:102 vessels	
2) With fishing permit in 1990	: 52	
Belonging to a company		16
Operated by individual bodies		36
3) Without fishing permit in 1990	: 50	

From one of the results by the interviews (Table 4.2.1-3, Fig 4.2.1-2) that have been made with the owners of middle scale fishing boats at the Port of Manta to obtain the information on fishery practice by the fishing boats of individual body, the size of the fishing boats which presently use the beach of Tarqui (called as "Los Tanques") as its landing spot is estimated as 40 GT in the maximum. This size will be adopted, for the examination on the further study, as the maximum size of industrial fishing boats of individual body that are planned to be incorporated in the Highest Priority Plan.

Meanwhile, two middle fishing boats in Jaramijo were accidentally included in 25 boats that have been extracted for the above interview. As shown in this example, many of middle fishing boats in Jaramijo use the facilities in the Port of Manta for landing of catch and supply of consumables. To meet with this situation, the middle fishing boats in Jaramijo are included in examination of the plan.

Total number of the boats less than 40 GT at Manta and Jaramijo is estimated at 37 vessels if excluding the boats which is clarified to belong to a company, which is considered, presumably with few exception, to be operated by individual managemnet bodies. The name and particulars of these boats are listed in Table 4.2.1-4, and histogram of the particulars is shown in Fig 4.2.1-3.

As shown in Fig.4.2.1-2, among the boats less than 40 GT, the ratio of the boats that use, for landing of catch, the beach of Tarqui to those that use the existing wharf is 6:12. From these study results, the boats under consideration may be classified as follows;

1) Total number of the middle fishing boats less than 40 GT : 37 vessels

   Among the above fishing boats,

2) Thoes using the existing wharf to land catch : 25 vessels

3) Those using Tarqui beach to land catch : 12

(3) Planning of the Fishing Boats and Landing Volumes

1) Small Fishing Boats

As the Master Plan, in the Highest Priority Plan, the number of small boats is planned at the present level, and increasing of the boats during the period of the project is likewise not considered. Catch per boat at present level (24 tons/boat) is considered as a planned landing volume.

Table 4-2-5 Plan for Number and Landing Volume of the Small Fishing Boat (1995)

Description	Number of Boat	Landing Volume
Small Fishing Boat (Manta)	vessels 341	tons/year 8200

2) Middle Fishing Boats

Among the 37 middle fishing boats, many boats have been first registered after 1980, while some boats have been registered in the years before 1980. As the average number of registration, 3.2 boats per year is given if it is taken for the 10 years term from 1981 and 1990. This average is assumed to present an annual increment, while the boat used for 15 years since the first registration year is assumed to expire its life. Under these conditions, the number of the middle fishing boats in 1995 are estimated. Following table shows the results.

Table 4-2-6 Middle Fishing Boats Less Than 40 GT

1) Transition for Total (37 boats)
unit: vessel

Districts	1990	1995
Manta/Jaramijo	37	53
Retired boats		-3
Balance	37	50(+13)

2) Transition for 12 boats :
The case that all of the increase are incorporated in the plan.
unit: vessel

Districts	1990	1995
Manta/Jaramijo	12	25(+13)

3) Transition for 12 boats:
The case that 1/3 of the increase are incorporated in the plan.

unit: vessel

Districts	1990	1995
Manta/Jaramijo	12	16(+4)

Among the above 37 middle fishing boats, 9 boats have obtained the fishing permits in 1990. From the fishing permit records and the results of the interview, the fishing method of 11 boats can be clarified, resulting in the ratio of purse seine and long line; 5:6. In the class less than 40 GT, there is no significant diffrence of the scale between purse seiner and long liner. If the middle fishing boats increase in the period of the project by the same ratio of fishing method and by the same increment during last 10 years, following three tables are presented to provide the number of the middle fishing boats to consider the Highest Priority Plan.

These tables have following condition;

- Plan (A) intends to incorporate, for accepting the middle fishing boats aggressively, all of the increased boats if less than 40 GT.

- Plan (B) presumes, like the present situation, 2/3 of the increased boats will use the existing wharf of the port.

- Plan (C) accepts only the number of boats at present level, and does not incorporate the future increase.

Table 4-2-7 Plan for Number of the Middle Fishing Boats Less Than 40

Plan (A) unit:vessel

Description	1990	1995
Manta/Jaramijo	12	25
Purse seiner	5	11
Long liner	7	14

Plsn (B) unit:vessel

Description	1990	1995
Manta/Jaramijo	12	16
Purse seiner	5	7
Long liner	7	9

Plan (C) unit:vessel

Description	1990	1995
Manta/Jaramijo	12	12
Purse seiner	5	5
Long liner	7	7

Through the above interview, the landing volume and operation times per year were also studied. 20 effective answers were obtained. From the result, average landing volume per year is estimated 420 tons for purse seiner and 35 tons for long liner. The average gross tonnage of the interviewed boats is around 25 GT if calculating both of purse seiner and long liner. Based on these averages, the landing volumes are planned. The results for plan (A) is shown as following table.

Table 4-2-8 Plan for Landing Volume of the Middle Fishing Boats Less Than 40 GT; Case for Plan (A)

unit:vessel

Description	Boat No.	Landing Vol.
Manta/Jaramijo	25	tons/year
Purse seiner	11	4620
Long liner	14	490

3) Planned Landing Volume per Day

From the results of the above estimates and plans, landing volumes per day are planned in case of the 280 operation days/year. The results are shown in the next table.

Table 4-2-9 Planned Landing Volume per Day

Case for Plan (A)

Descriptions	Manta
Annual Landing	tons/year
Small fishing boats	
..............(A)	8200
Middle fishing boats	
Purse seiner..(B)	4620
Long liner....(C)	490
Daily Landing	tons/day
(A) + (C)	31.0
(B)	16.5

Remarks : (A) Demersal fish, large pelagic fish
(B) Small pelagic fish
(C) Large pelagic fish

The total landing volume in the planned facilities is around 13300 tons / year. As stated in section 2.4.1, the present land ing volume in the Port of Manta and the beach of Tarqui is esti mated as around 101 thousands tons, of which the above planned landing volume accounts 13 %.

(4) Fishery Processing Companies

At present around 16 companies and a national corporation are estimated to be engaged in fishery processing and related industry at Manta. The major products by these companies are cannned fish, fresh fish, frozen fish/fillet and ice. Some of the companies own and operate a fishing fleet which has its base in the port of Manta. In addition to these, there are two ice making firms which supply the block ice for the general demand including for the fishery sector.

