ATTACHMENT

Tables and Figures

Table II. 2. 1 Major Cyclones

year	month	min. atmospheric pressure
1935	Feb.	—
1943	Dec.	984
1967	Dec.	975
1987	Jan.	967

Table II. 3. 1 Cook Island's Main Exports and Imports

(in $ 000)

EXPORTS	(1981)	IMPORTS	(1980)
Banana	684	Foodstuffs	5270
Copra	348	Textiles	1580
Fresh citrus	40	Oil, petrol, etc.	2428
Pearl shell	323	Tabacco, cigarettes	259
Pineapple juice	8	Vehicle, parts	1293
Citrus juice	770	Timber, cement, etc.	481
Other juice	-		
Fruit, canned	42		
Clothing	2038		
Handcrafts	-		
Footwear	47		
Pawpaw	378		
Fresh pineapple	42		

Source : Pacific Island Year Book (15th Edition, 1984).

Table II. 6. 1 Rainfall Record at Totokoitu

Date	Rainfall (mm)
28 December 1986	0.3
29 December 1986	2.9
30 December 1986	10.0
31 December 1986	10.1
1 January 1987	225.0
2 January 1987	6.5
3 January 1987	0.3
4 January 1987	-

Source : Meteorological Office at Rarotonga International Airport.

Table II. 6. 1 Topography of Rarotonga Is. —— Seacoast and Width of Coral Reef

(Unit in Meter)

No.	Name of Survey Point	Width of Coral Reef	Natural Ground Height	Road Surface Height	Wave Run-up Height
1	Estuary of Tupapa Stream (TUPAPA)	20	5.6	4.8	5.6
2	Tamure Resort (KIIKII)	60	5.6	4.7	5.6
3	Health Department (VAIKAI)	90	4.5	6.1	4.5
4	Yankee (NGATIPA)	160	3.9	3.9	3.9
5	Petroleum Tanks (ATUPA)	50	5.2	5.4	5.2
6	Meteorological Station (NIKAO)	360	5.4	6.5	5.0
7	Black Rock (POKOINU)	630	5.7	6.3	5.0
8	Ministry of Works (TOKERAU)	850	4.0	-	4.0
9	Beach Hotel (TUPAPA)	250	3.3	-	3.3
10	Estuary of Muriavai Stream (VALAKURA)	430	3.6	4.6	2.1
11	West of Rarotongan Hotel (AROA)	360	3.4	3.4	3.4
12	Rutaki School (RUTAKI)	920	3.3	3.2	3.0
13	Estuary of Totokoitu Stream (TOTOKOITU)	730	2.7	-	2.7
14	R. C. (TIKIOKI)	620	4.1	4.1	3.0
15	Sailing Club Muri Beach (AREITI)	1,520	2.7	2.7	2.5
16	Ngatangiia Harbour (AVANA)	400	1.8	1.7	1.5
17	Norrie Park (MATAVERA)	60	3.9	-	3.9

Table II. 7. 1. List of Damages in Harbour

1. Avatiu Harbour

	Th : NZ$
Eastern Beakwater (NZ)	220
Western Breakwater (Australia)	150*
Apron (NZ)	150
Reclamation (NZ)	25
Dredging	
Wharf-side (NZ)	100
Basin (NZ)	130
West-side (Australia)	280(237*)
Repare of Pontoon and Barge (NZ)	50
Miscellaneous (NZ)	120
.....	.....
	1,225(1,182*)

2. Avarua Harbour

Concrete paving	200
Sheet Piling	60
Dredging	100
Miscellaneous	40
.....	.....
	400

Notes : Values for Avatiu Harbour are given by New Zealand and Australian Mission. Numbers marked by * are those told by Australian Mission. Those for Avarua Harbour are from the Cook Islands Government.

Table III. 1. 1 Comparision of Sea Wall Plans.

Plan and Cost	Advantage	Disadvantage
1. Simple sea wall (Fig. III. 1. 2) NZ$ 730,000	Cost : Low. Safety from storm surge, waves and coral debris : Secured. Scenery : Trees can be maintained.	Future expansion of road : Sea wall could become an obstacle.
2. Sea wall-cum-new road (Fig. III. 1. 3) NZ$ 990,000	Safety from storm, waves and coral debris : Secured. Scenery : Some of the trees to be cut. Traffic conjection : Can be dissolved.	Cost : Relatively low.
3. Sea wall-cum-detached Breakwater (Fig. III. 1. 4) NZ$ 1,280,000	Safety from storm. Future development : Reclamntion is easy. Sedimentation : Expected.	Cost : Relatively high. Scenery : Affected.
4. Sea wall-cum-reclamation. (Fig. III. 1. 5) NZ$ 2,430,000	Safety from storm. Utilization of reclaimed land.	Cost : Expensive. Scenery : Affected.

Table III. 1. 2 Comparision of Breakwater Plans.

Plan and Cost	Advantages	Disadvantages
1. Extended Breakwaters (Fig. II. 1. 6) NZ$ 5,850,000 without dredging	Waves in harbour : Small (H<1 m). Structure : Strong and safe. Wave setup in harbour : Small. Harbour area : Large. Future development : Allowed. Effect of breakwaters for reclamation on the reef could be expected.	Cost : Very expensive. Wave setup on lagoon : Enhanced. Construction :Difficult, long period. Work vessels and divers : Required. Cement and iron bars : To be imported. Dredging : Large volume required. Effect of return current on incident waves : Can not be expected.
2. Original Plan (Fig. II. 1. 7) NZ$ 620,000 without dredging and training wall.	Waves in harbour : High (H<2.5 m). Construction materials : Available. Wave setup in harbour : Small. Harbour area : Large. Future development : Allowed. Effect of breakwaters for reclamation on the reef : Coud be expected.	Cost : Expensive. Wave setup on lagoon : Enhanced. Benefit of breakwaters : Small. Construction : Difficult at the head, large rock (11 tons with 1:3 slope) required. Dredging : Large volume required. Effect of return current on incident waves : Cannot be expected.

3. Smaller Breakwaters (Fig. III. 1. 8) NZ$ 500,000 without dredging and reclamation	Waves in harbour : Small at whart (H<1 m). Wave setup on the reef : Small. Construction : Easy, short period. Materials (5-7 ton rock with 1 : 2 slope) : Available. Effect of return current on incident waves : Maintained and can be expected. Dredging : Relatively small volume.	Cost : Moderate. Harbour area : Small. Service for small boats only. Waves in harbour : High at basin (H>2.6 m). Effect of breakwater on the reef for reclamation : Not assured.
4. Existing Break-waters. (Fig. III. 1. 9) NZ$ 100,000 without dredging, with armour stone with armour	Cost : Cheap Construction : Easy, short period. Materials (3-5 ton rock with 1 : 2 slope): Available. Effect of return current on incident waves : Maintained and can be expected. Wave setup on the reef : Small.	Effect of breakwaters for the harbour : Very small. for reclamation on the reef : Not assured.