Table 4-2-10 Total Capacity of Fish Preservation and Processing Plant Opearated by 10 Companies at Manta

Facilities		Capacity/Capability
Cold Storage		9,555 Tons
Freezer		713 Ton/day
Canning Plant		10,479 Case/day
Ice Making Plant:	Flake	191 Ton/day
	Block	180 Ton/day

Remarks: A case of fish can holds 48 cans of 184, 225, or 450 grams in net weight

4.2.2 Demand of Fishery Products

(1) Local Consumption

Per capita fish consumption in Ecuador is estimated to be 10 kg/year and that in Manabi province is assumed to be same. Then total consumption volume of fishery products in Manta area (restricted to the project site area) is 1,224 tons in 1990, while that in whole Manta is 1,353 tons and that in whole Manabi province is 10,261 tons.

Fish Consumption in Manta

	1990 Population	Fish Consumption(MT)
Manabi Province	1,026,066	10,261
Manta	135,286	1,353
Manta (site area)	122,426	1,224
Jaramijo	8,207	82
San Mateo	1,382	14
Manta Rural	3,271	33
Other Area	890,780	8,908

(2) Exports

Exports volume from Manabi province in 1990 is estimated to be 61,944 tons (in raw fish weight; values will have same meaning for the weight of fishery products in this section) by using the volume frozen shrimp is 9,105 tons, frozen fish is 6,893 tons and canned fish (tuna, sardine etc.) is 31,079.

According to the method of transport, 5,178 tons is exported by air, 49,401 tons by ship and 7,365 tons by truck. As for the exports by air, most of it is the fresh fish for United States. By ship, frozen or canned products are transported mainly. Moreover exported country by ship is United States at first (35%); followed by Spain (32%) and Puerto Rico (10%). By road, canned fishes are transported to United States and Colombia.

According to the statistics(1990) of APM, the exports volume of fishery products from Manta port is 23,684 tons in frozen fish, 4,874 tons in frozen shrimp and 23,528 tons in canned fish, while according to the copies of invoice 14,862 tons is in frozen fish, 8,961 tons in frozen shrimp and 23,528 tons in canned fish. These values have much differences. However, the values of APM statistics data are the values of loading volume, which has much accuracy than that of the invoice data. The values in invoice are the scheduled one, and there are other ports than Manta for loading such as Guayaquil. Therefore, the frozen fish and the canned fish might be exported from Guayaquil port, whereas the export of frozen fish might include the inflow from Guayaquil.

The production of shrimp is hardly found in Manabi province. Then the value of exported volume by the invoices subtracted by the volume of frozen shrimp should be assumed as the export volume from Manabi province.

(3) Supply/Demand Balance of fishery products

Using the said results the supply/demand balance will be estimated. Here the share of the export volume by the landing site is hardly estimated. Therefore the balance will be estimated in the assumption that the export contains the landing from each site by the share of landing volume. The results of estimation is as follows;

Fish Supply/Demand Balance in Manta

Supply		Demand		
	Production	Consumption	Export	Sub-total
Manabi Province	80,400	10,261	53,275	63,536
Manta	63,970	1,353	42,477	43,830
Manta (Site area) Jaramijo San Mateo	62,800	1,320	41,708	43,028
Manta Rural	1,170	33	769	802
Other Area	16,430	8,908	10,798	19,706

There is 20,140 tons of surplus in the whole Manta. The other area contains the fishing villages such as Puerto Lopez, Machalilla etc. (as the fish supply area), but it also contains population density area such as Portoviejo etc. Then there is 3,276 tons of deficit in this area. In whole Manabi province, there is 17,000 ton of surplus, which seems to be supplied to Guayas province and the provinces in mountain area.

4.2.3 Fish Marketing

(1) Estimation of the Inflow Volume to the Fishery Company from the Artisanal Fishery Sector

According to interview to the merchants at Manta, the destinations of the fish purchased by the merchants are as follows.

a) The merchants who deal big quantity of fish sell them to the fishery companies around 50%-80% of the total dealing volume, and those fishes are exported by the fishery companies.
b) Almost all volume purchased by the small scale merchants is sold at the local markets.

The inflow volume to the fishery companies fluctuates by season, but considering that those volume occupies the large shares of the landing volume from the artisanal fishery, the estimation of inflow volume is set to be 50% of the total landing volume. Here, fish sold to the fishery companies will be assumed not to be kept in refrigerator at the planned fishing port. Therefore, 50% of the total landing volume by the artisanal fishery is planned to be stored at the fishing port.

(2) Share of the preservation volume which will not outflow to the fishing companies between refrigerator and freezer

The fish landing around Manta are mainly swordfish, tuna and bonito, which in total has the 60% of the share of landing; followed by dorado in 30%. Those fishes can be sold by the good prices in the frozen conditions at the local markets or exports markets. So, in this study, of those fishes one of third (4.5 tons per day) will be selected as in fair quality and stored in freezer to sell to exporters and supermarkets. In future, these will be exported directly by the fishermen association. The rest (9tons per day) is to be stored in refrigerator and will be sold in consideration of the markets price.

As for demersal fish, about half of the landing volume (0.5 tons per day in product weight) is assumed to be stored in freezer at the style of fillet. these will be expected to be sold to supermarkets, restaurants, hotels and hospitals. The rest (1 ton per day) will also be stored in refrigerator and will be sold according to the fish market price.

4.3 Natural Conditions of Manta

4.3.1 Matural Conditions

(1) Meteorology

1) Velocity of Wind
According to the statistics of meteorology observation for the period of 1981-1988 at Manta Province, annual average wind direction and velocity are shown in Table 4-3-1 and Fig. 4-3-1 respectively represent that average velocity of the wind is 6 knot and predominant wind direction is S-WNW. This period includes for the period 1982-1983 which El Nino occurred. Table 4-3-2 and 4-3-3 show monthly average wind direction and velocity respectively represent average wind velocity is 5-6 knot and predominant wind direction is S-W.

2) Precipitation
Table 4-3-4 shows the precipitation at Manta for the period 1965-1989. While annual average precipitation is 320mm, 1983's record was 2,022mm owing to the influence of El Nino. To analysis these records statistically, this probability occurs per 150 years. (Fig. 4-3-2)

(2) Geology

1) Subsoil Conditions
Fig. 4-3-3 shows the geological map of the selected site and transverse section as well. This figures is carried out for Cysica-Scamdic consultant. These materials consist of clays and sedimentation sand. Manta area has at least three quarry. These materials has a very good performance so is use extensively on breakwater construction. Those reserves will be more than one hundred million cubic meter. It is possible to get 708 to rock.

2) Boring
Soil investigation was conducted at 500m and 1,000m offshore point in La Poza area. (Fig. 4-3-4) According to this investigation, there are the soft siltation layer of around 1m thickness at the seabed surface, and following this there appear the hard clay layer and the silty sand layer alternately. Under 3m of the seabed (-5m depth), N values show more than 30. (Fig.4-3-5)

3) Seismicity
Because of lack of information for Manabi region, it is difficult to evaluate an earthquake risk. But Lommnitz reports the five biggest earthquakes on Ecuador as follows.

Date	Epicenter	Magnitude
January 7, 1901	Guayaquil	---
January 31, 1906	North of Ecuador	8.9
May 14, 1942	Outside Ecuador	8.3
August 5, 1949	Ambato	6.8
January 19, 1958	Colombia-Ecuador	6.8

Except 1949 earthquake, above information is not enough to evaluate the seismic intensity. But considering existing structures of Manta port, the earthquake factor of 0.1 is adequate to design the port structures.

(4) Oceanography

1) Tide

Tide of Ecuador is shown in the following Fire that represent two high and two low tide every 24 hours. the period interval is 12 hours. The highest tide amplitude between low and high tide is 2.9m. Tide at Manta is shown below.

MHWS = 3.46 m
MHW = 2.99 m
MSL = 2.08 m
MLW = 1.21 m
MLWS = 0.49 m

2) Wave

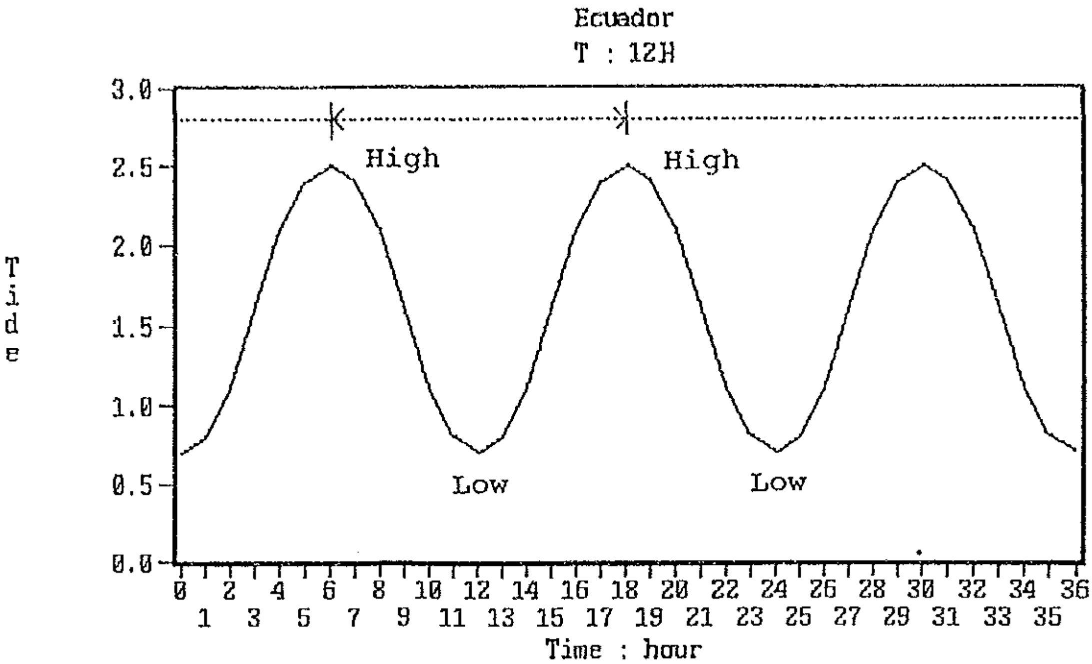
Wave at Manta coast have the following characteristics.

-The wave period is 10-20 sec, and significant wave height is 0.4-0.6m.
-Higher waves occur in June - November.

ESPOL carried out wave observation for 3 months (August-November, 1989) at Manta coast. The distributions of significant wave height and wave period are shown in Fig. 4-3-6(1) and Fig. 4-3-6(2). Following Table shows the wave refraction coefficients at Manta coast.

Refraction Coefficient at Manta Coast

Angle of incident wave	Period(sec) 14	16	18	20
225	0.30	0.32	0.34	0.35
270	0.45	0.45	0.50	0.50
315	0.74	0.79	0.73	0.75
0	0.56	0.53	0.35	0.63



Tide of Ecuador Coast

3)Tidal Current

ESPOL carried out tidal current observation at Manta coast from March, 1986 to February, 1987. Summary of observation is shown on f ollowing Table. According to those data, maximum of monthly mean velocity is 14.4 cm/sec on January. Maximum velocity is 31.9 cm/sec on April. Prevailing current direction is 244. Fig. 4-3-7 shows the current direction and velocity of tidal current for one year. Table 2-18 shows observation period and samples numbers.

Surface currents tend to describe a cyclonic (clockwise) circulation within the Manta Bay; toward the northeast near the port facilities and toward the southeast to the right of Burro river mouth.

Monthly Mean, Current and Direction of Tidal Current at Manta

Months	Mean Velocity cm/sec	Mean Direction Degrees	Max Velocity cm/sec
January	14.40	238.43	29.4
February	6.64	278.23	16.5
March	6.31	226.48	23.8
April	6.71	214.72	31.9
May	7.33	188.69	21.1
June	5.49	260.27	27.1
July	8.45	203.33	16.7
August	7.21	216.02	23.4
September	6.31	290.69	17.4
October	5.53	268.10	16.9
November	7.01	275.52	20.5
December	14.00	269.03	29.6
Global Mean	7.95	244.12	22.9

4.3.2 Beach Evolution

(1) Sand Drift of Manta Coast

The whole coast of Manta is divided in three zones. Placed to the west coast, port area and east coast. The west coast is left side of the port breakwater. The west coast is sandy beach about 1km long. There is a reef at 500m offshore. Max. wave height of the west coast is about 1.0-1.5m and the current is strong. Therefore, sand drift is not so weak. There is sand deposition near the breakwater.

The port area is sheltered by the breakwater. Therefore, wave height is less than 0.5m at the port area. The sand drift is not so strong. The direction of the sand drift is to the west. That is caused by the diffracted waves of the breakwater. There is large sand deposition in this port area. Seabed materials of the port area are very fine sand and silt. Distributions of seabed materials are shown in Fig.4-3-8(1). The average grain sizes become smaller from the Horn Jaramijo to the west as shown in the grain size distribution of the seabed material along the shoreline at the low tide. (cf. Fig.4-3-8(3)) The average grain size between La Poza and Tarqui is 0.2mm. (ESPOL, Oceanography Survey Report)

The east coast is defined as the east side of the Bravo river. Max. wave height is about 1.0m at the east coast. Seabed materials are sand and gravel. There are some rocky stones also. The sand drift is not so strong. The direction of sand drift is to the east. The east coast is eroded someplace.