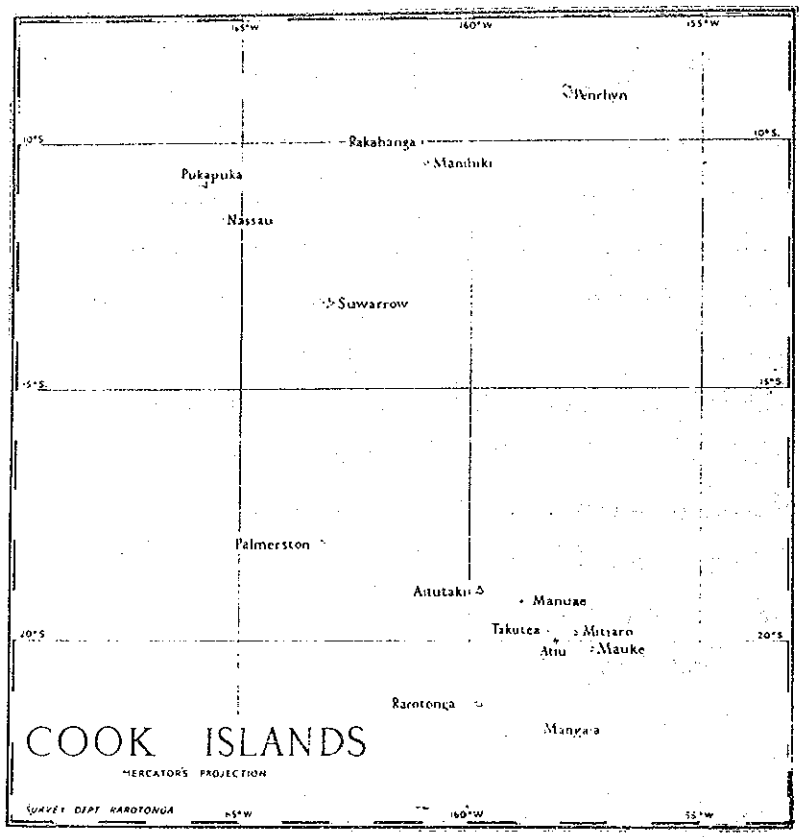


Fig. Ⅱ. 1. 1
Cook Islands

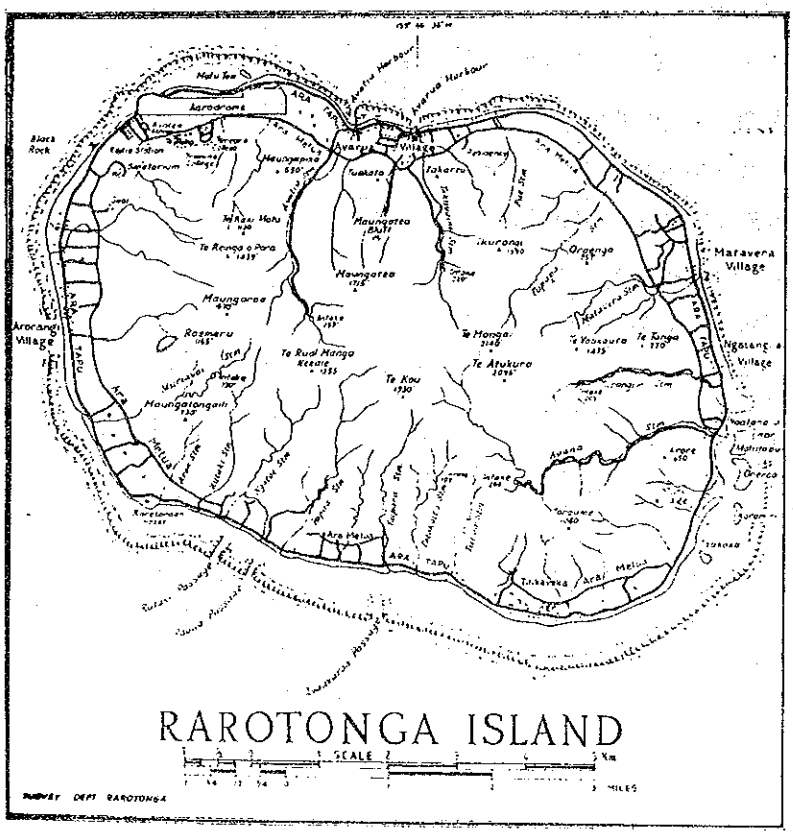


Fig. Ⅱ. 1. 2
Rarotonga

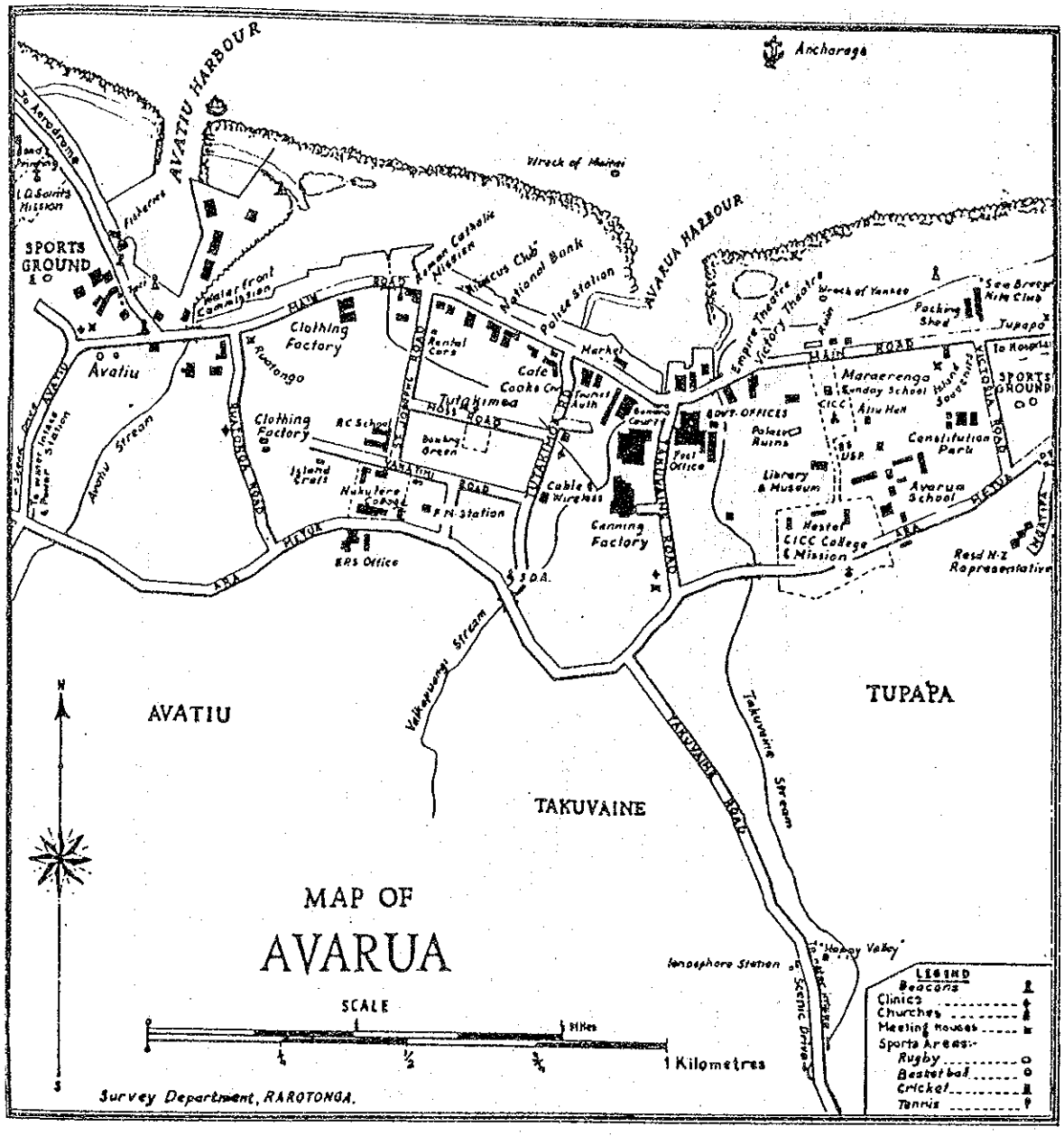


Fig. Ⅱ. 1. 3 Avarua Town, Rarotonga

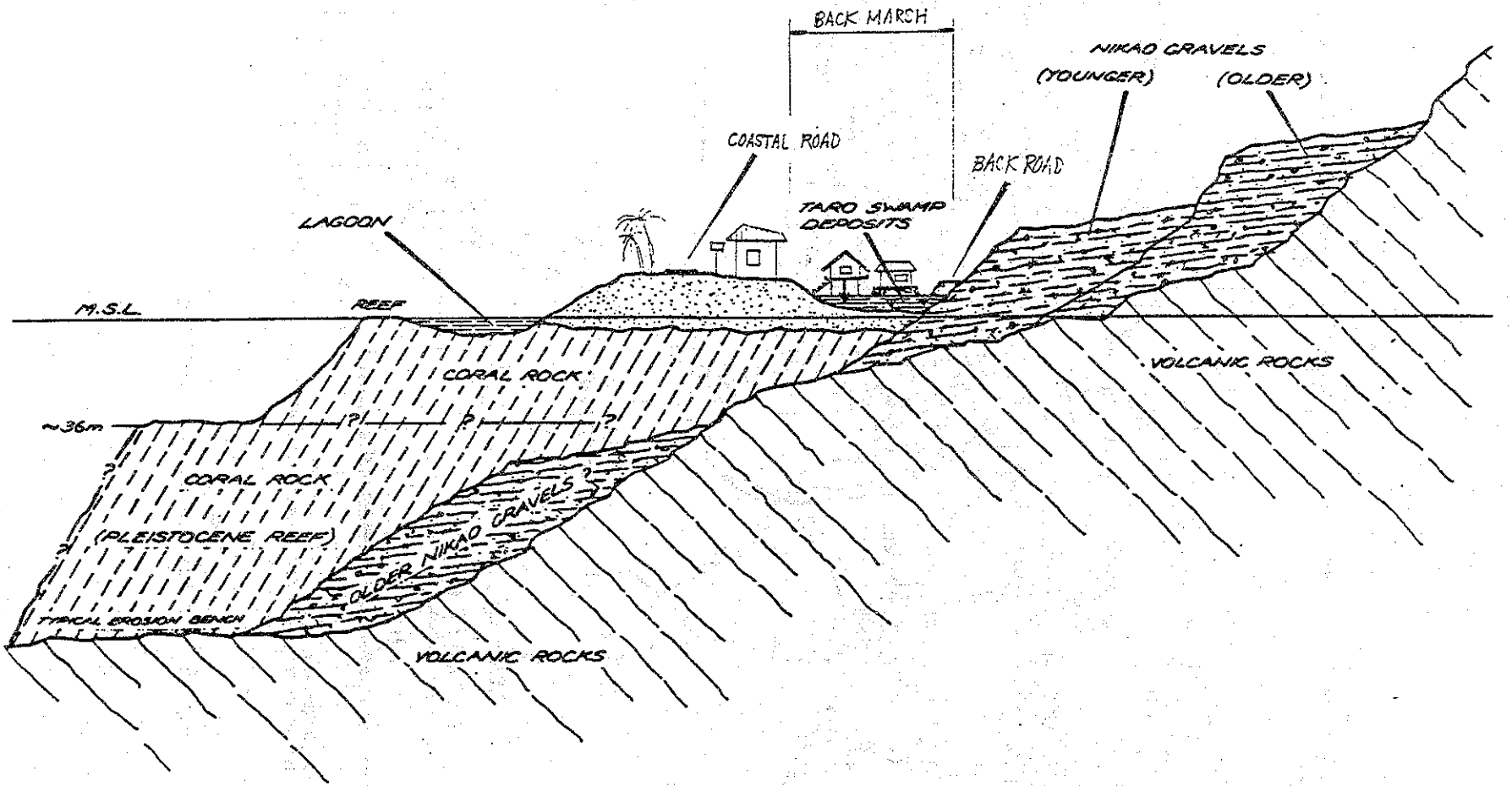


Fig. Ⅱ. 2. 1 Typical Coastal Section Sohwing Geological Relationships

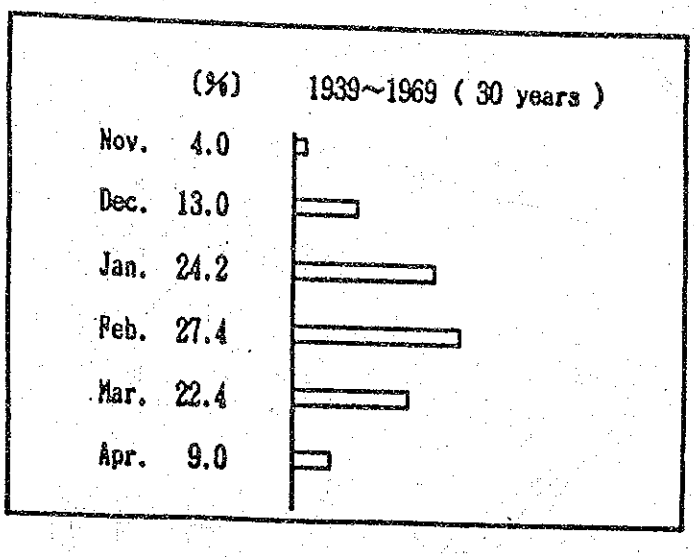


Fig. Ⅱ. 2. 2 Monthly Distribution of Cyclones in the Past

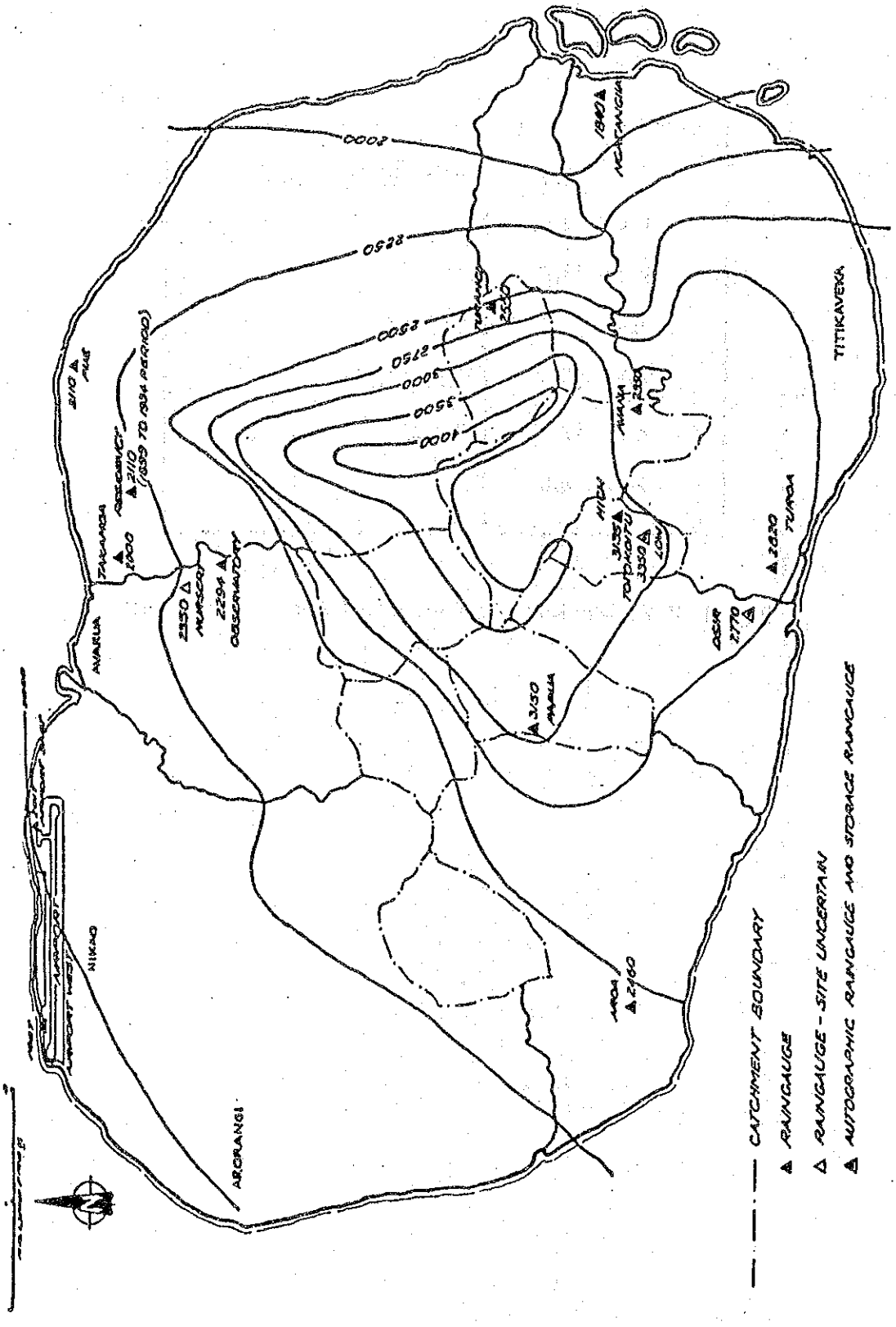
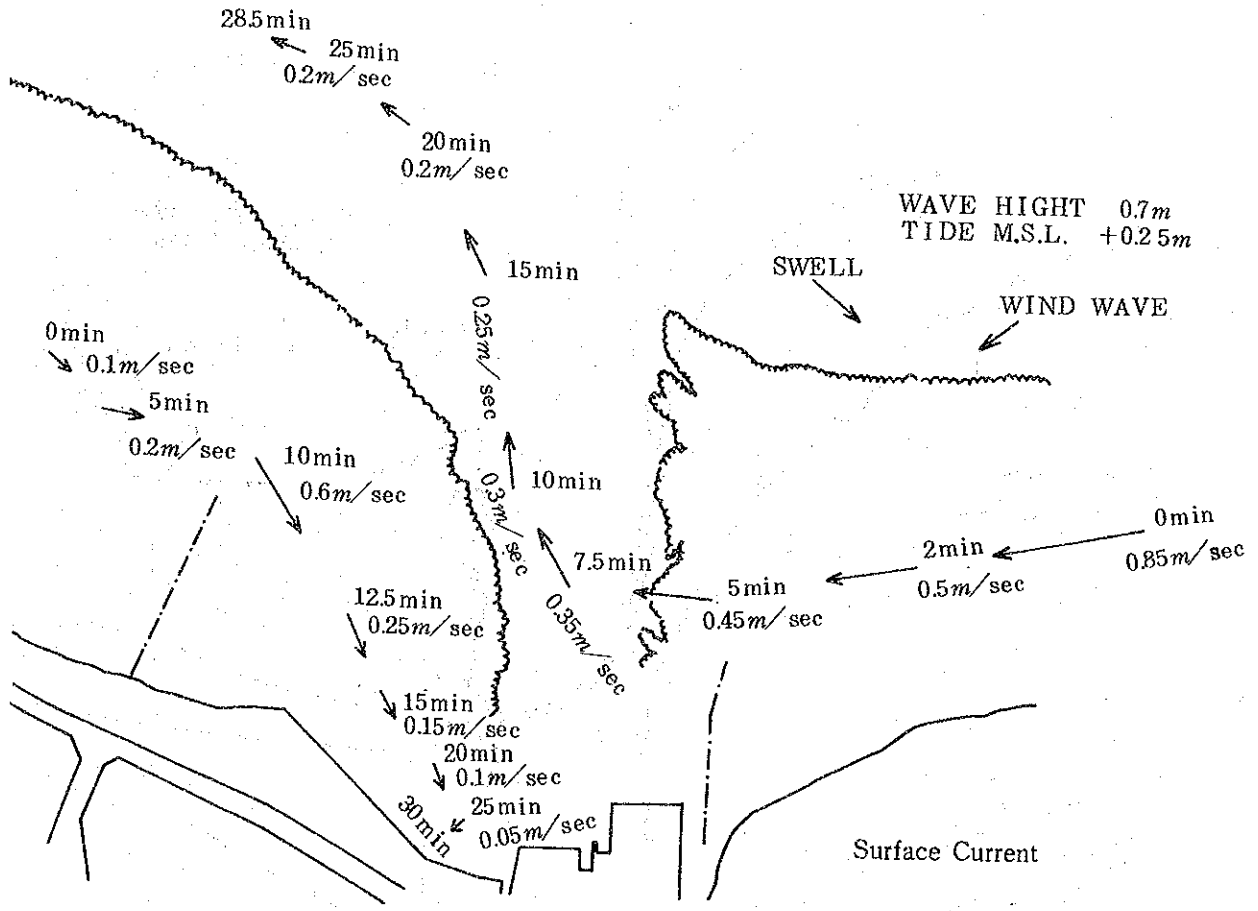


Fig. Ⅱ. 2. 3 Map of Average Annual Rainfall in mm (1947 to 1983)



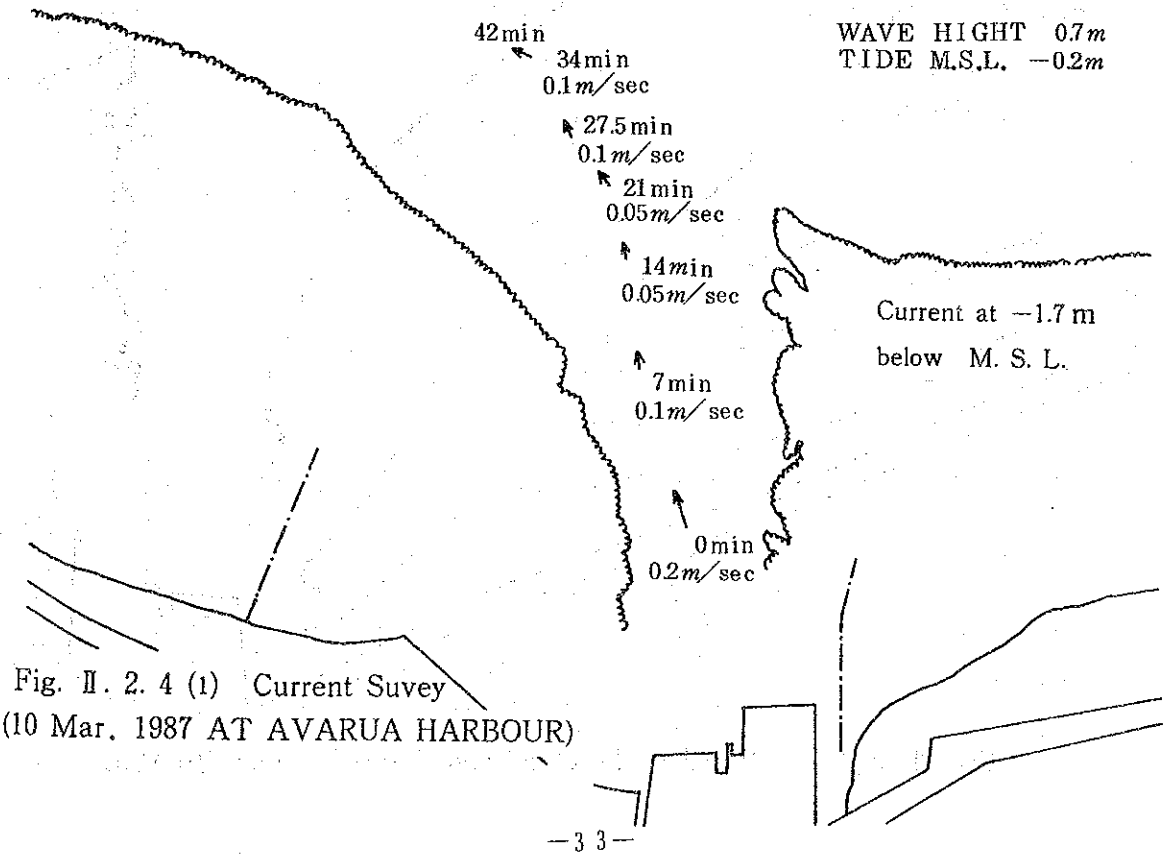


Fig. Ⅱ. 2. 4 (1) Current Suvey
(10 Mar. 1987 AT AVARUA HARBOUR)

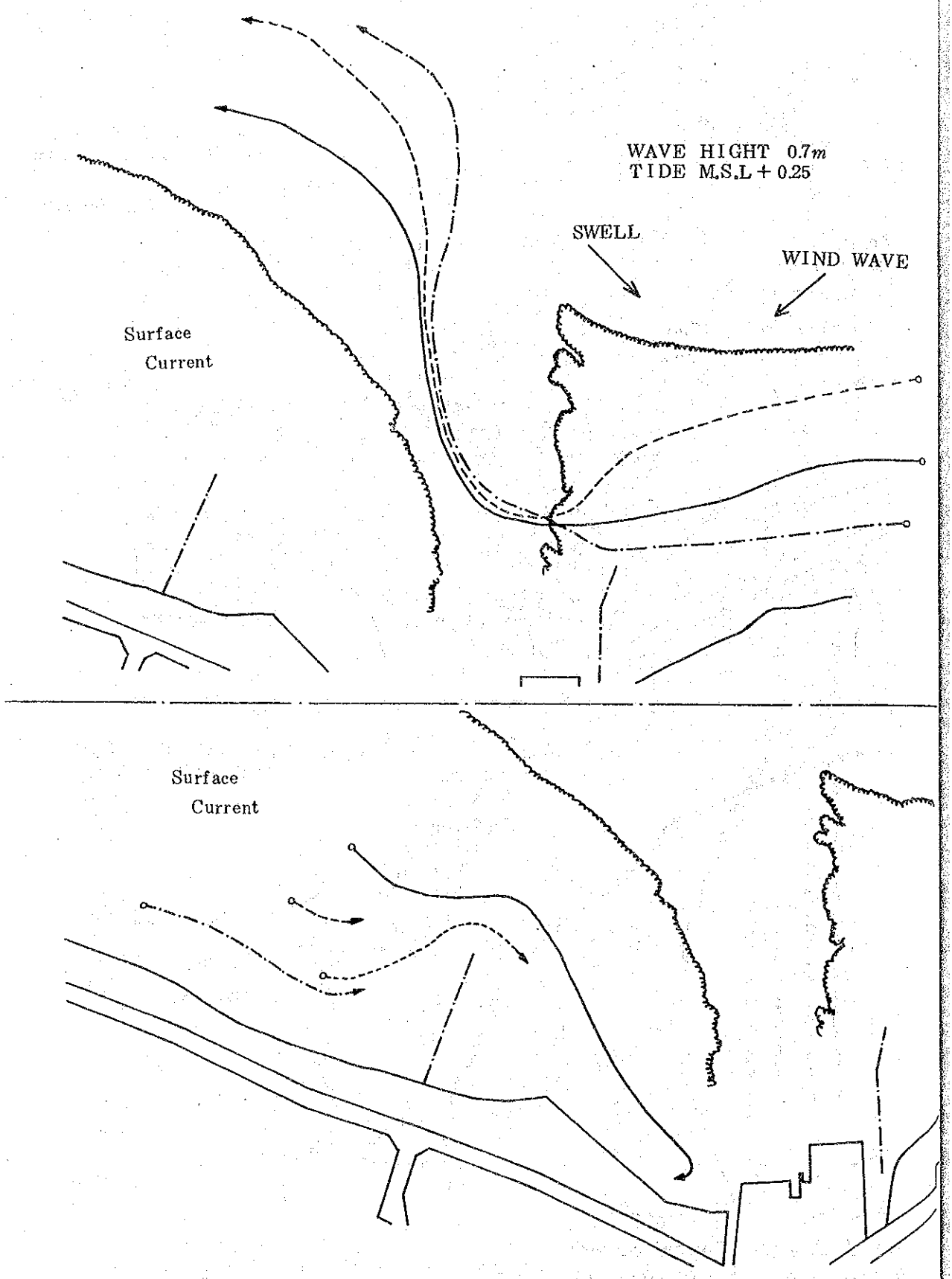
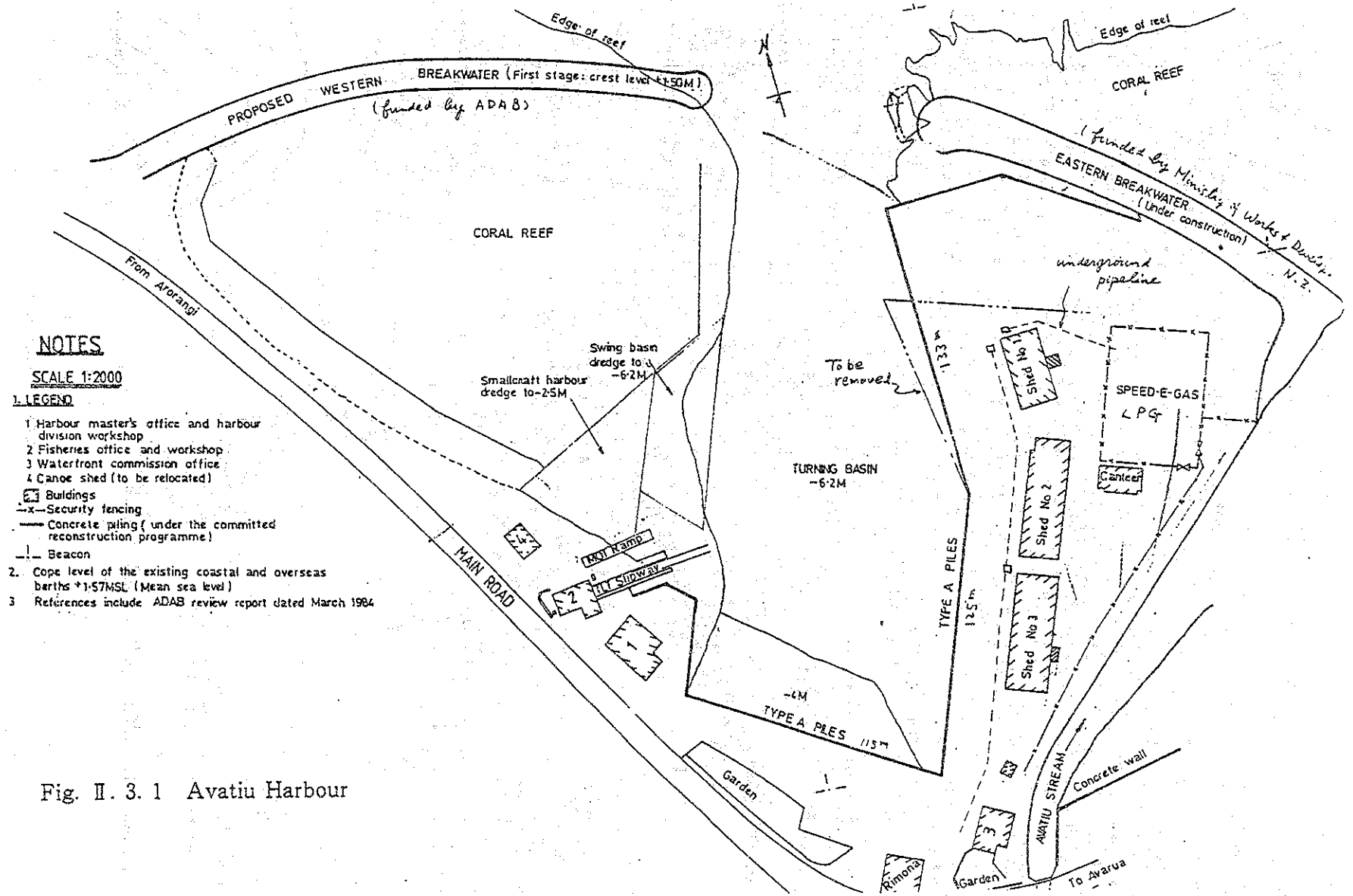


Fig. Ⅱ. 2. 4 (2) Rassline of Lateral and Return Current (10 Mar. 1987)



NOTES

SCALE 1:2000

1. LEGEND

1 Harbour master's office and harbour division workshop
2 Fisheries office and workshop
3 Waterfront commission office
4 Canoe shed (to be relocated)

Buildings
—x— Security fencing
—— Concrete piling (under the committed reconstruction programme)
—!— Beacon

2. Cope level of the existing coastal and overseas berths +1·57MSL (Mean sea level)
3 References include ADAB review report dated March 1984