The coastal sand drift volumes are estimated by the sand drift formula to be 3,000m^3 at the port area and 5,000m^3 at the east coast. (Fig.2-5-4(2))

(2)Accumulation Volume at Manta Coast

Manta and Bravo river flow into Manta Coast. Those river's discharges are very small in the normal year. But, those discharges are large in El Nino year. From 1965 to 1990 there were 3-4 times El Nino events. In 1983, the abnormal precipitation was caused by El Nino event that is presumed to be the biggest in this century. This precipitation is 2022mm/year being more than 5 times the average year. Sediment discharges of Manta and Bravo river were also large in 1983. These sediment discharges were deposited at port area.

The coastal sand drift is not so strong because of the low wave heights and the sedimentation at the seabed is caused mainly by the sedimentation discharges of the rivers. Accumulation volumes at port area are shown in Fig. 4-3-9. Those figures are based on sounding maps of 1965 and 1990. The seabed changes are large between -2m and -3m at the port area.

The total accumulation volume is about 1,350,000 m^3 for about 25 years lasting from 1965 to 1990.
The probability discharges of Manta river is estimated as follows by the report of water resources dept. Manabi Province.

The accumulation volume at the planned Manta fishing port caused by the flood of Manta river is calculated using the 50 years probability discharges. (Appendix 4.4.1(5))

Probability Discharges of Manta River
(unit:m^3/sec)

Q5	Q25	Q50	Q100
103.8	220.0	278.3	358.7

(3) Shoreline Change

The comparison of the shoreline changes after 1965 using the sounding maps carried out at Manta coast are shown in Fig.4-3-9(7). (ESPOL, Oceanography Report) The beach erosion is recognized at the east coast, while the beach accretion at the port area. The beach erosion has been proceeded continuously from 1965, but the beach accretion increased owing to El Nino event at 1983. The beach accretion at the port area is probably caused by the sediment discharges of the Manta River. So, it is necessary to consider the effect of the sediment discharges of the river when planning the fishing port at the port area.

4.4 Required Scale for Port Facilities

4.4.1 Required Scale for Fishing Wharves

(1) Dimensions of a wharf

The dimensions of a wharf for fishing boats are calculated based on the dimensions of the boats concerned and by adding adequate allowances or surplus to these dimensions.

In this project, the small and middle boats were taken consideration and the dimensions of the wharves to accommodate them were calculated as follows:

1) Wharf for small boats

a) Dimensions of boats
The gross tonnage, overall length (OAL), breadth (B) and depth of 521 registered small boats are shown in Fig. 4-2-1. From these figures, the average sizes of a small boat were determined as follows:

OAL: 9.0m
B: 2.0m
Depth: 1.0m
Draft: 0.8m (considering the draft of the outboard-engine)

b) Dimensions of the berth (wharf)
Based on the above-mentioned dimensions of boats, the dimensions of water area for one boat, that is to say "berth", for small boats were calculated as follows:
Berth length = OAL + allowance/surplus (15%) = 10.3m
A value of 10.0m is considered satisfactory.
Width = B + allowance/surplus (50%) or 1.0m on each side
A value of 3.0m is considered satisfactory.
Water depth of berth = Draft + allowance/surplus (0.5m) = 1.3m
A value of 1.5m is considered satisfactory.

2) Wharf for middle boats

a) Dimensions of boats
The gross tonnage, overall length (OAL), breadth (B) and depth of 37 middle boats (of less than 40G/T class) which regularly use the Port of Manta are shown in Fig. 4-2-1,2,3.

As the total number of medium size boats is small, the average of these values is not always the adequate sizes for this project. Therefore, in calculation of the dimensions of the boat, 70% of the total number was referred to determine the length and width, while the maximum value was referred to determine the depth.

The dimensions thus determined are as follows:

OAL: 15.0m
B: 4.5m
Depth: 2.4m
Draft: Depth x 84% = 2.4 x 0.84 = 2.0m
(The case with a maximum depth of 3.0m was excluded. As to the value of 84%, see Appendix 4.4.1(1))

b) Dimensions of the berth
Based on the above figures, the dimensions of the berth for middle boats were determined as follows:

Berth length = OAL + allowance/surplus (15%) = 17.3m
A value of 18m is considered satisfactory.
Width = B + allowance/surplus (50%) or 1.0m on each side
A value of 6.5m is considered satisfactory.
Water depth of berth = Draft + allowance (1.0m) = 3.0m

c) Summary
The dimensions of the berths for small and middle boats calculated as mentioned above are summarized bellows:

	Length	Width	Water Depth
Small Boats	10.0m	3.0m	1.5m
Middle Boats	18.0m	6.5m	3.0m

(2) Required scale for fishing wharves

Wharves are classified as follows according to the purpose of use.

1) Landing wharf
2) Outfitting wharf
3) Idling wharf

Landing wharf is a wharf used for mainly landing fish catch from boats, and the fishing boats are usually moored alongside the wharf.

Outfitting wharf is a wharf used mainly for supplying water, fuel oil, etc. to fishing boats and loading them by using appropriated facilities, and fishing boats are usually moored alongside the wharf.

Idling wharf is a wharf used mainly for mooring fishing boats (including loading of fishing gear, food etc.), and fishing boats are usually moored fore and aft the wharf.

1) Small boats

The number and dimensions of each wharf required were calculated under the following preconditions:

a) The planned number of boats is 341.
b) The wharves to be constructed are: for landing berth and for outfitting and idling berth.
c) The mooring method
   Landing wharf: moored alongside
   Outfitting and idling wharf: fore and aft, or 3 boats alongside.

- Calculation (1): Required scale of landing wharf
The number of boat was counted from early morning until evening in TARUQI where small boats usually come and land their catches.

The result is shown in Appendix - 4.4.1(2)
Based on this result, the number of the berth was calculated for the following four peak arrival periods, and the required number of berths was determined.

	Period	Number of Arrivals	Interval	Landing Hour	Number of rotation	Required Number of berths
1)	20/7/1991 9:00-9:30	21	30 min.	10 min.	3	7
2)	20/7/1991 8:30-9:30	35	60 min.	10 min.	6	6
3)	20/7/1991 8:30-10:00	44	90 min.	10 min.	9	5
4)	29/6/1991 7:00-8:20	26	80 min.	10 min.	8	3

Notes:

a) It was assumed that the hour for fish landing is 10 minutes per one boat.
b) Number of rotation = Interval/Hour for landing.
c) Required number = Number of arrivals/Number of rotation.

On an average, 5 berths are required, When mooring 1 boat alongside, the dimension of a berth length is 10.0m and the required wharf length is 50.0m.