Fig. Ⅱ. 3. 1 Avatiu Harbour

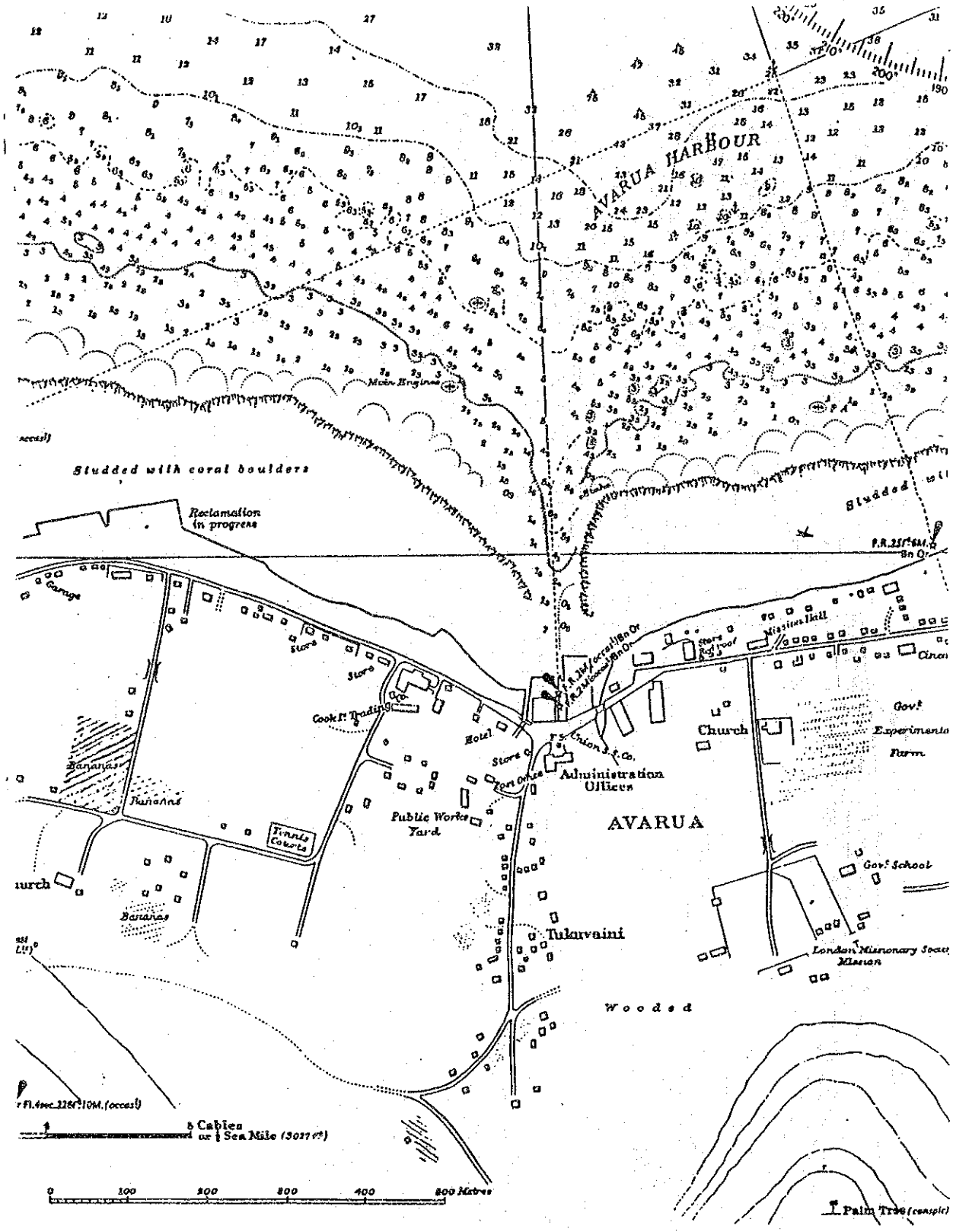


Fig. Ⅱ. 3. 2 Avarua Harbour

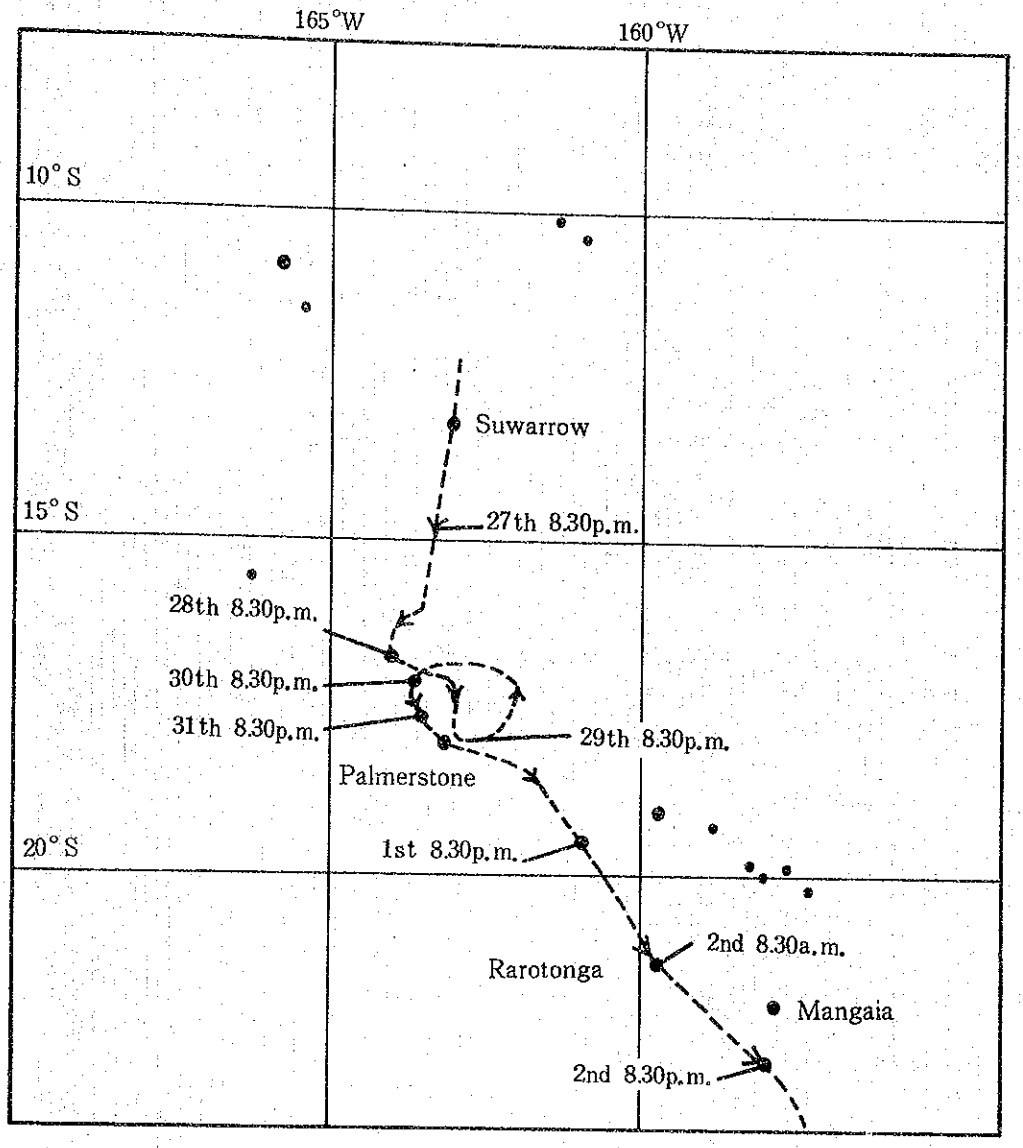


Fig. Ⅱ. 6. 1 Rout of Cyclone Sally (Dec. 1986－Jan. 1987)

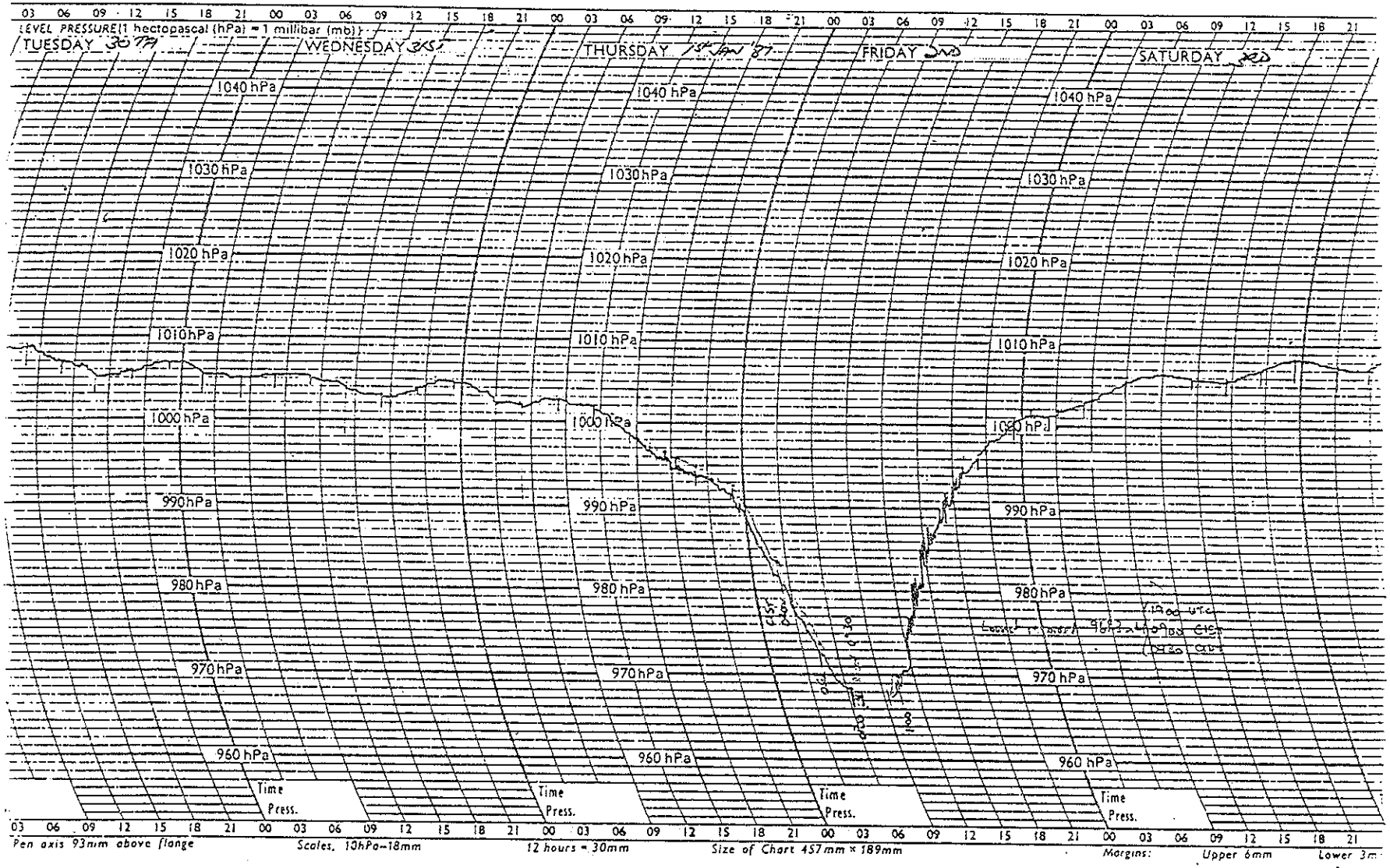


Fig. Ⅱ. 6. 2 Air Pressure of Cyclone Sally at Rarotonga

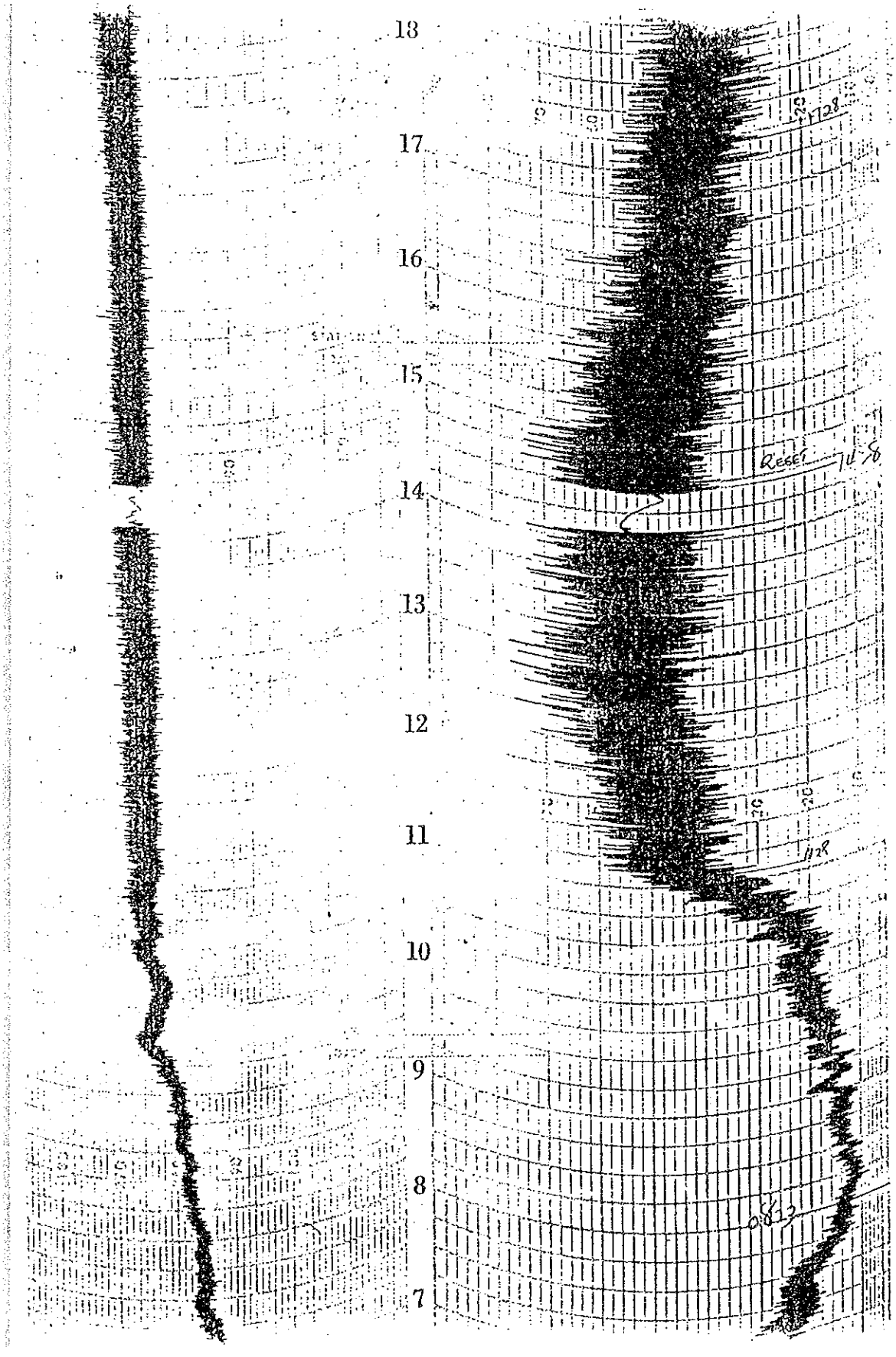


Fig. II. 6. 4 Wind and Wind Direction of Cyclone Sally at Rarotonga

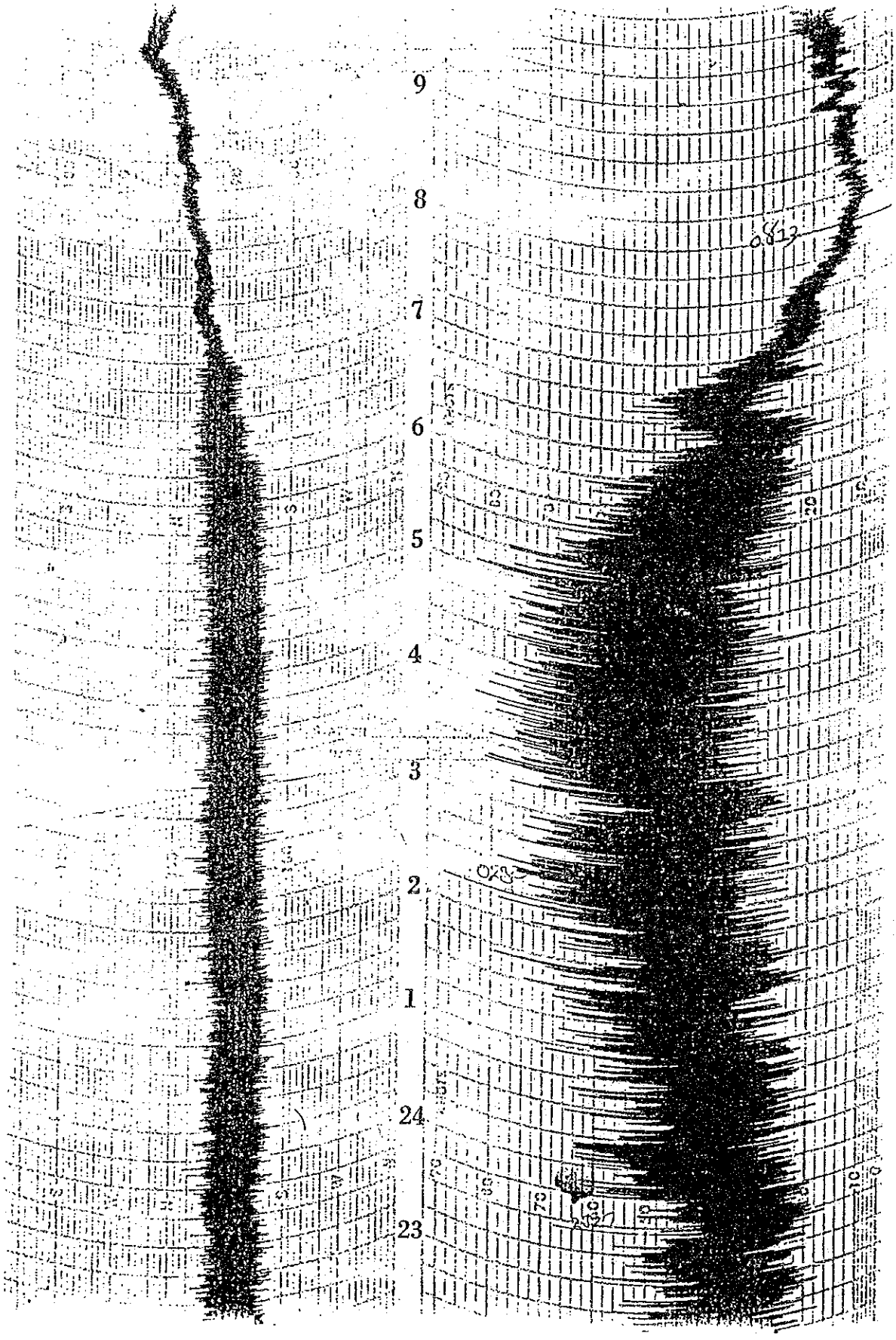


Fig. II. 6. 3 Wind and Wind Direction of Cyclone Sally at Rarotonga

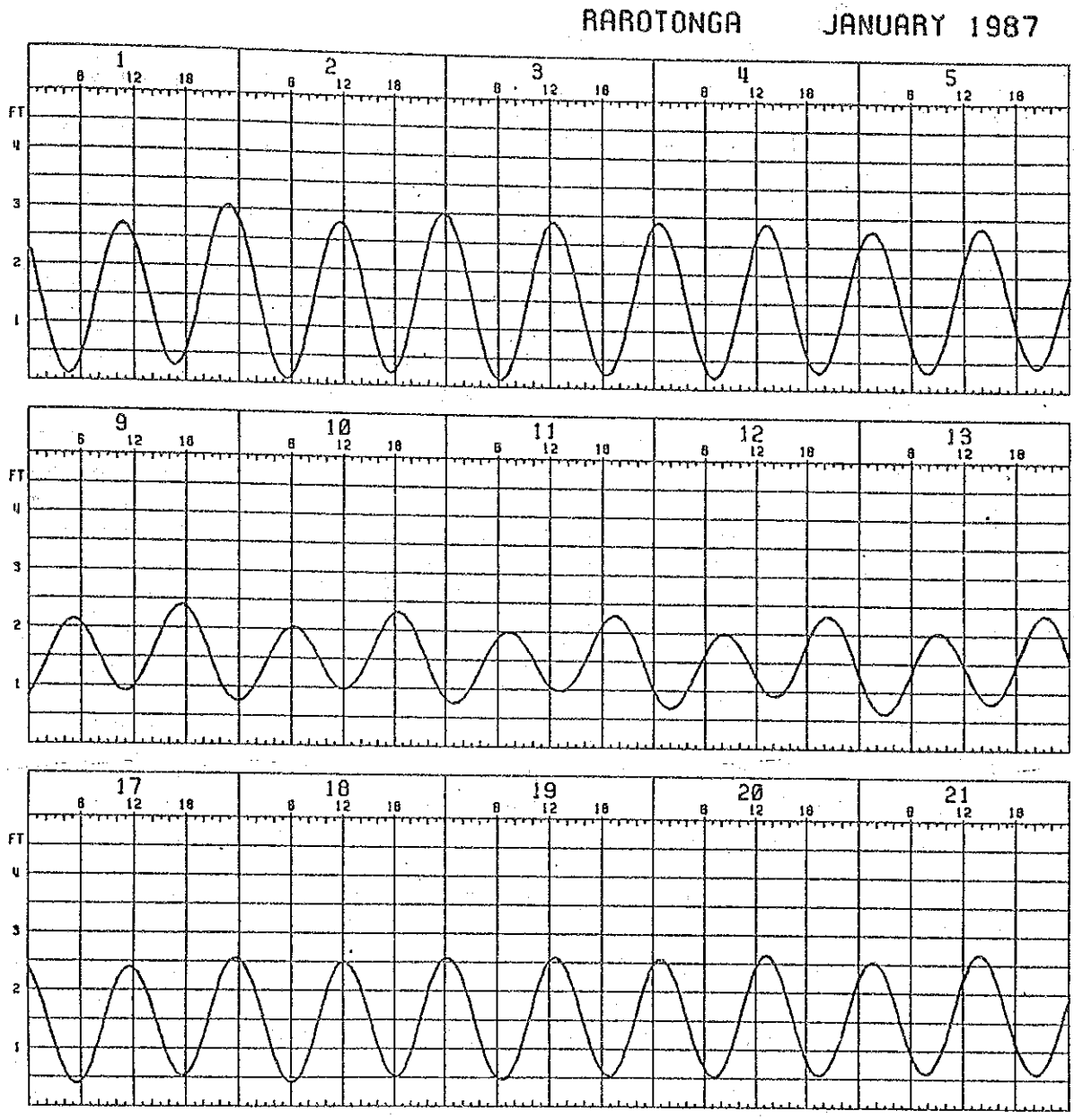


Fig. Ⅱ. 6. 5 Predicted Tide at Avarua Port

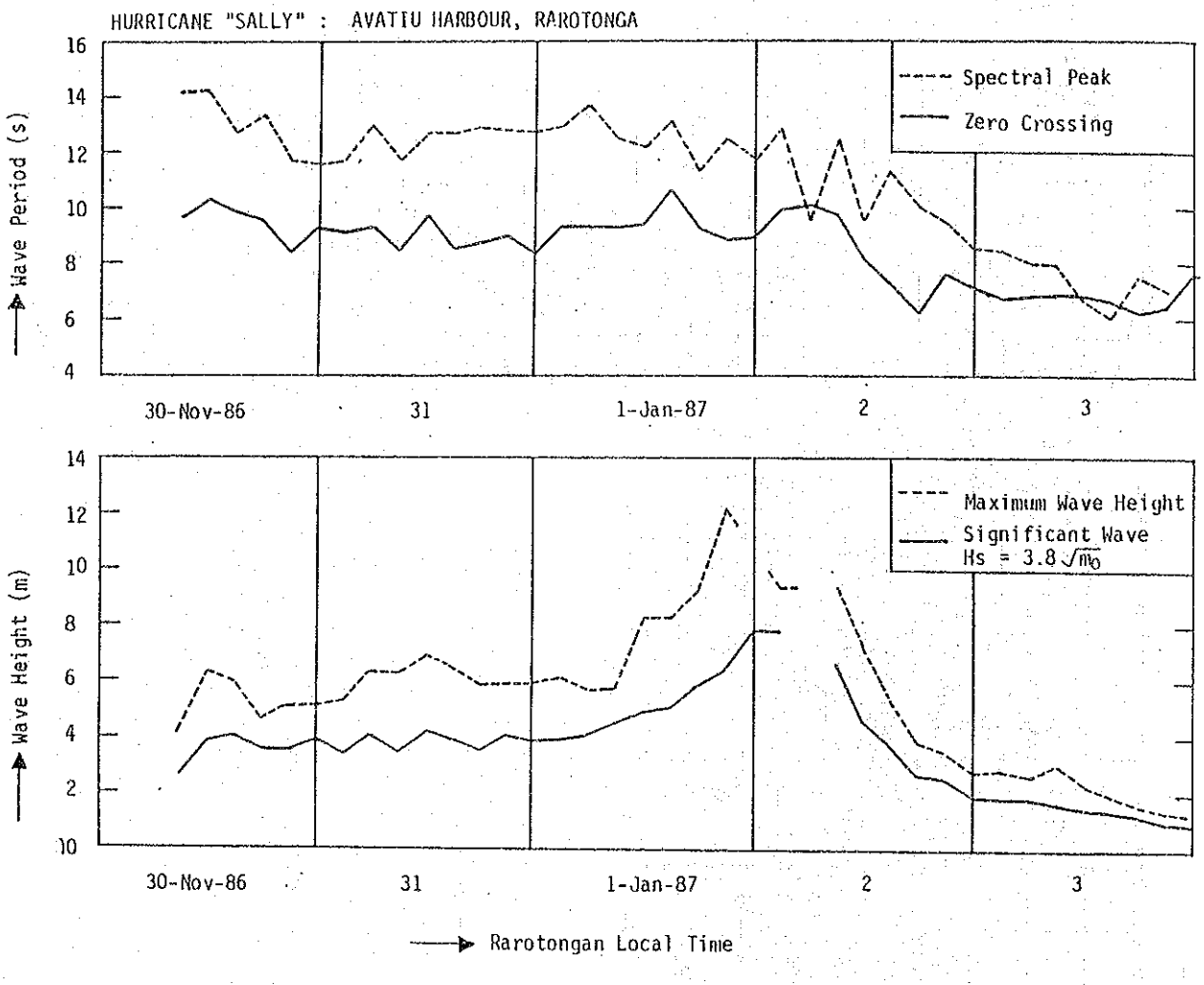


Fig. Ⅱ. 6. 6 Waves Observed off Avatiu

(Source) Central Laboratory, Ministry of Works and Development, N. Z.

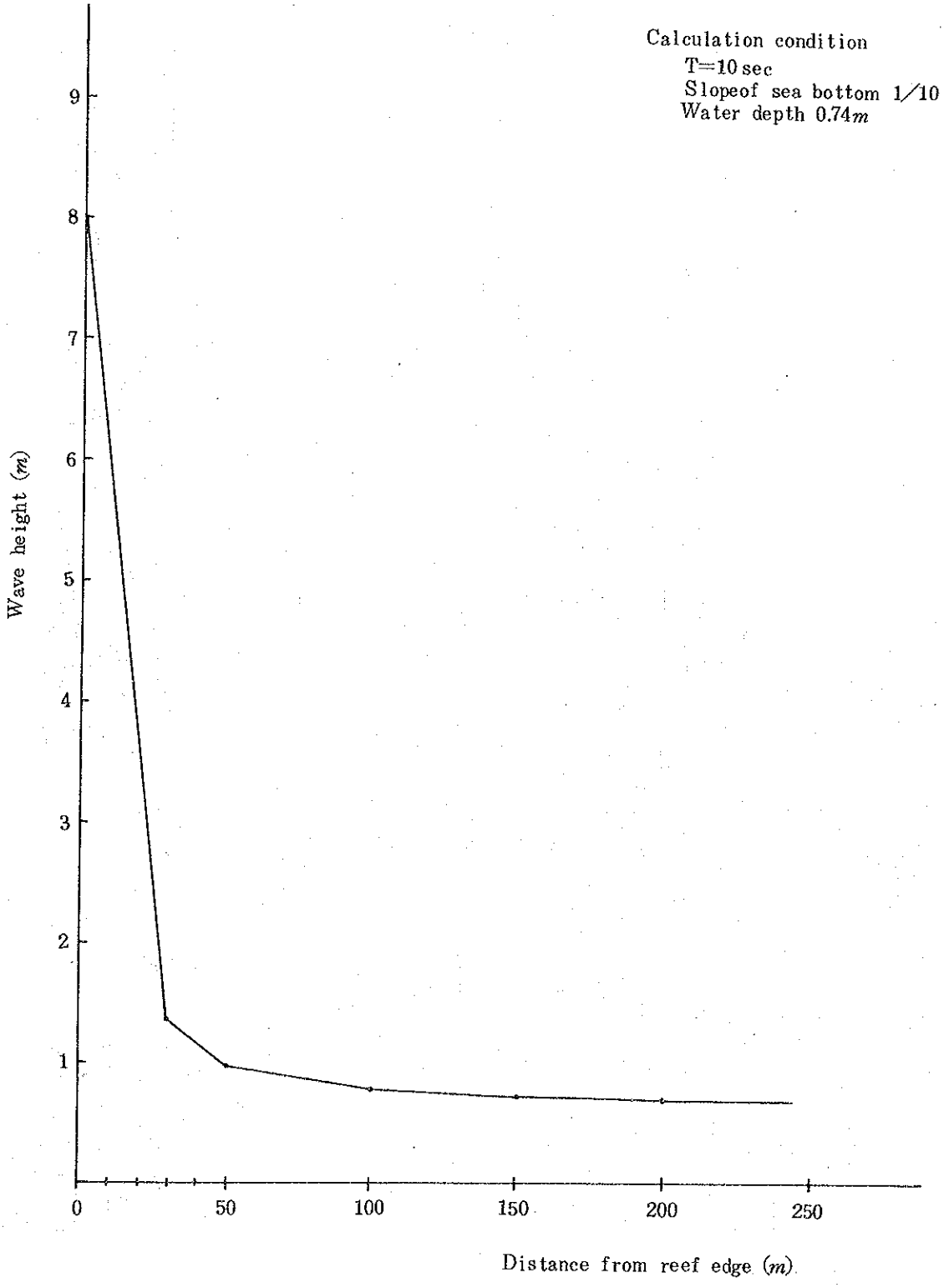


Fig. Ⅱ. 6. 7 Decrease of Wave Height on the Ragoon

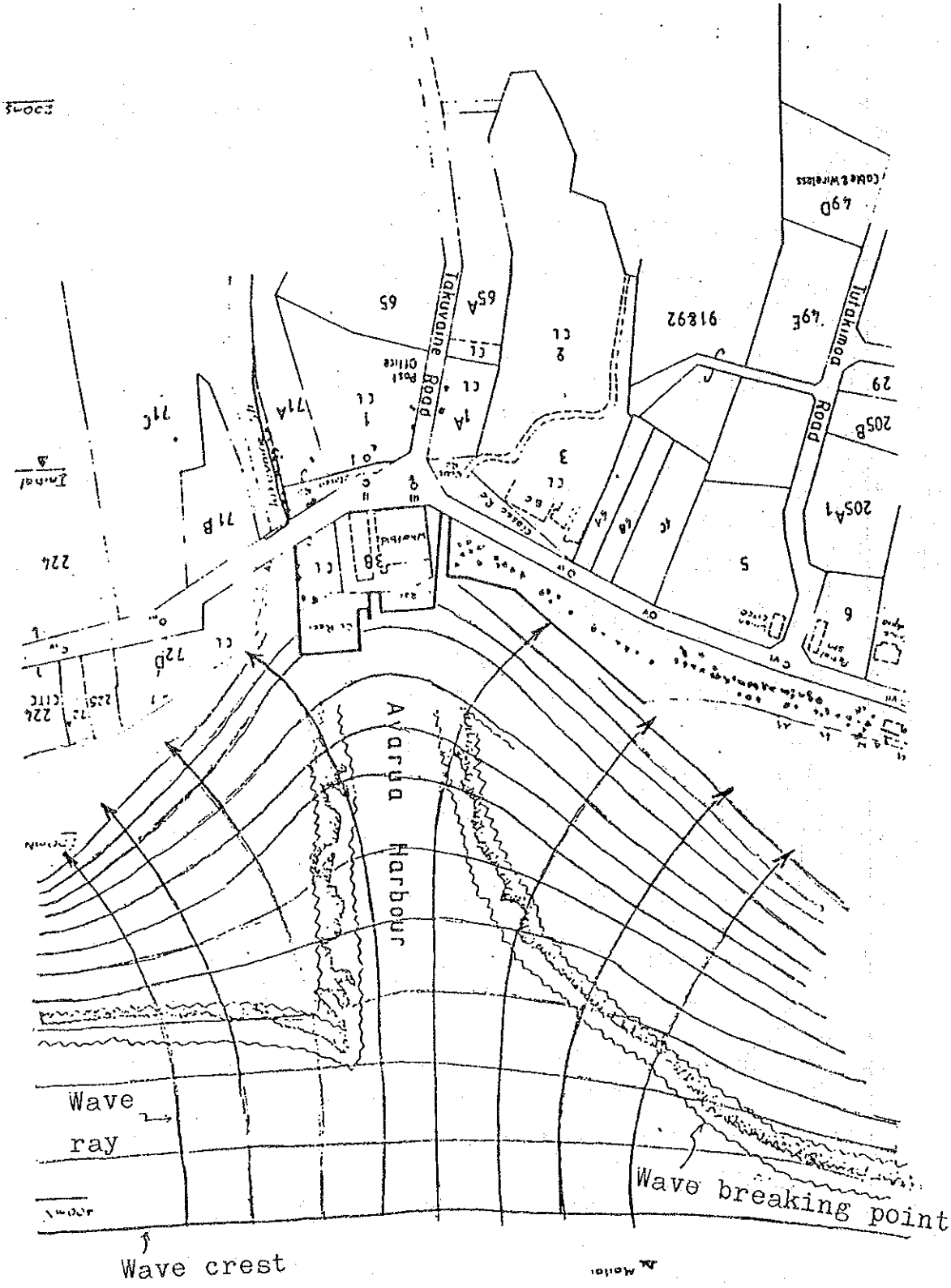


Fig. Ⅱ. 6. 8 Refraction and Breaking of Waves

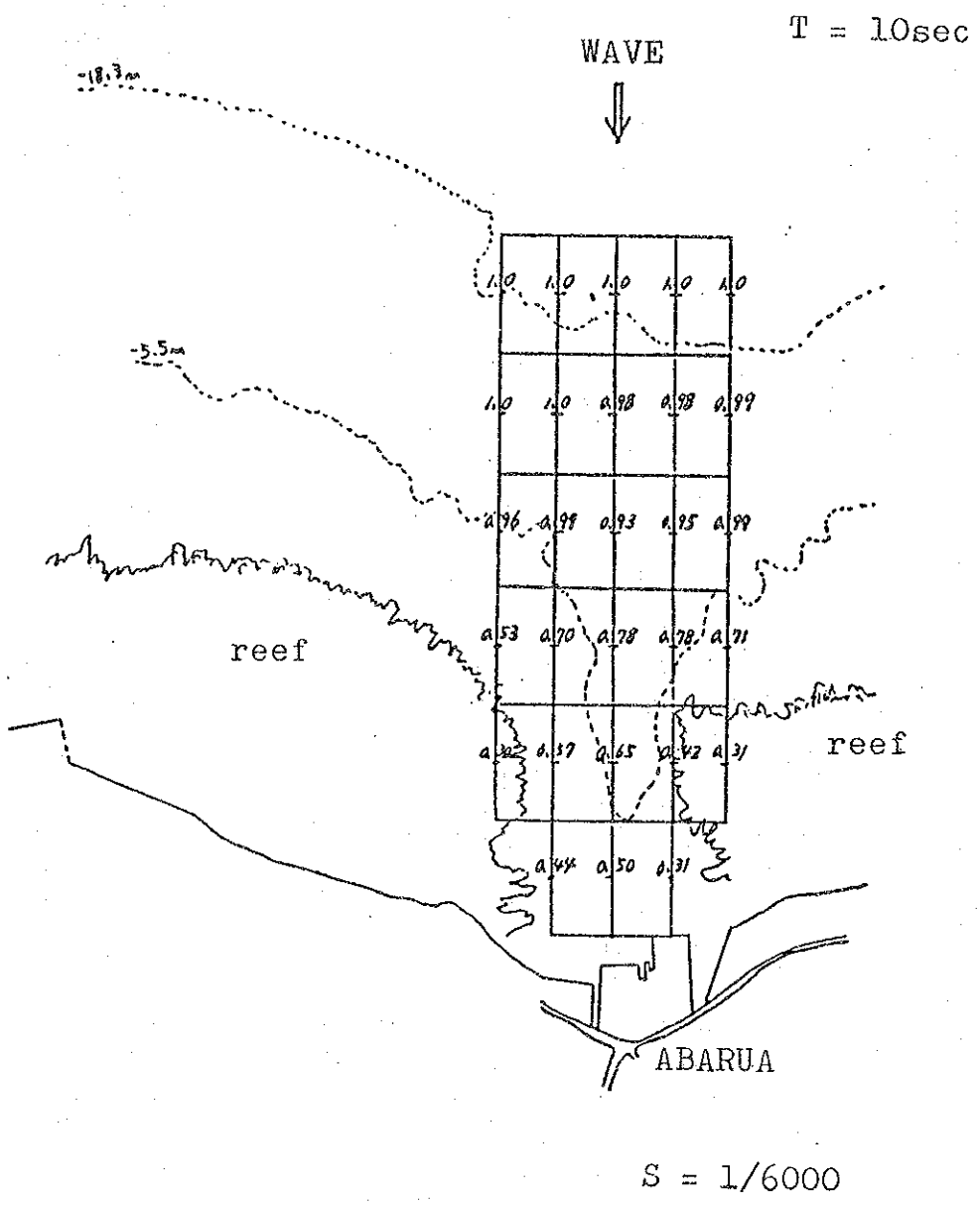


Fig. Ⅱ. 6. 9 Change of Wave Height
(Theoretical Calculation of Irregular Waves)