- Calculation (2): Required scale of outfitting and idling wharf.
a) The mooring conditions for small boats were investigated. (See Appendix 4.4.1(3))
   Observation was conducted during four days. The number of moored boats varied with the times of observation, but was on an average 120 boats in the "S" zone and 140 boats in La Poza. The total was 260.
   Assuming that the boats are moored in the quay, the required length for the wharf was calculated as follows:

- Case (1) one boat fore and aft: 780 m, assuming that one boat occupies 3 m width.
- Case (2) 3 boats alongside: assuming that the dimension of the berth is 10 min. length.
  260 / 3 x 10 = 870 m

In any case, about 800 m in length will be required for the wharf.

b) According to the information of the fishermen, the number of small boats permanently moored at the Port of Manta is approximately 330-340, of which approximately 10% are not operating due to breakdowns or other reasons and each half of the removing boats are continually fishing and idling. With regard to the small boats (see Appendix 4.4.1(2)), almost the same results were obtained. That is, the boats operating on observation (29/6/1991) numbered 134 in total.
Assuming that the number of boats is 150, the required length is 450~500 m when 3 boats alongside or boat fore and aft.

c) Taking into consideration the service level fishing port and the amount of investment for the short-term plan, the required length of outfitting and idling wharf is fixed at 400 m at present.

2) Middle boats

a) Planned numbers of the middle boats
At present, fishing wharves of Manta commercial port are used fully by the existing middle fishing boats, and those wharves can not facilitate the increased fishing boats in the future. (Ref. Appendix 4.4.1(4))
To shift the fish catches from the fishing wharves at Manta commercial port to the functional facilities at the planned fishing port is considered not to be efficient judging from the facilities location of the both ports. Moreover, it is economical to plan the full usage of the functional facilities by the middle scale fishing boats owned by individuals at the target year 1995.

Based upon the above reasons, planned numbers of the middle boats are set as 25.

b) Preconditions
The wharves to be constructed are decided based upon the following comparison:

Study-1: Landing, outfitting and idling at the same wharf.
Study-2: One for landing and another for outfitting and idling.

The mooring method is as follows:

Landing wharf: one boat alongside.
Outfitting and idling wharf: 2 boat alongside or 1 boat fore and aft.

c) Calculation (1): Required scale of landing wharf
Of the fishing boats leaving the Port of Manta, the number of middle boats of less than 40T was 10 per day on an average (Ref. Appendix 4.4.1(4))
It is assumed that the 37 middle boats using the Port of Manta are divided into 4 groups categorized by types of operation.

It is assumed that the middle boats sail out and fish for 4 days and then idle for 3 days per week (Pattern A), or work for 5 days and idle for 2 days (Pattern B), although the types of operation varies with fishery or season.

It is also assumed that this pattern will not change in the future until 1995.

If 50 boats repeat Pattern A or Pattern B in 1995, the number of boats that would stay in the Manta area will be 21 on an average for Pattern A and 14 on an average for Pattern B.
(Ref. Fig.4-4-1)

The number of boats that use the fishing port planned in the project is assumed as 9 boats as the share is 25 / 50 = 0.5.

The required length for 9 middle boats was calculated as follows:

Study-1 As 1 berth is 18.0 m long, 18.0 x 9 = 162.0 m
Study-2 (Wharf for landing)
One boat is moored alongside. Assuming that the hour necessary for landing is 1 hour/boat and the waiting time in the berth is less than 1 hours, the number of berths required is 5. 18.0 m x 5 berths = 90.0 m.
(Wharf for outfitting and idling)
Supposing the boat is moored fore and aft, the required width per boat is 6.5 m.
6.5 x 9 = 58.5 m
In case of 2 boats alongside,
9 / 2 x 10 = 45.0 m
Total: 135 ~ 150 m

Considering both cases, the required length in total is 160.0 m.

d) Summary
The results of required scale are summarized as follows:

Boat	Wharf for landing	Wharf for outfitting and idling	Total length
Small boats	50.0 m	400.0 m	450.0 m
Middle boats	For landing, outfitting and idling		160.0 m

e) Besides landing wharves, a slip-way for repairing of fishing boats will be planned. As the average breadth of a small boat is 2.0m, an allowance of 1m for both sides is considered. The total width of slip-way is planned as 12m in order to facilitate 3 small boats at the sasme time.The slope shall be 1/8.

4.4.2 Required Scale for Functional Facilities

(1) Components of the Planned Facilities

The components of the functional facilities for the Highest Priority Plan are considered in the similar way with the Master Plan. In case of Manta, the freezing plant is examined to include, considering that there is the frozen fish market in this site, which is not seen in the other districts.

(2) Distribution of the Fish

Considering the present situation of the fish distribution at Manta, the distribution of landed catch in the planned facilities is planned as following diagram;

(unit:tons/day)

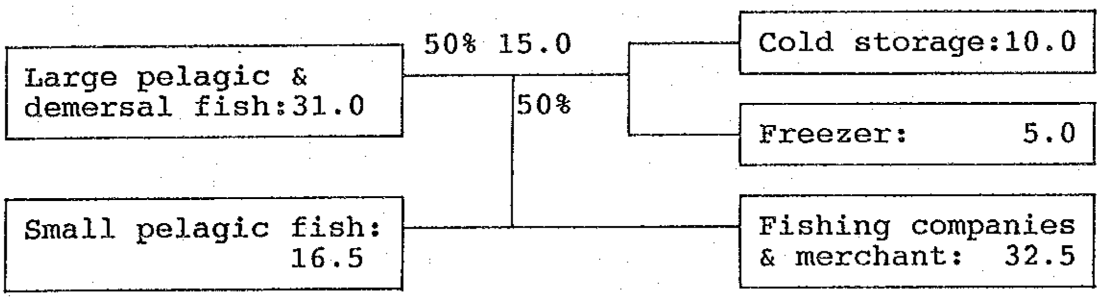


Fig. 4-4-2 Allocation of Fish Cathes by Planned Facilities

(3) Scale of the Planned Facilities

1) Cold Storage

The capacity of the storage is planned as to hold three days stock of catch with conservation temperature of 0 Centigrade. The stacking ratio is planned to enable the storage of fish contained in iced boxes.

2) Freezer

The capacity of the storage is planned as to hold 20 days stock of catch with conservation temperature of minus 30 Centigrade. The storage is made contained in pallet, carton or fish box. Blast freezer is planned to treat both of block and fillet of large fish.

3) Ice Making Plant

Ice of the twice quantity of the landed volume of fresh fish is planned to produce. Taking into consideration the fluctuation of landing volumes, the double units operation is planned. Ice storage bin is of a capacity corresponding to 3 days production volume, and divided to two rooms; one is refrigerated at 0 Centigrade, and another has insulated panels.

4) Fish Handling Space

In this space, fish selection, washing and preliminary processing are made. The floor space approximately of a 400 sq.m is required for these works, though it should be examined by the architectural plan.

5) Fishing Gear Repairing Space

This space is used for the maintenance and repair of longline, purse seine and gill net. The space is paved, but does not have erected structures. The reclamation of the area of around 1000 sq.m is examined.

6) Warehouse

The warehouse is planned to store fishery equipment and materials including various kind of fishing gear. The floor space of around 100 sq.m is examined, which should be finalized after the architectural plan.