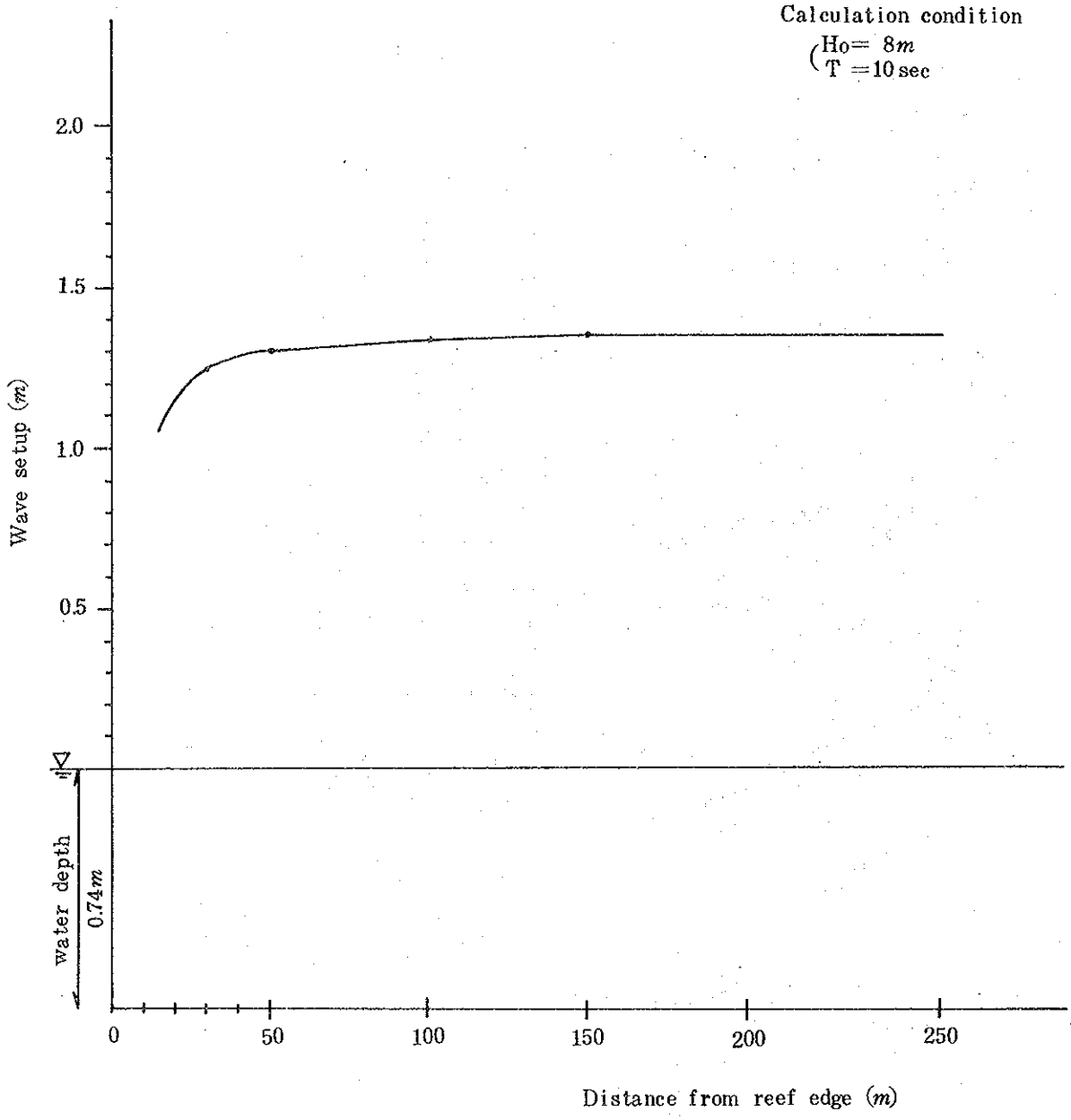


Fig. Ⅱ. 6. 10 Wave Setup on Avarua Lagoon

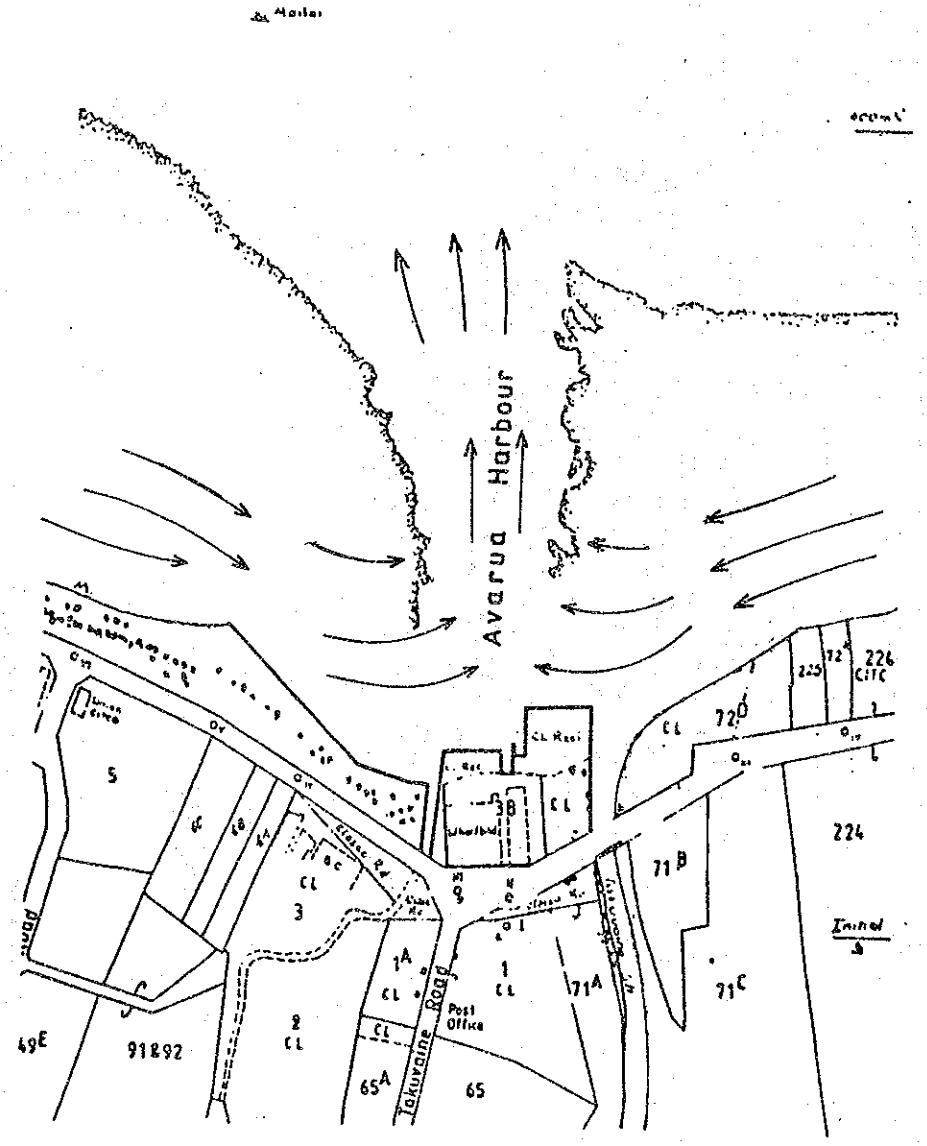


Fig. Ⅱ. 6. 11 Lateral and Return Current

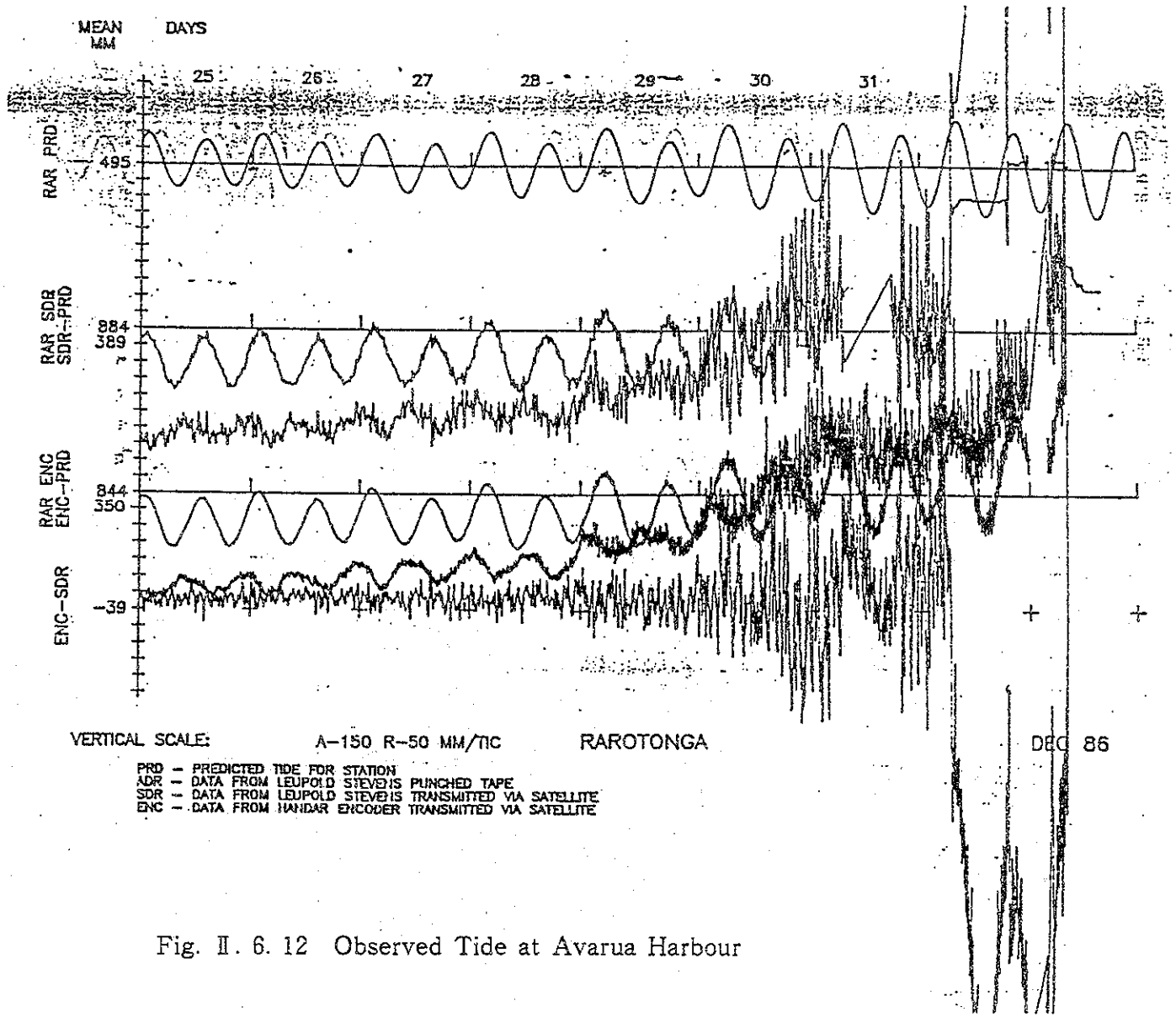


Fig. Ⅱ. 6. 12 Observed Tide at Avarua Harbour

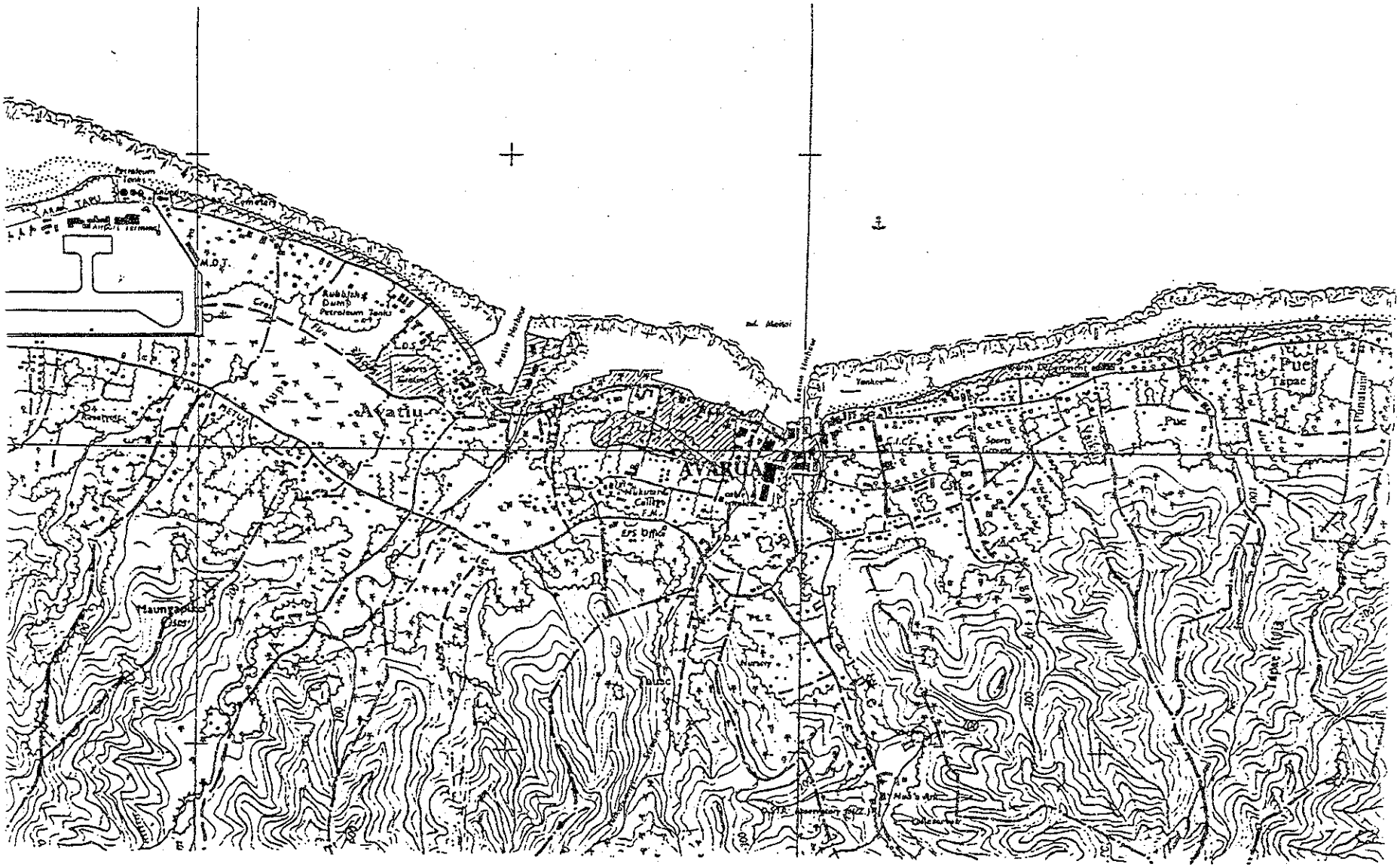


Fig. Ⅱ. 6. 13 (1) Inundated Area by Sea Water, Cyclone Sally

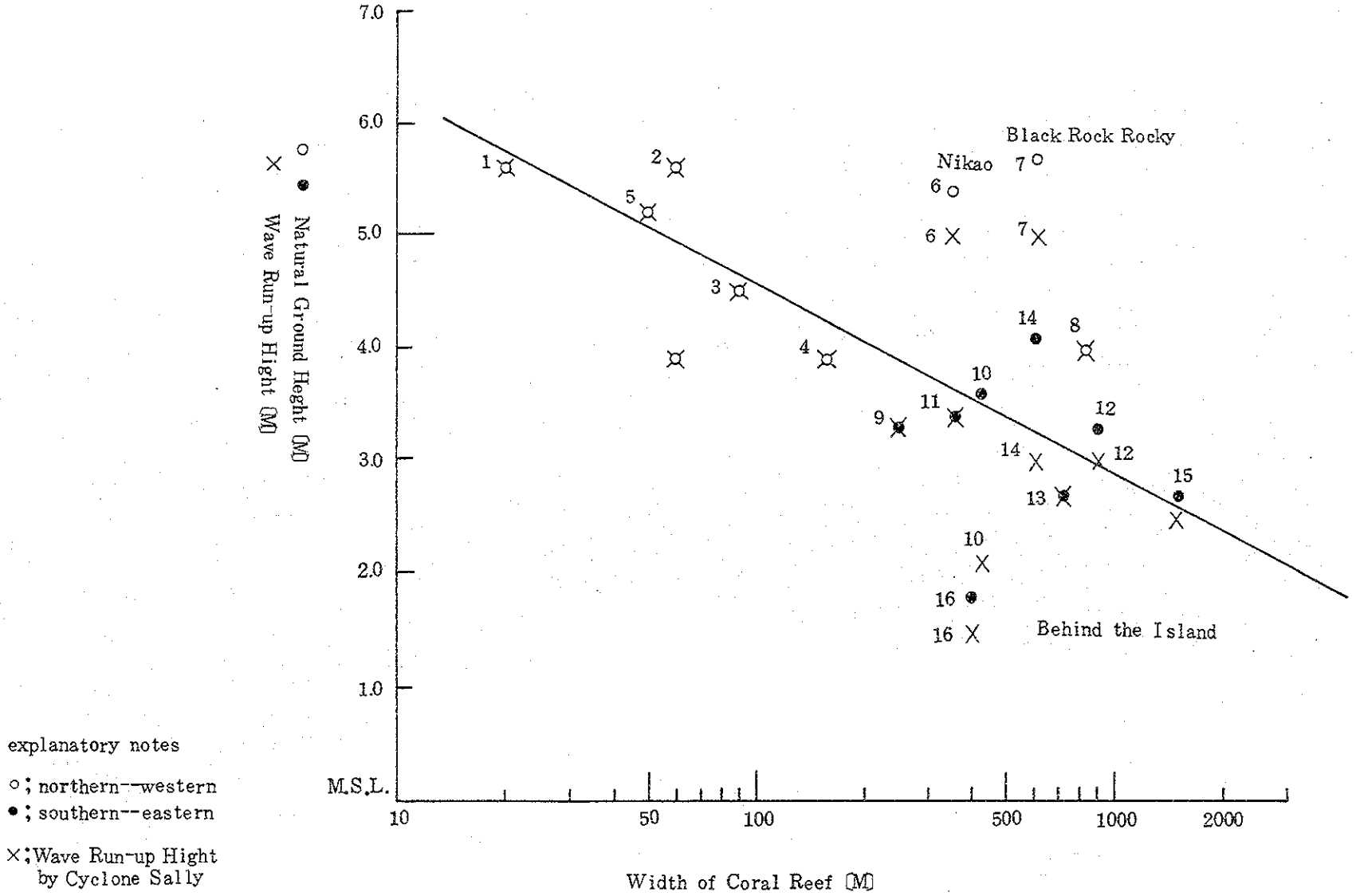


Fig. Ⅱ. 6. 14 Topography of Rarotonga Is. Seacoast and Width of Coral Reef

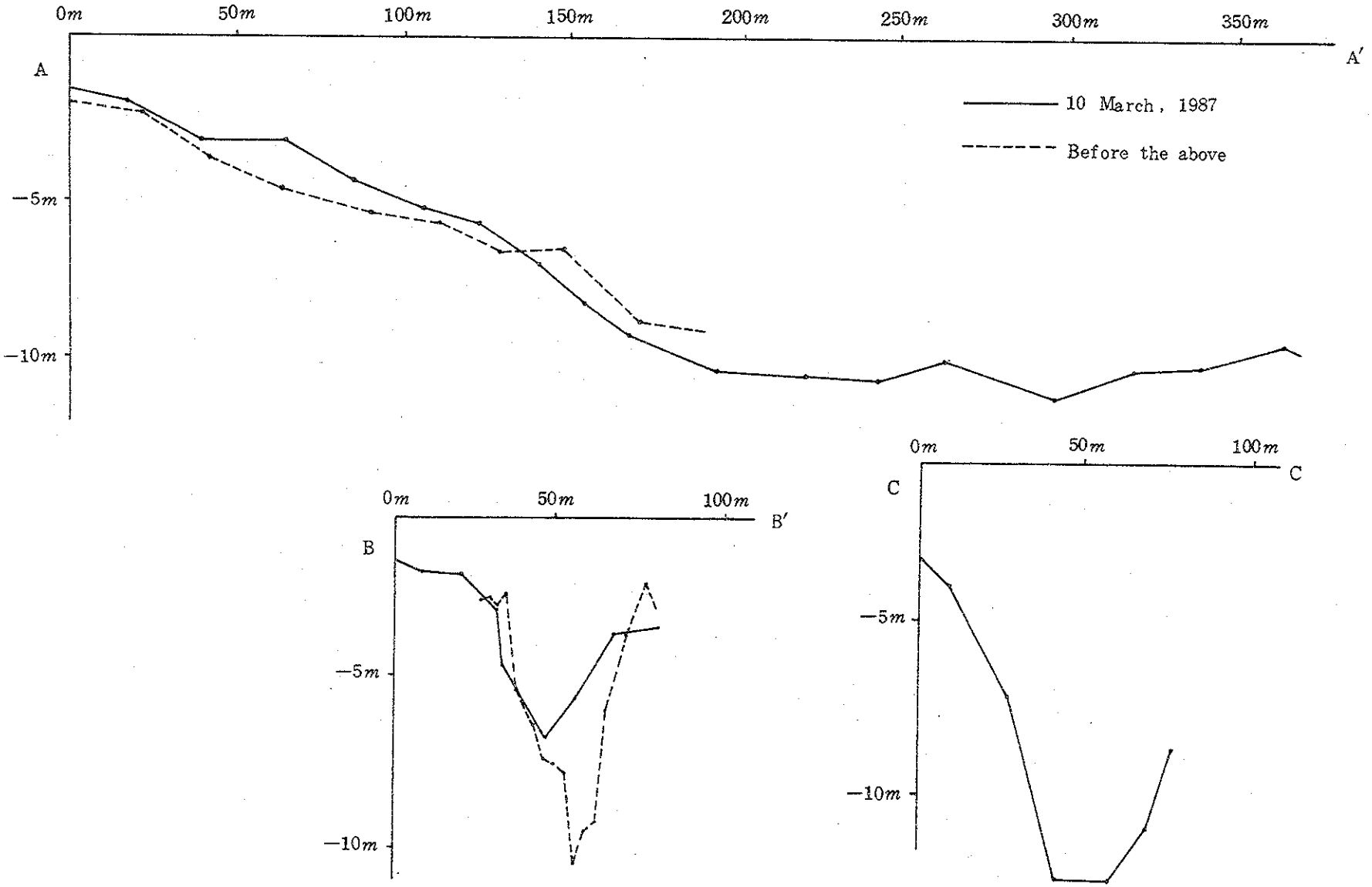


Fig. Ⅱ. 7. 1 (1) Avarua Harbour Profiles

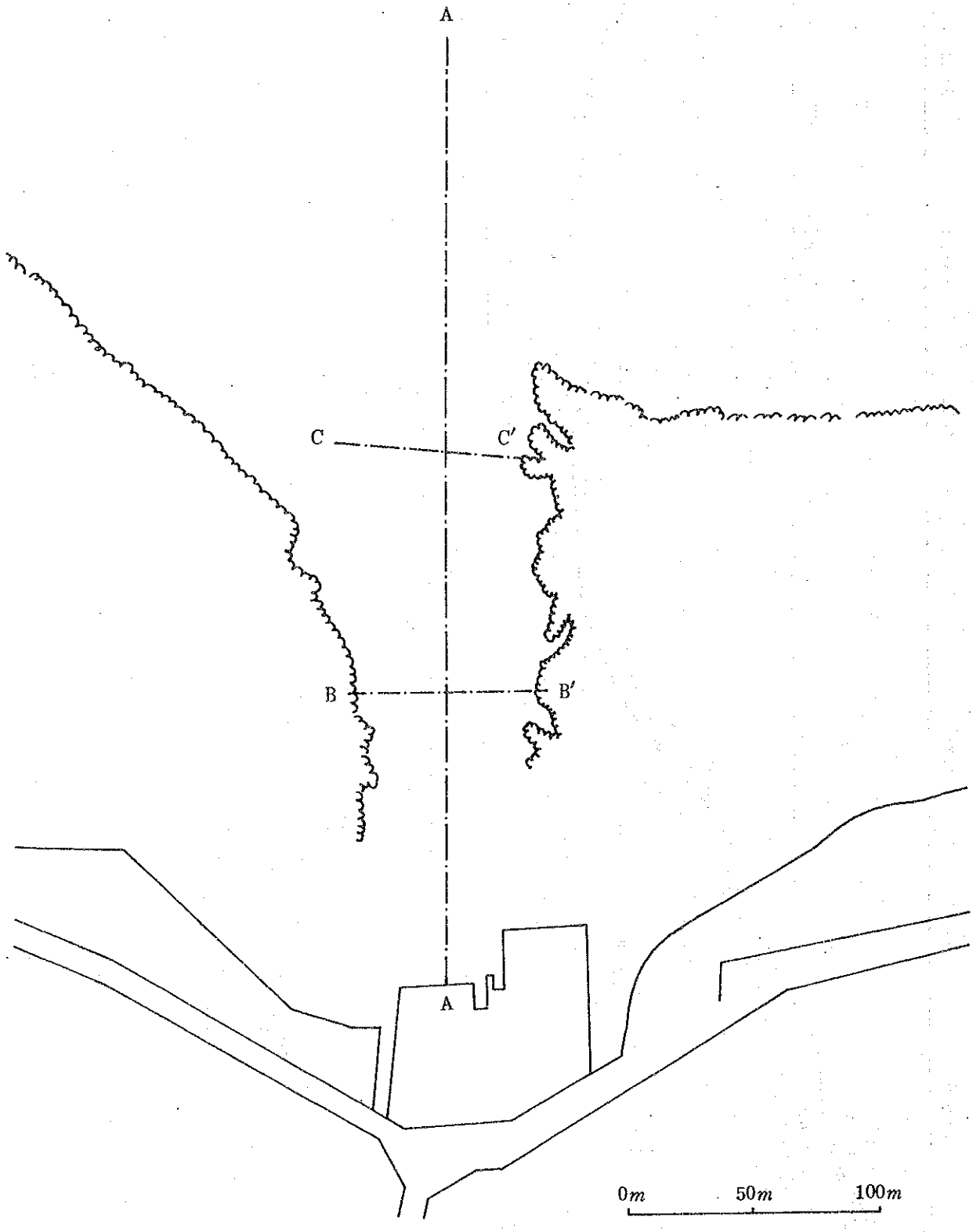


Fig. Ⅱ. 7. 1 (2) Lines of Sounding

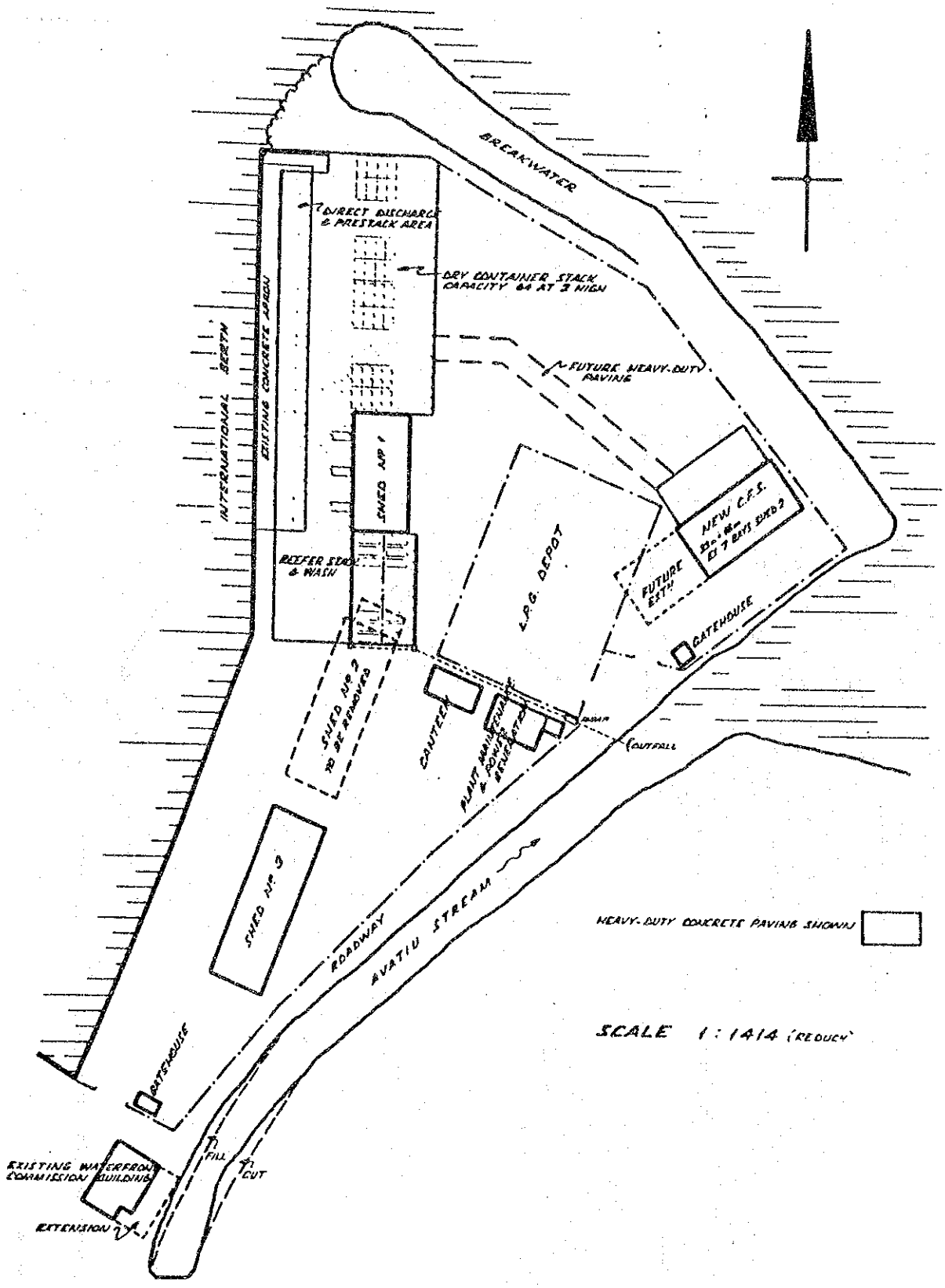


Fig. Ⅱ. 8. 1 Avatiu Harbour Development Plan (Eastern Side)