7) Workshop

For the maintenance of outboard engine, the space to place around 10 engines is examined. In addition to this, work benches and tools are installed. The floor space of around 100 sq.m is examined, which should be finalized after the architectural plan.

8) Fuel Oil Tank

The fuel oil tank and piping facilities are planned for fishing boats. The capacity of the tank is planned for the provisions of 5 operation days.

Gasoline	200 ltr.x 150 boats (depart./day) x 5 days	= 150 Kltr.
Diesel oil	230 cc/hr/PS x 24 hr x 5 days x 140 PS	= 3900 ltr.
	3900 ltr x 25 boats	≒ 100 Kltr.

9) Freshwater Tank

The tank for freshwater to supply the fishing boats is examined. 5 ltr./day is considered as a planned supplying volume for a person. For both of the small and middle fishing boats, a tank of around 12 Kltr. and piping facilities are planned.

10) Administration Building and Others

a) Administration building
Approximately 180 sq.m is considered for the administration building based on the management and personal plans.

b) Parking space
The reclamation of the parking area for around 40 vehicles is

examined. Approximately 800 sq.m is considered.

c) Road
15m wide main road and 10m wide connected road are planned with drain.

d) Greenbelt
Greenbelt of total length 350m is planned in the fishing port area.

e) Waste water disposal
Waste water disposal is planned within fresh handling space. Waste water generated from fish selection, washing and preliminary processing is treated. Handling fish volume is 31 tons per day.

f) Others
Water inlet to use sea water is planned in the fish handling space.

Following table summarizes the results of the above planning;

Table 4-4-1 Scale Outlines of the Planned Facilities
The Year of 1995

Descriptions	Manta
Cold storage(0°C)	30 tons (net capacity)
(-30°C)	100 tons (net capacity)
Blast Freezer	2 Mt/8hr
Ice making plant	10 Mt/day x 2 units
Ice storage	30 tons (0 Centigrade)
	30 tons (insulated)
Fish handling space	Fish selection, preliminary processing, etc.
Fishing gear reparing space	1000 sq.m
Warehouse	Storage for fishing gear
Workshop	Maintenance for outboard engines
Fuel oil tank:	
Gasoline	150 Kltrs
Diesel oil	100 Kltrs
Freshwater tank	12 Kltrs
Administration Bld.	
Parking space	For around 40 vehicles

4.5 Fishing Port Layout Plan

4.5.1 Layout Plan of Main Facilities

In planning short-term improvement, the following requirements are adopted:

- External Facilities
  From the viewpoint of long-term countermeasures against sedimentation, the Master Plan is to be based on an end-of-jetty depth of -5.5m. For short-term plans, however, -3.0m (threshold depth for sediment movement) is to be adopted.

- Harbor Facilities
  Roadstead for small boats -1.5m
  Roadstead for middle boats -3.0m

- Mooring Facilities
  Wharf for small boats (-1.5m)
  Landing 50.0m
  Outfitting/Idling 400.0m

  Wharf for middle boats (-3.0m)
  Landing 90.0m
  Outfitting/Idling 70.0m

As a result of the comparison of the possible sites of Manta fishing port in the fishing port area and the east coast area mentioned in the preceding chapter (3.5.1), the site in the fishing port area has been selected. However, since there are two alternatives available in the fishing port area, they were compared so as to decide the better option:

Alternative 1: Locating the facilities outside La Poza
(A-1)--Fig.4-5-1

Alternative 2: Locating the facilities inside La Poza
(A-2)--Fig.4-5-2

Comparison of the two methods is as follows:

1) Calmness

Study has been made on the calmness of wave in the water area of the Master Plan under ordinary and stormy conditions.

- Ordinary Condition
  Wave Direction (Ref. Table 2-1-5):
  From the above referenced figure, the prevailing waves predominantly come from the south direction, followed by the SW direction and therefore, the WSW direction wave has been adopted for the study.

  Wave Height/Wave Period (Ref. Table 4-3-6):
  From the above referenced figure, the wave height is estimated

to be under 1.0m calculated from 90% probability of nonexceedance at the front of the existing breakwater, and the wave period is taken at 15 seconds.

Results of the Study:
The deepwater waves mentioned above approach the entrance to the Port as shown in Fig.4-5-3(1) and the height in the water area is analyzed as shown in Fig.4-5-3(1).

The critical wave height for possible fish landing and outfitting is mentioned in Section 3.5.1. Judging from the diffraction diagram, each wharf maintains the desirable calmness at the water front.

- Stormy Condition
  Although seldom, there are cases when the wave comes from the NW direction. Therefore, NW direction wave has been considered in calculating the calmness under stormy condition.

  Stormy condition is defined as follows.
  Deep water wave direction;NW, deep water wave height;3.0m, deep water wave period;15sec (provability of occurrence 1.3%). Under above condition, refraction diagram and calmness at Manta are calculated as shown in Fig.4-5-3(2).

  Regarding the calmness of the port anchorage, the wave height at water area along the training jetty is less than 0.5m (Refraction coefficient; Kr=0.2), while the wave at the area off the jetty shows the height less than 0.7m (Kr=0.2-0.3). Therefore, water area along the jetty is available as safety anchorage in the stormy condition. Water area off the jetty is sometimes difficult for small boats to anchor, but another water area can afford the sufficient sheltered space(under 0.5m wave height) to small boats within port area

2) Sand Drift

Throughout the year, the water flow in the direction of prevailing waves (northwest) bifurcates towards west and east about 2km to the west of the fishing port area. The sedimentation discharges from the Manta River as a whole fluctuates widely, and the area in front of the river mouth is one of the areas vulnerable to sedimentation. Actual sedimentation of around 3,000 cub.m per year, however, does not pose a major problem. In this regard, therefore, there seems to be no difference between Alternative 1 and Alternative 2.

3) Sedimentation Discharges

Likely causes of sedimentation in Manta fishing port area include sand drift and sedimentation discharges of rivers.
Judging from the annual sand drift of about 3,000 cub.m per year and the sedimentation discharges of 46,000 cub.m, the sedimentation discharges are considered to greatly affect to the shoaling of the fishing port.

In view of this, a flow regime model simulating sedimentation in the fishing port area during the period between 1982 and 1983 was developed. In this flow regime model, flow regime for a peak flood discharge of 280 cub.m, which corresponds to a 50-year flood, was calculated. Then, based on the result of calculation, topographical changes were simulated using Einstein-Brown's formula.

In the study, three cases were considered: present site, Case A-1 (Alternative 1 with an end-of-jetty depth of -2.5m) and Case B-1 (Alternative 2 with an end-of-jetty depth of -2.5m). Results of calculation (stream line vectors and topographic changes) are shown in Fig. 4-5-4 and Fig. 4-5-5.

Stream line vectors indicate that the present state and Case A-1 have similar flow regimes in roughly corresponding areas, while in Case B-1 the influence of flow regime extends beyond the end of the jetty.

As a result, it was concluded that there is no direct inflow of sediment into the fishing port.

In Case B-1, sediments are deposited beyond the end of the jetty, and unlike in Case A-1, sediments could flow into the fishing port.
There could be inflows of sediment into the fishing port due to littoral drift after floods even in Case A-1. Therefore, influences will be made ignorantly small by setting the end-of-jetty depth at 3.0m, allowing for a safety margin.

4) Site Conditions of Fishing Port

Alternative 1 has the following merits:
- It makes future expansion possible.
- Lots of land for the fishing port and fishery-related facilities can be acquired more easily. On the other hand, Alternative 2 has the following problems:
- A plan for Construction of a coastal road in the rear (plan for improvement of Malecon Jaime Chaves St.) reduces the possibility of future expansion of the fishing port.
- It is difficult to acquire land for fishery-related facilities.
- Since the water area is closed, sea water quality in the harbor might be contaminated by effluence from fishing port facilities.
- There is a plan for constructing a recreation zone (yacht harbor, etc.) in this area.

5) Construction Cost

Alternative 2 permits the best use of existing structures in the fishing port area, but the required extension of the jetty is longer than in Alternative 1. As a result, the estimated construction costs are 16.4 million US$ for Alternative-1 and 20.0 million US$ for Alternative-2.

As a result of the above comparisons, it is concluded that Alternative-1 is better.

4.5.2 Layout Plan for Functional Facilities

In order to secure the sufficient land space and the coastline required by main facilities and the functional facilities, the short-term development plan is to include a 160m wide, 350m long lot to be constructed by reclamation to the north of La Poza's jetty. The functional facilities will be built in this space (Ref. Fig. 4-5-6).

- Administration Building will be place inside and near the gate.
- The movement line of catches landed at the wharf to the handling facilities should be the shortest. The entrance of the handling space should be wide enough(40m), and the fish catches classified there can be either moved to storage facility or shipped out along a linear movement line.(Ref. Fig.4-5-6(1), Flowchart of Fish Catches)
- Enough space is allotted behind the fish handling space for loading of fish catches and car parking.
- A fishing gear repairing space is planned next to the fish handling space for maintenance and repair of fishing net. Behind the fishing gear repairing space, an open space is prepared for peak hour and for tentative usage.
- Workshop and warehouse are arranged next to the fishing gear repairing space and keep separate the fish catches flow and fish instruments flow.(Ref. Fig.4-5-6(2), Flowchart of Fish Instruments)
- A slipway for repair of boats is located at the eastern end of the site. This slipway is used for maintenance and small scale improvement of fishing boats and available for around 10 boats at the same time.
- Fresh water tank and fuel oil tank are installed behind the slipway. Water and fuel are supplied to boats using pipelines.

4.6 Construction Plan

4.6.1 Facilities Design

(1) Design of Major Structures

Floor planning and selection of the types of structure for major structures are made considering the following requirements:

1) Loading/unloading of catches and materials required for fishing during the "in port" period of fishing boats should be easy.

2) Operation of fishing boats around the wharf should be easy.

3) Structures should be easy to construct.

4) Construction cost should be relatively inexpensive.

5) Operation and maintenance of completed facilities should be easy.

6) Facilities should be expandable.

(2) Identification of Requirements of Landing Facilities for Small Fishing Boats

Dimensions of small fishing boats of 5GT-minus class assumed in the design are as follows:

Length	9.0m
Width	2.0m
Draught	0.8m

Tidal range at the site is around 3m. If the crown of the vertical landing facility is too high for manual landing at low tide, machinery like cranes needs to be used for unloading catches or the landing facility should have a ramp pontoon. This system involves risk and increases construction cost, so it is not suitable for this particular site.

As a solution to these problems, the slipway type landing wharf which is structurally simple and safe, allows the use of a landing method similar to the one fishermen use at beach for unloading catches, and is easy to maintain. Landing facilities of this type permit unloading at any time, unaffected by tidal range.(Fig.4-6-1) But, it is desirable to reconfirm again from the user's view point.

Results of comparison of different types of landing facilities are shown in Appendix 4-6-1.

(3) Gravity Type Quay with Stepped Crown for the Middle Boats

Dimensions of fishing boats of 40GT-minus class assumed in the design are as follows:

Length	15.0m
Width	4.5m
Draught	2.0m

In determining the height of the crown, the highest priority was given to the efficiency of unloading. Although the deck of a middle boat is several meters higher than sea level, catches cannot be unloaded directly at low tide if the height of the land is 3.5m. For this reason, a 2.2m high, level intermediate wharf with a stairway has been added to the planned 3.2m high wharf. Since even this configuration cannot make unloading at low tide easy enough, a 1.2m high lower wharf with a sculptured stairway is provided to every berth. This design enables the unloading of catches without being influenced by tidal differences.(Fig.4-6-2) Table 3-6-2 compares different types of wharves.

(4) Outfitting Wharf for the Middle Boat

Water area along the training jetty (70m length) is assigned for both outfitting and idling of middle boats. Within this area, one berth (berth length 18m) for outfitting is designed for the purpose of loading and unloading of necessary materials and instruments. Standard cross section of this wharf is shown in Fig.4-6-3.

(5) Preliminary Design of Functional Facilities at Fishing Port

Quantitative requirements of major functional facilities at the fishing port are as follows:
- Target catch quantity: 50% of the catches of demersal and large pelagic fish of 30.2 tons/day is to be stored at the planned facilities.
- Refrigerator: Catches are to be stored in fix boxes; preserving temperature is to be 0, and net stock is to be 30 tons.
- Freezer: Catches are to be stored using pallets, cartons or fish boxes; preserving temperature is to be -30, and net stock is to be 100 tons.
- Ice machine: Should have a capacity of 50kg of cubic ice; two 10 t/day units are to be installed.
- Ice storage room: The capacity of the ice storage room is to be equivalent to three days' output of the ice machine.

Configuration and Sizes of Planned Facilities

Building Facilities

Freezing storage	:	276 sqm
Ice factory	:	900 sqm
Ice storage room	:	195 sqm
Fish handling space	:	400 sqm

Fishing gear repairing space	:	1,000 sqm
Warehouse	:	100 sqm
Workshop	:	100 sqm
Administration building	:	180 sqm
Electric power building	:	80 sqm
Guard house	:	23 sqm
Parking lot	:	800 sqm
Auxiliary Facilities		
Water supply facilities	:	12 kl
Electric power facilities	:	1 lum
Telephone facilities	:	1 lum
Drainage facilities	:	1 lum
Plants		
Air blast freezer	:	1 set
Refrigeration equipment	:	1 set
Ice making equipment	:	2 sets
Emergency generator	:	1 set

(6) Functional Facilities at Fishing Port

The structures of major functional facilities are shown in Fig. 4-6-6 and Fig. 4-6-12.