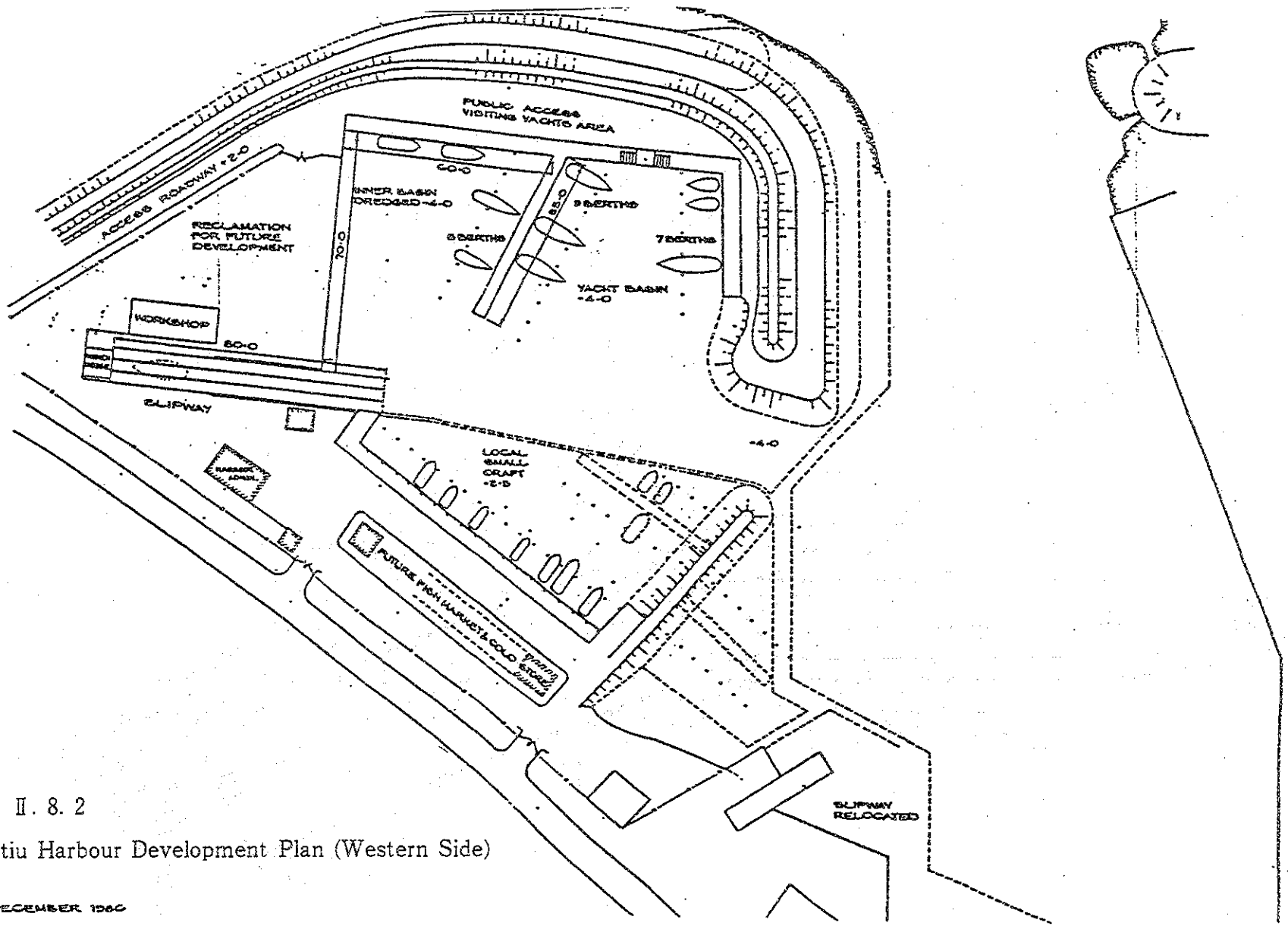


Fig. Ⅱ. 8. 2

Avatiu Harbour Development Plan (Western Side)

DECEMBER 1980

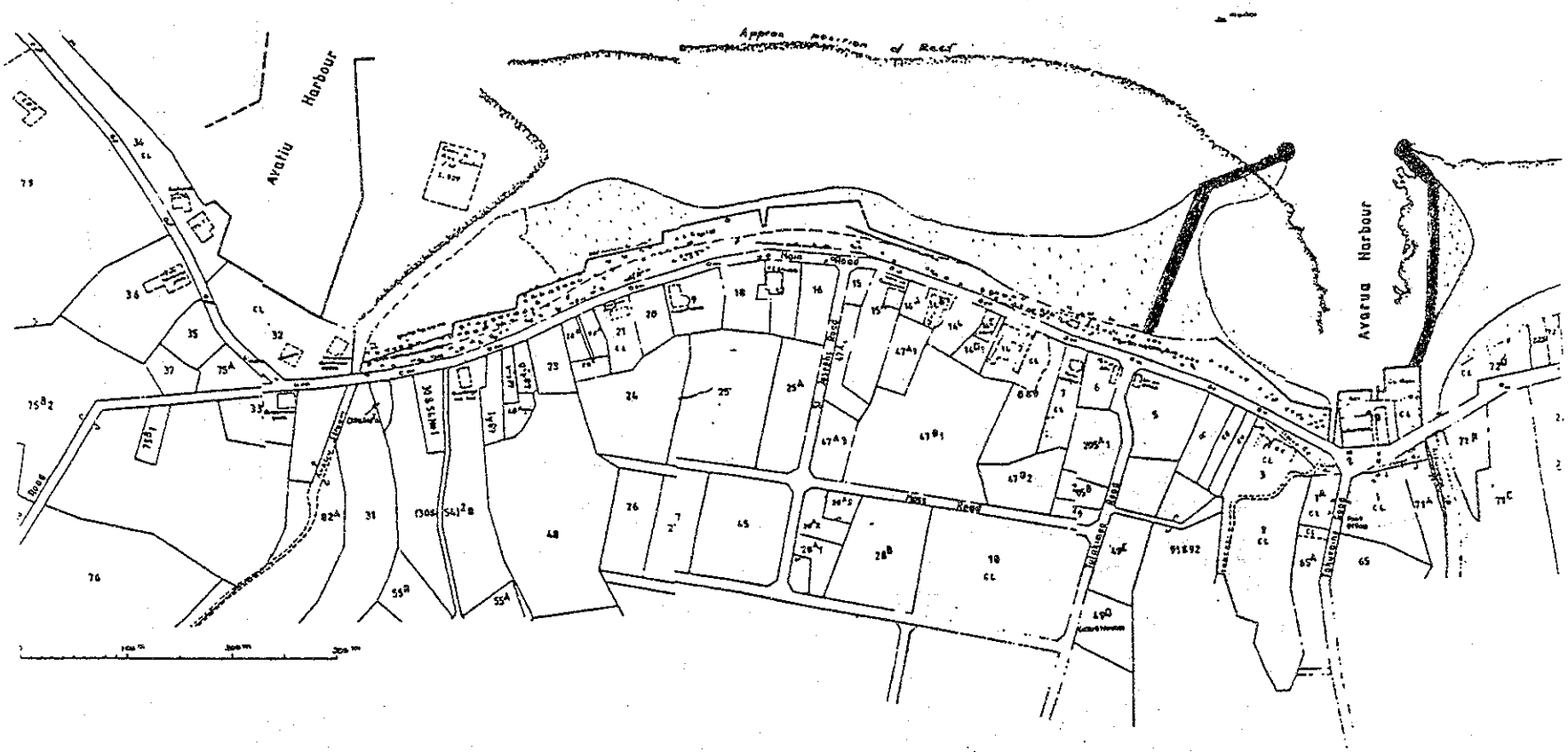
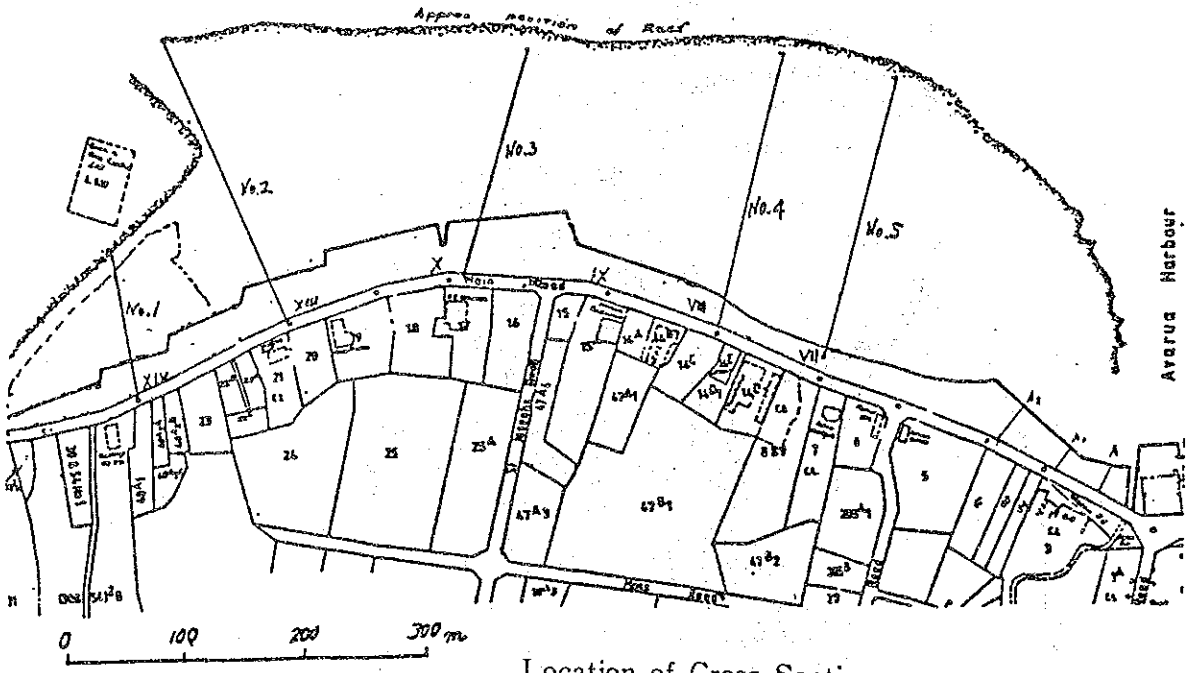
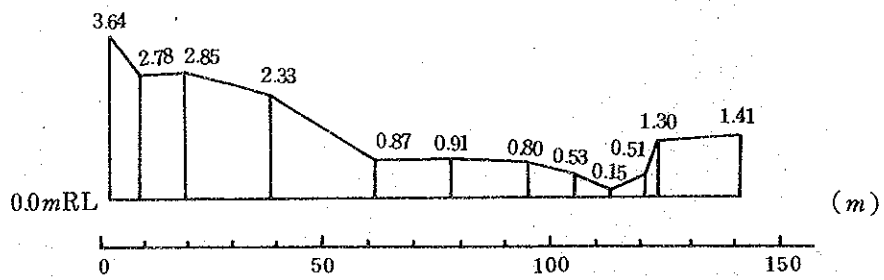


Fig. II. 8. 3 Planned Avarua Breakwater



Location of Cross Section

SECTION No.1



SECTION No.2

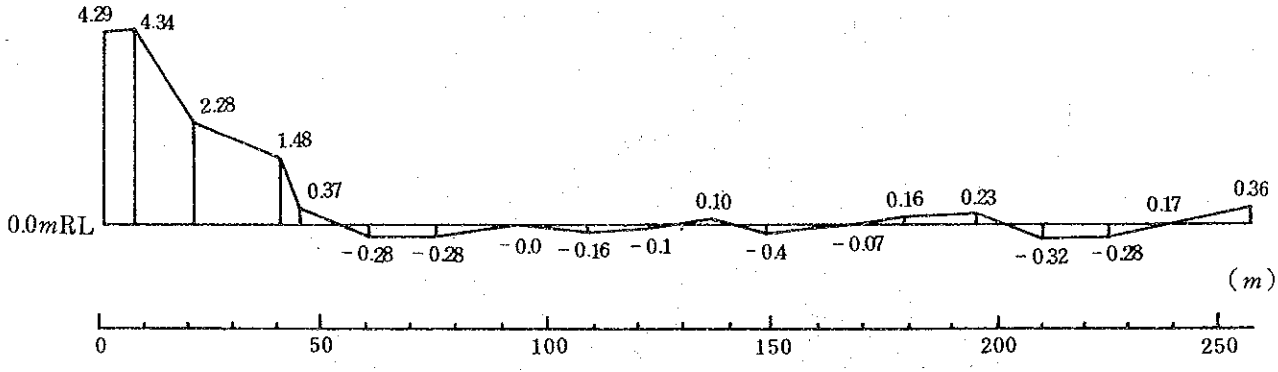
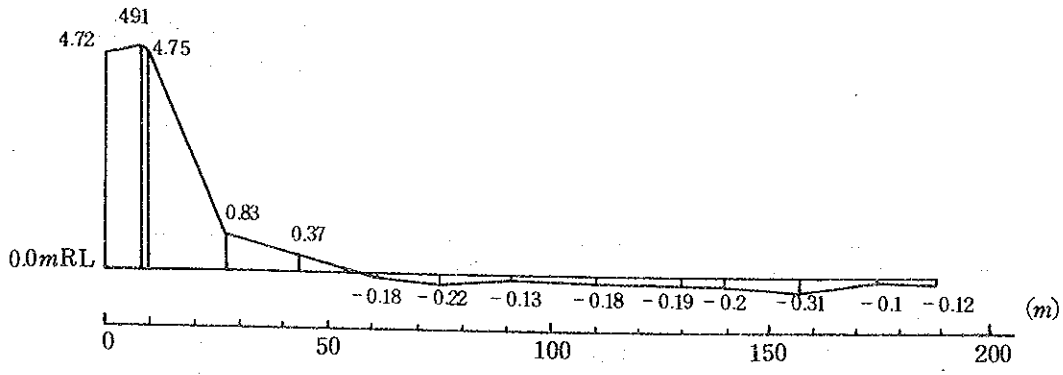


Fig. Ⅲ. 1. 1 (1) Cross Sections of Avarua Coast

SECTION No.3



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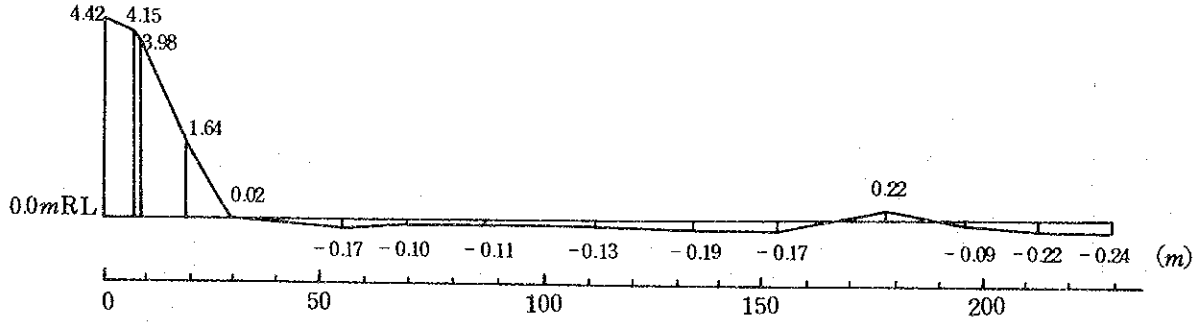

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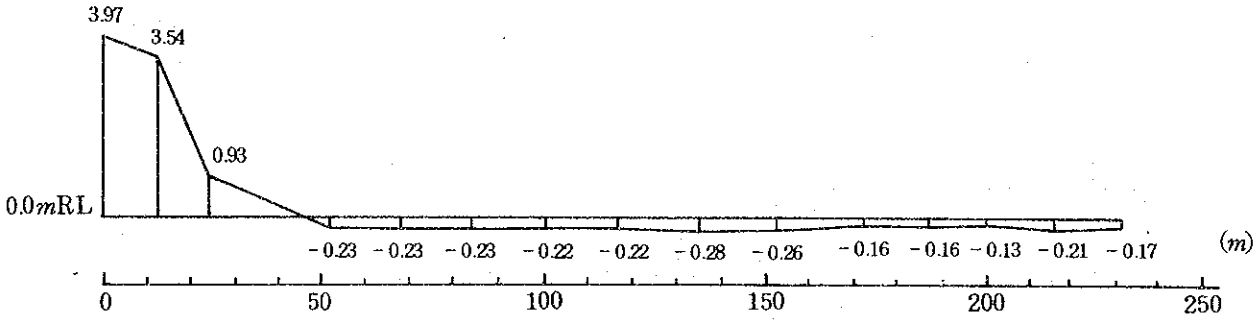


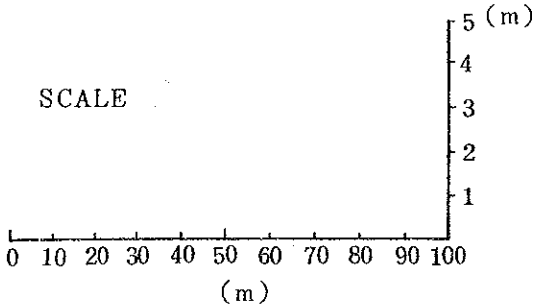


Fig. Ⅲ. 1. 1 (2)