4.6.2 Construction Plan

(1) Construction Method

1) Preconditions to Construction

Annual rainfall in the project area including the city of Manta is 400-500mm. Rainfall is high in January through April. Rainfall in the other months is so low that it does not affect construction work.
However, rainfall jumps to 500-1000% of normal level once in several years under the influence of El Nino Current. During this period both offshore construction and on-land construction are influenced.Wind velocity is usually 4m/sec or less, and wind-blown high waves do not occur.

The site of the fishing port is located at an existing fishing port buried in sediments from the Manta River, at the deepest part of Manta commercial port. This site is not affected by wind-blown waves. However, since most of the anchorage area dries up at low tide because of the sediments, work barges cannot enter the area.

Meteorological and hydrographic conditions, except local topographic conditions, are favorable, so construction work can be continued throughout the year.

A considerable portion of submarine sediment in the area is fine sand containing loose, gray silt. The lower layers contain more compacted, finer sand with an N-value of 30 or more.

Of major construction materials and ground construction equipment necessary in Manta, such materials as reclamation material, crushed stone, rock, cement and reinforcing bars can be procured locally. Ordinary construction equipment, such as bulldozers, trucks, motor graders, truck cranes and concrete plants, can also be procured locally. However, piling barges, crane barges, barges, towing boats, dredgers and hopper barges have to be brought in from neighboring countries including Japan.

2) Construction Procedure

Major construction work under the short-term development plan can be divided into preparatory work, temporary work, etc. Fig. 4-6-14 shows the procedures of these works.

3) Preparatory Work and Temporary Work

Preparatory work and temporary work include the procurement of construction equipment. These works also include the installation of temporary roads, temporary piers and temporary buildings, as well as electric power and water supply facilities. Preparatory work is the preparation of reliable materials and equipment, and roads by which materials and equipment are carried in, and should be completed before the commencement of the main work.

Temporary roads usually connect existing streets with the job site, and are used for carrying materials into temporary storage space and construction equipment into the job site.

Temporary buildings include field offices and stations for workers directly or indirectly involved in the construction, storage space for materials and equipment, and other buildings required for smooth execution of construction work.

Electric power for temporary facilities can be supplied from a place 1.5km away from the job site. Since there is a concrete plant within the distance of 10km from the job site, concrete can be supplied in the form of ready mixed concrete.

Since there is not any asphalt plant in the neighborhood, one needs to be prepared if necessary.

4) Dredging and Reclamation

Dredging work is the dredging of the anchorage area. Since this work is done under water, small cutter suction pump dredgers are used.

About 56,000m3 of dredged earth is not enough, so additional earth will be brought in from neighboring areas.

Reclaimed land will be enclosed with temporary embankment using riprap placed for revetment as well as earth nearby. The crown height of the embankment will be DL+3.5m.

As shown in the schedule in Table 4-6-4, reclamation should be performed before the construction of the wharves for middle fishing boats and the jetty slipways for small fishing boats.

5) Construction of Landing Wharf and Jetty Slipway

Landing wharves for middle boats are of gravity type and has a cellular block structure.

Since the planned site is at a water depth of DL-1.0m or so, construction will be mainly performed offshore. A standard construction procedure is outlined below.

Construction Procedure for Landing Wharf
(1) Foundation excavation (under water)
(2) Riprap placement and leveling (under water)
(3) Placement of lower concrete cellular blocks (under water)
(4) Filling the above blocks and placing cover concrete (under water)
(5) Placement of upper concrete cellular blocks (under water)
(6) Filling the above blocks and placing cover concrete (under water)
(7) Cobble stone backfilling and leveling (under water)
(8) Placement of upper concrete (on land)
(9) Cobble stone foundation for apron (on land)
(10) Apron and concrete pavement (on land)
(11) Placement of mooring posts (on land)
(12) Installation of fenders (under water)
(13) Placement of foot protection riprap for scour protection (under water)

The jetty slipway for the small fishing boats is planned to be placed near the landing wharf for the middle fishing boats. The ground height at this place is now about DL-1.0m, but because the structure consists of riprap, concrete block side walls, etc., both offshore and on-land work are necessary. A standard construction procedure is outlined below.

Construction Procedure for Jetty Slipway
(1) Foundation excavation for embankment (under water)
(2) Riprap placement and leveling (under water)
(3) Placement of concrete blocks (under water)
(4) Placement of backfilling cobble stone and food protection cover (under water)
(5) Placement of side wall concrete blocks (under water)
(6) Placement of backfilling cobble stone and leveling
(7) Riprap for slipway, leveling of riprap mound (under water) (on land)
(8) Leveling of riprap mound for slipway concrete blocks (under water) (on land)
(9) Placing the above concrete blocks (under water)
(10) Laying sand-proofing sheet
(11) Concrete pavement (on land)
(12) Slipway wood protection (under water) (on land)
(13) Installation of holding rings (offshore)

(14) Installation of buffer stops (under water) (on land)
(15) Installation of fenders

6) Revetment

The revetment mainly consists of riprap. Riprap brought from quarries is dumped into the sea water, and the revetment is built by the formwork method using bulldozers.

The stone lining on the sea-side slope will be executed using divers. The land-side slope will be covered with sand-proofing sheet so as to prevent the runoff of reclamation material. Banks thus protected should be completed before the commencement of reclamation.

Tha crown concrete for riprap embankment is to be placed on the job site.

7) Training Jetty

The training jetty is planned for preventing sand brought down by the Manta river from settling in and filling up the anchorage areas. The training jetty will be constructed of cheap quarry run rock, which will be brought in and dumped continually from the shore until the required height is reached. The training jetty has a width same as a large dump truck. The quarry run rock will be pushed into the harbour with a bulldozer.(end-on system)

8) Buildings

The building to house the refrigerator, ice making plant and water reservoir will be a steel-framed one story building. The walls will be made of concrete blocks and will be finished off with a coating of mortar and paint. The roof will be covered with long pitch slate. The floor will be made of troweled concrete. Apart from the construction of the framework and the roof (a crane will be used for this), the building will be mainly constructed with skilled human labour due to the usage of fiber boards in the walls of the icemaking room and the water reservoir room.

A crane will be used to construct the framework and roofing of the relatively simple structures such as the loading building, the boat repair shop, the warehouse and operations building. Flooring will be constructed with human labour as is with the concreting work.

The operations office building and the gate keeper's office will be steel-framed one storey concrete buildings. All manual work such as the painting of the reinforced concrete pillars, the mortar work on the concrete block walls and the troweling work on the concrete and the waterproofing of the asphalt will be carried out by skilled laborers.