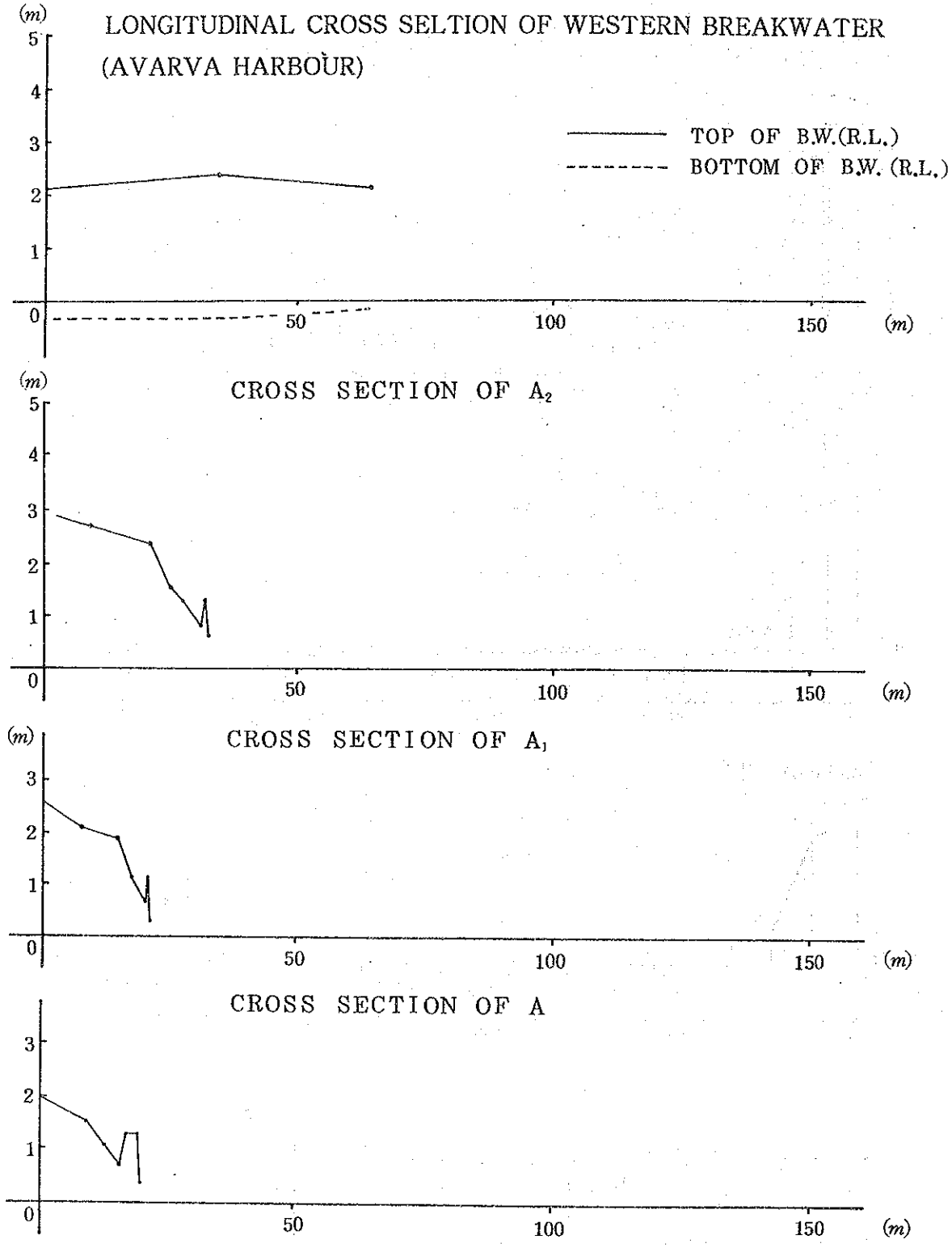

LONGITUDINAL CROSS SELTION OF WESTERN BREAKWATER
(AVARVA HARBOUR)
TOP OF B.W.(R.L.)
BOTTOM OF B.W. (R.L.)
CROSS SECTION OF A2
CROSS SECTION OF A1
CROSS SECTION OF A
(m)
0
50
100
150

Fig. Ⅲ. 1. 1 (3)

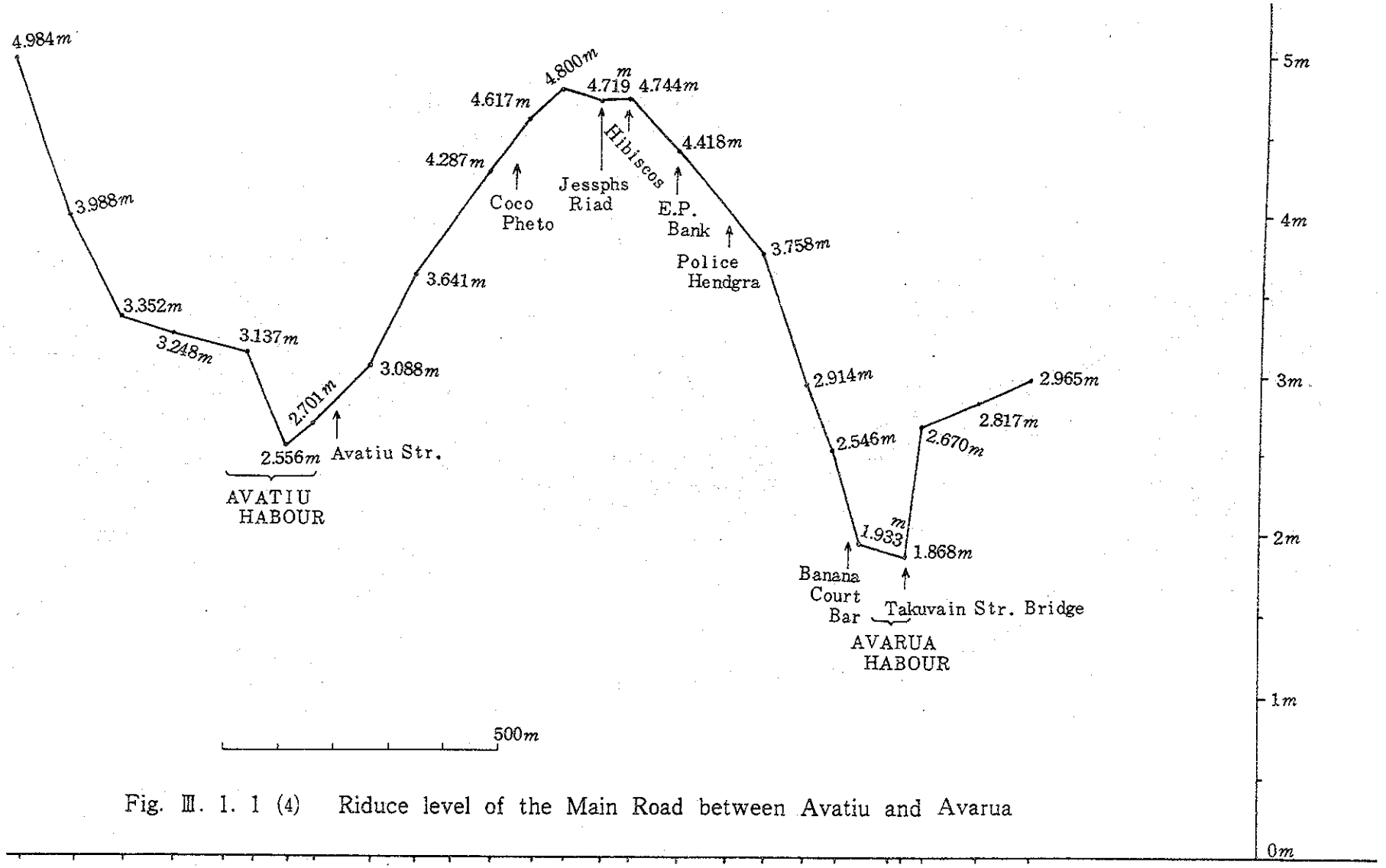


Fig. Ⅲ. 1. 1 (4) Riduce level of the Main Road between Avatiu and Avarua

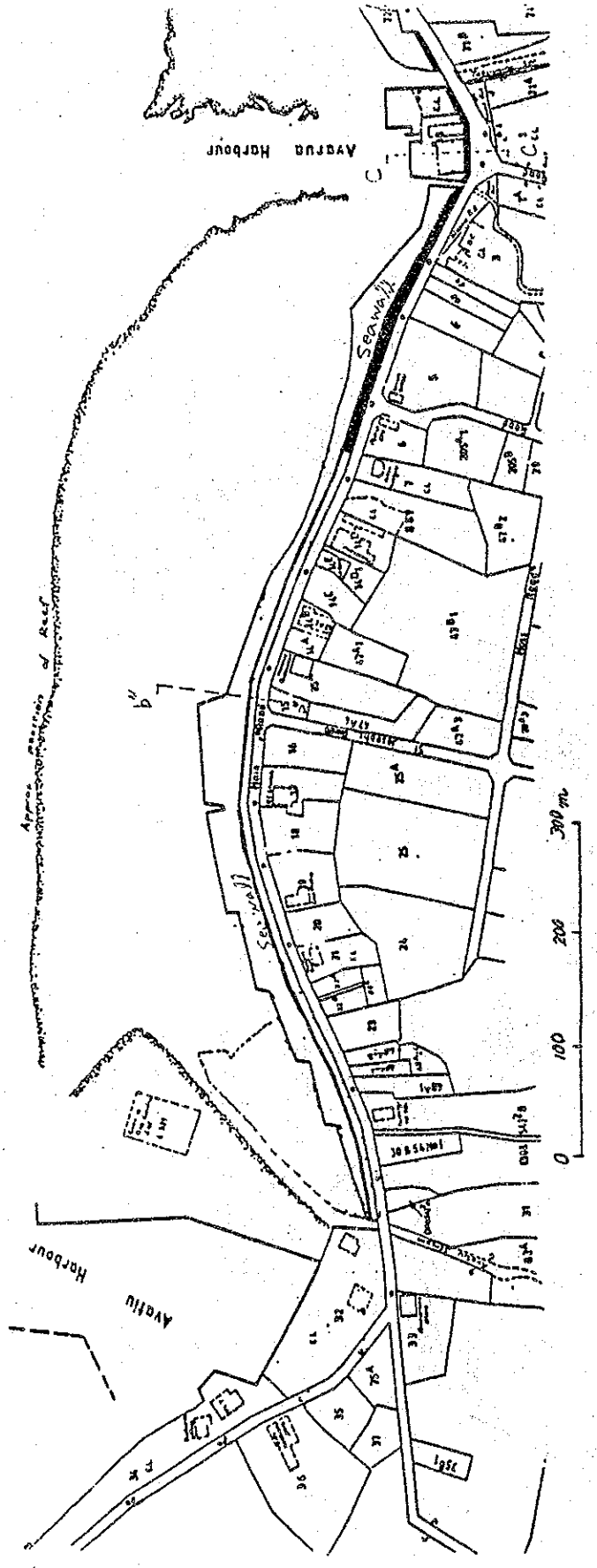


Fig. Ⅲ. 1. 2 Seawall Plan

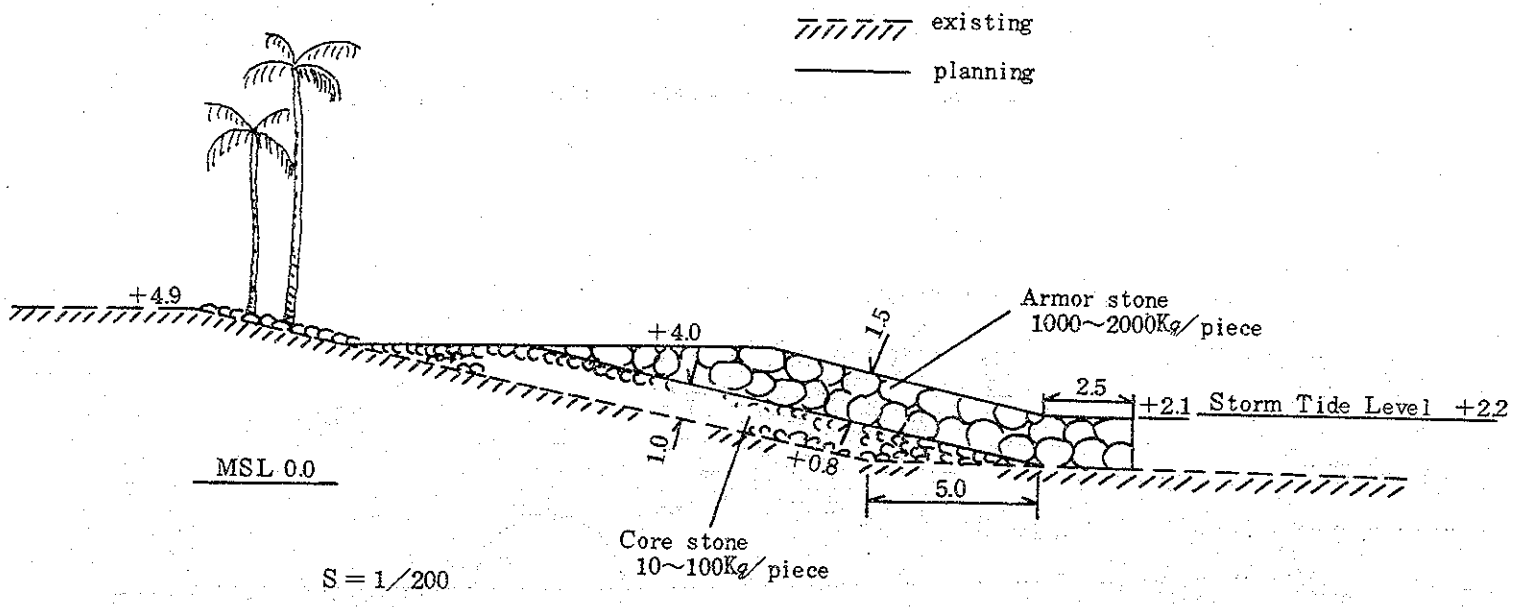


Fig. Ⅲ. 1. 2 Stone parapet profile (b″—b″ section)

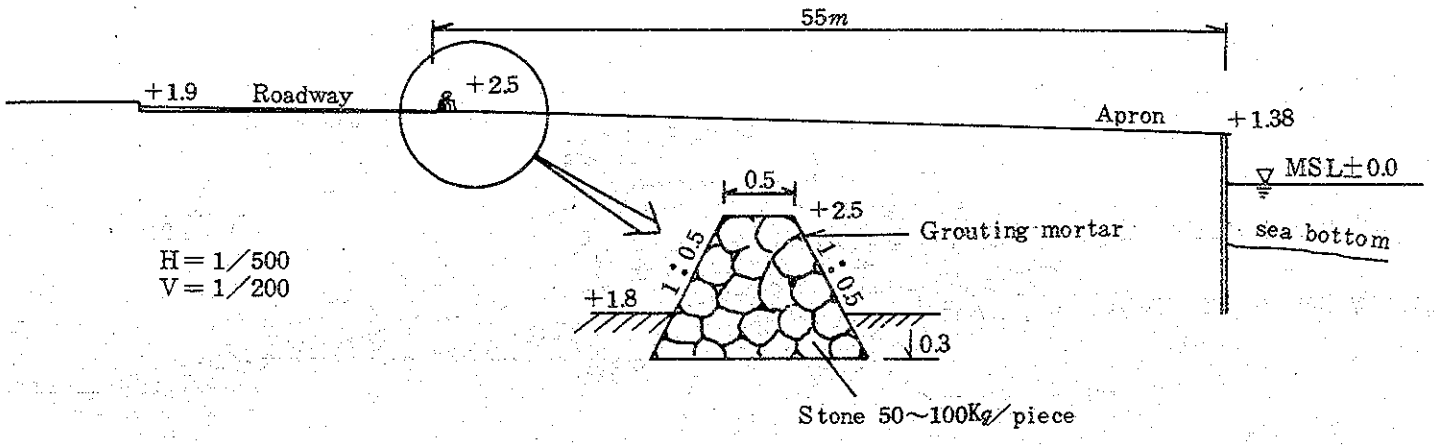


Fig. Ⅲ. 1. 2 Stone parapet profile (c—c section)

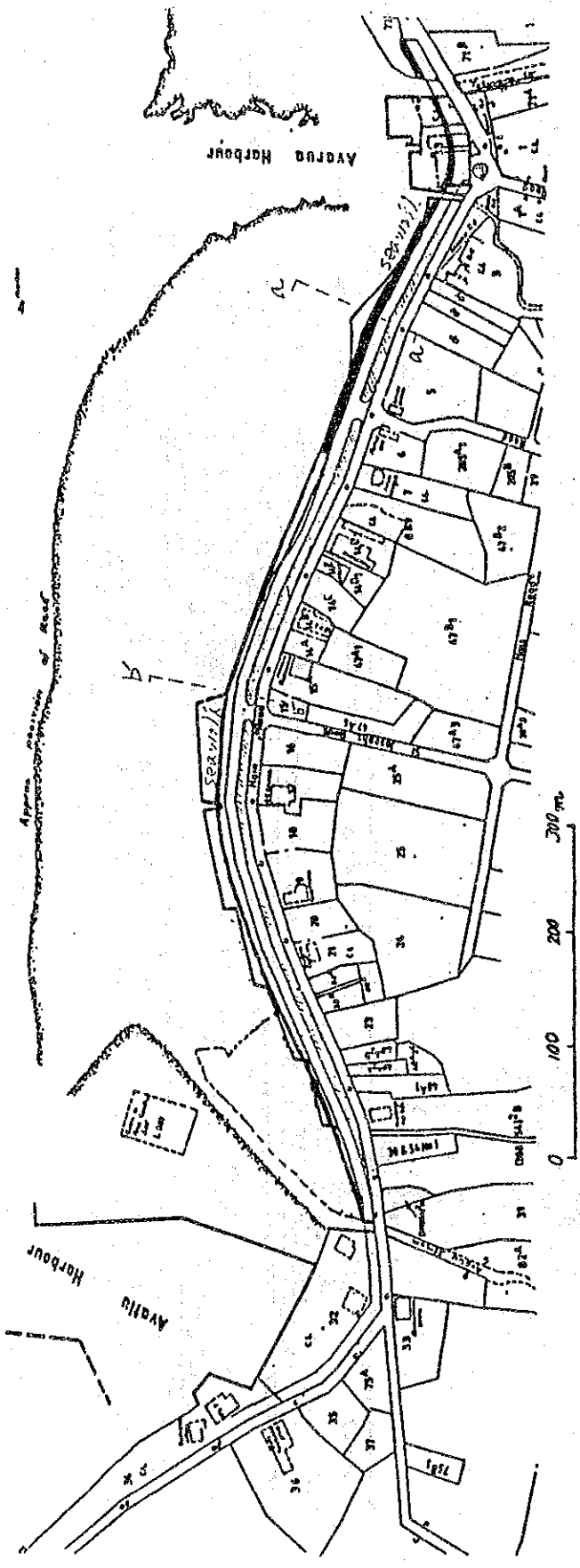


Fig. Ⅲ. 1. 3 Seawall—cum—roads Plan

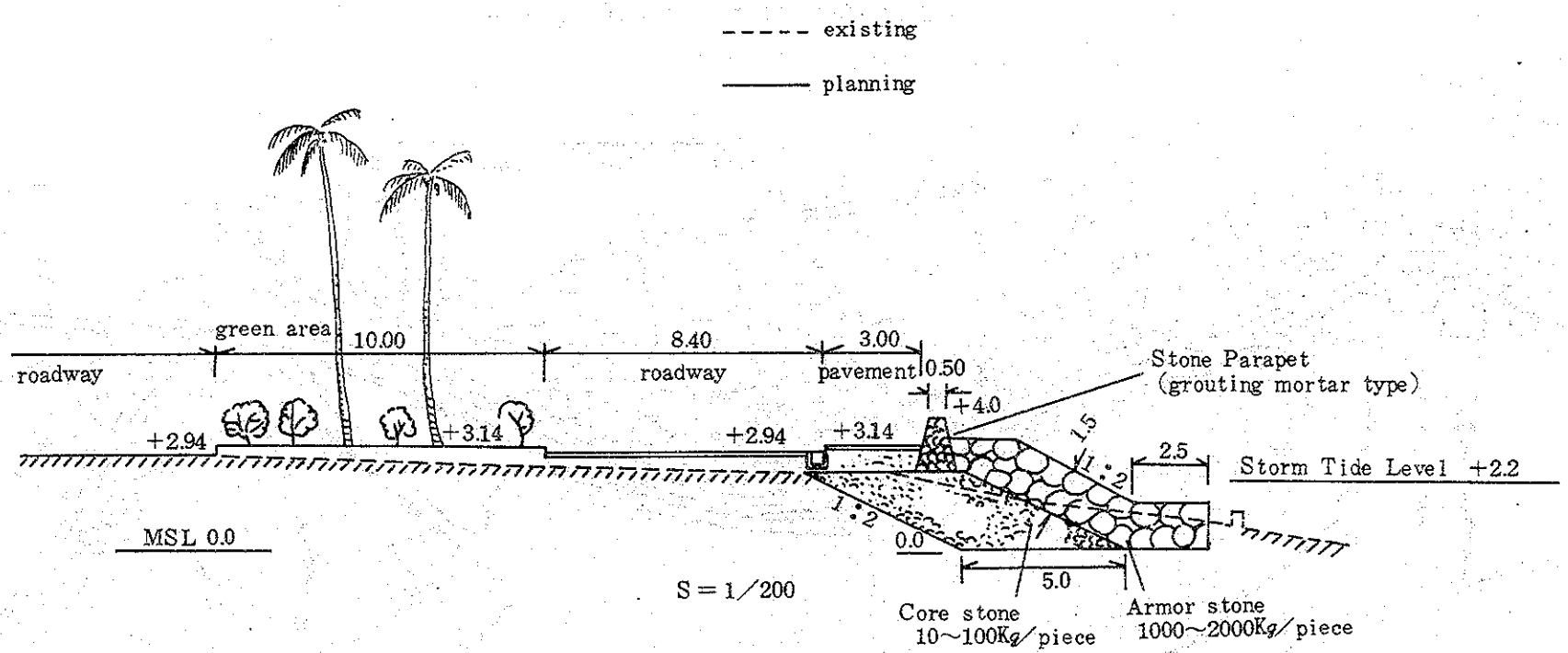


Fig. Ⅲ. 1. 3 Seawall profile (a—a section)

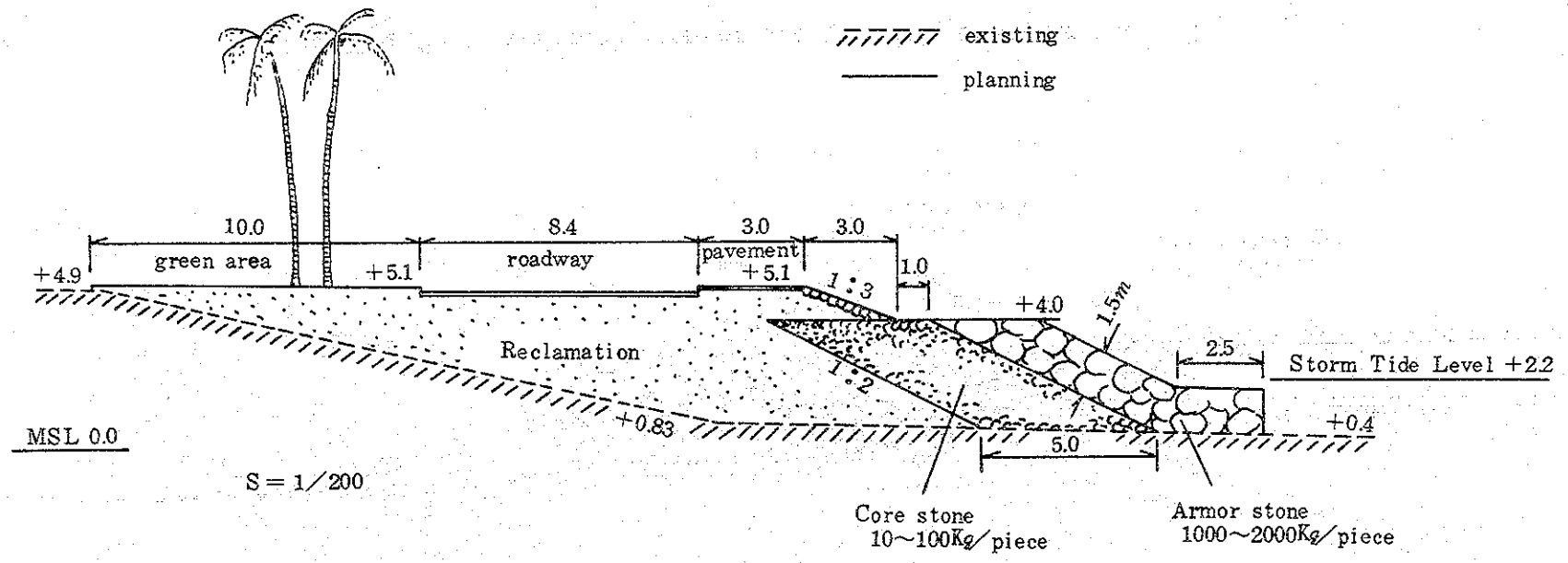


Fig. Ⅲ. 1. 3 Seawall profire (b′—b′ section) case—1

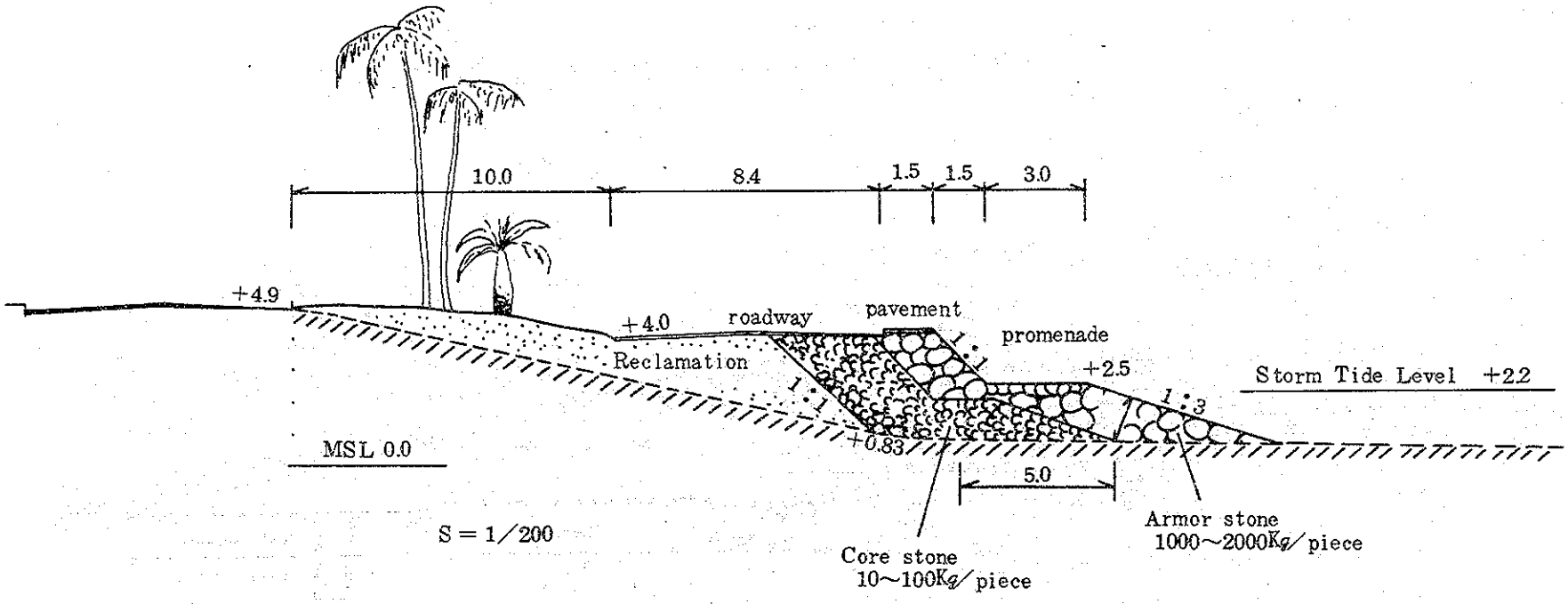


Fig. Ⅲ. 1. 3 Seawall profile (promenade type) (b′—b′ section) case—2

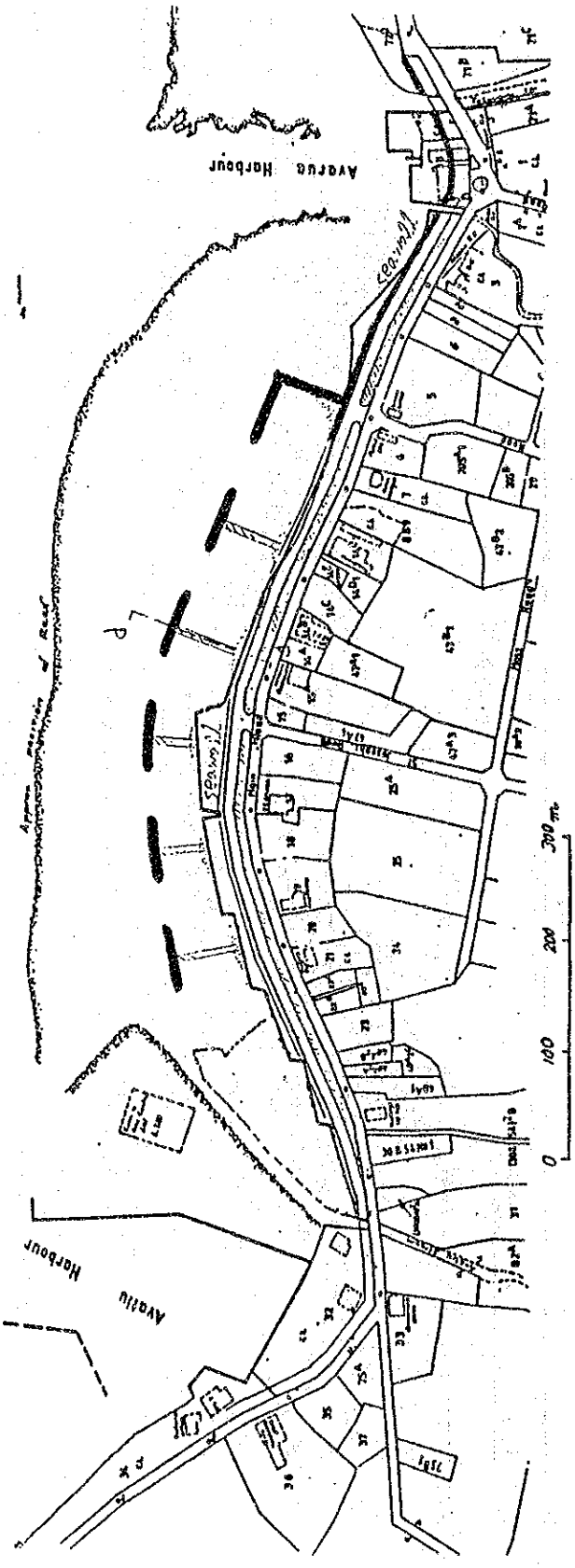


Fig. Ⅲ. 1. 4 Detached Breakwater Plan

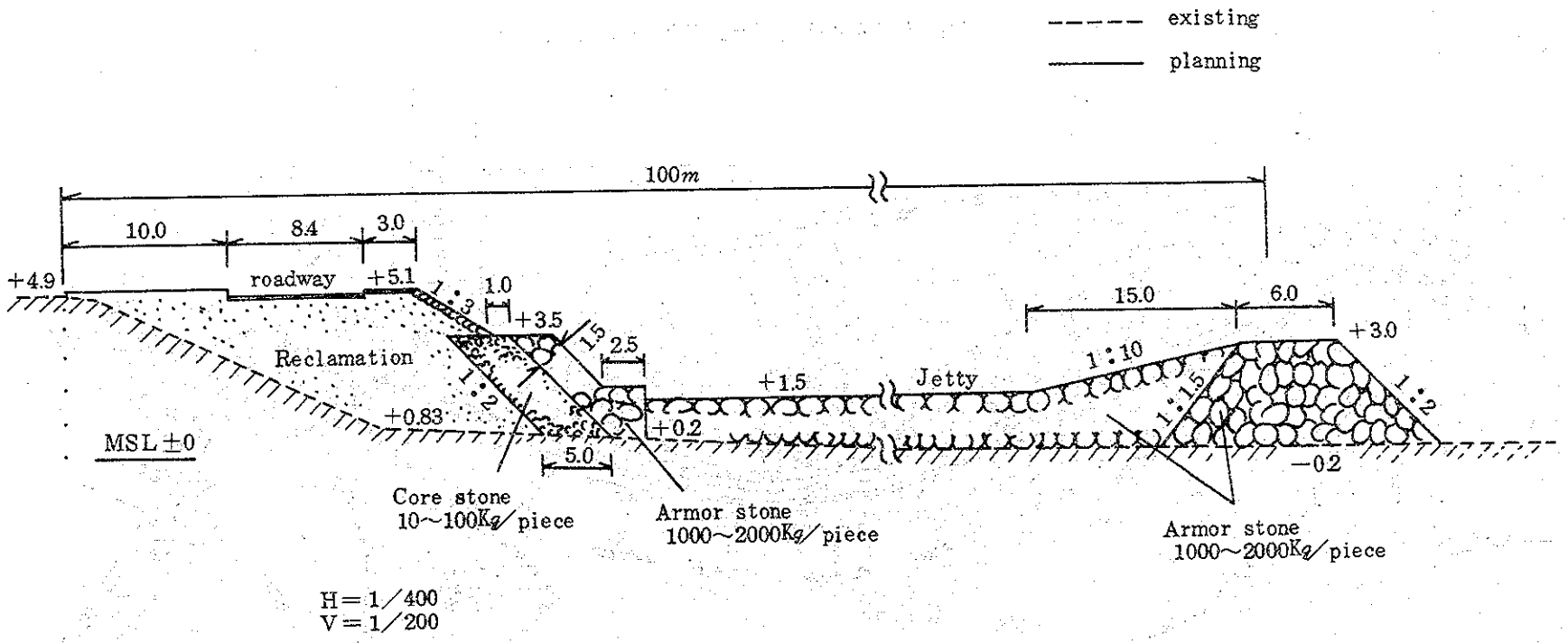


Fig. Ⅲ. 1. 4 Seawall and Detached Breakwater profile (d−d section)

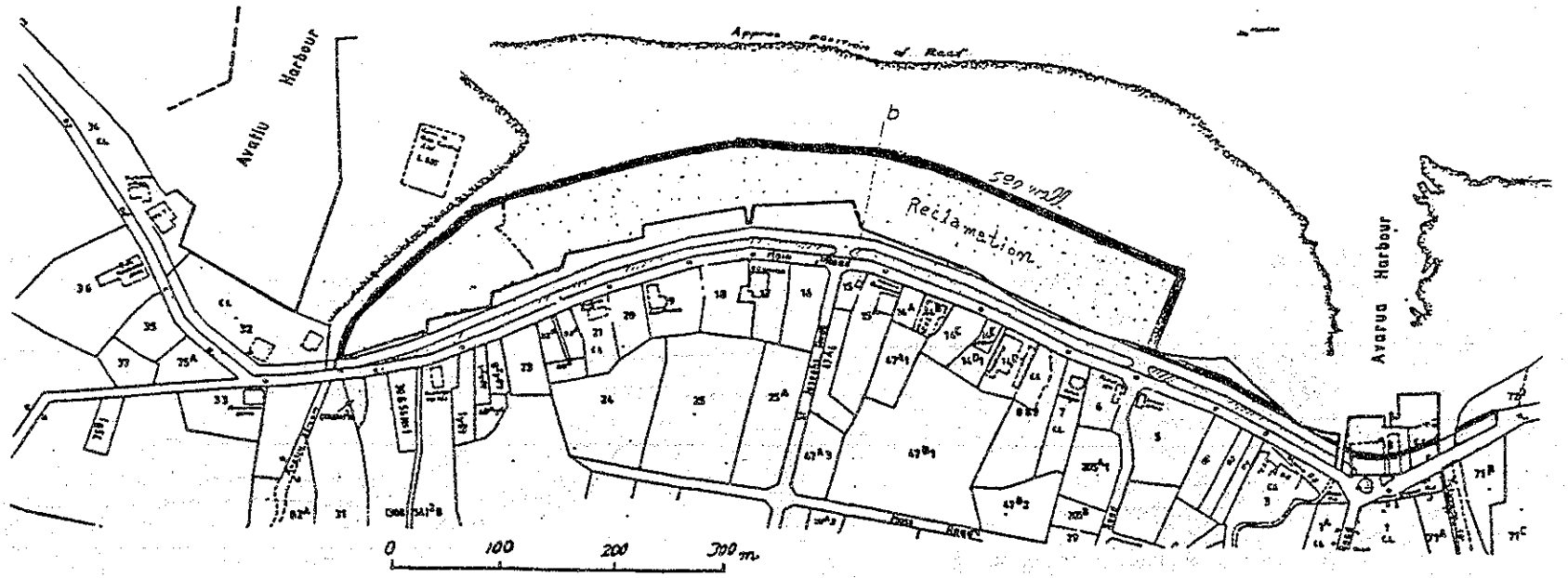


Fig. Ⅲ. 1. 5 Low Land Reclamation Plan

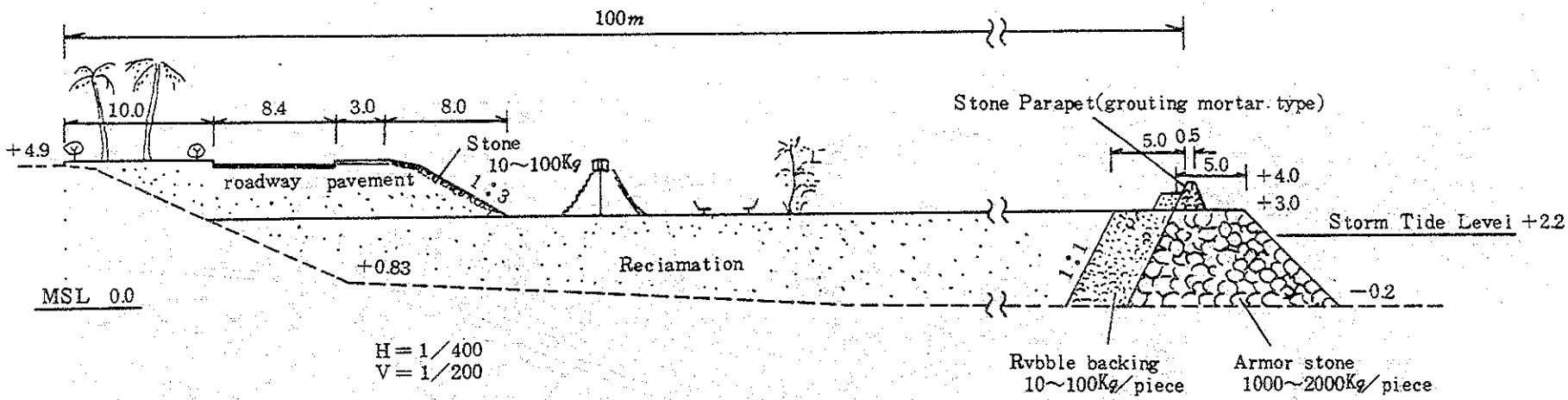


Fig. Ⅲ. 1. 5 Reclamation profile (b—b section) Case—1 High Land Level

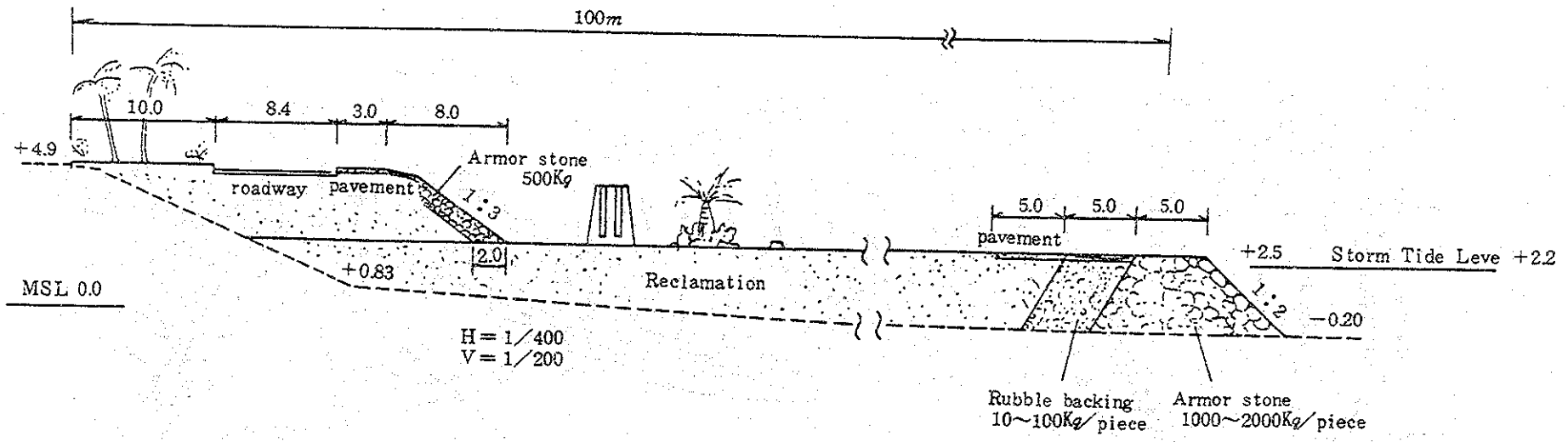


Fig. Ⅲ. 1. 5 Reclamation profile (b—b section) Case—2 Low Land Level

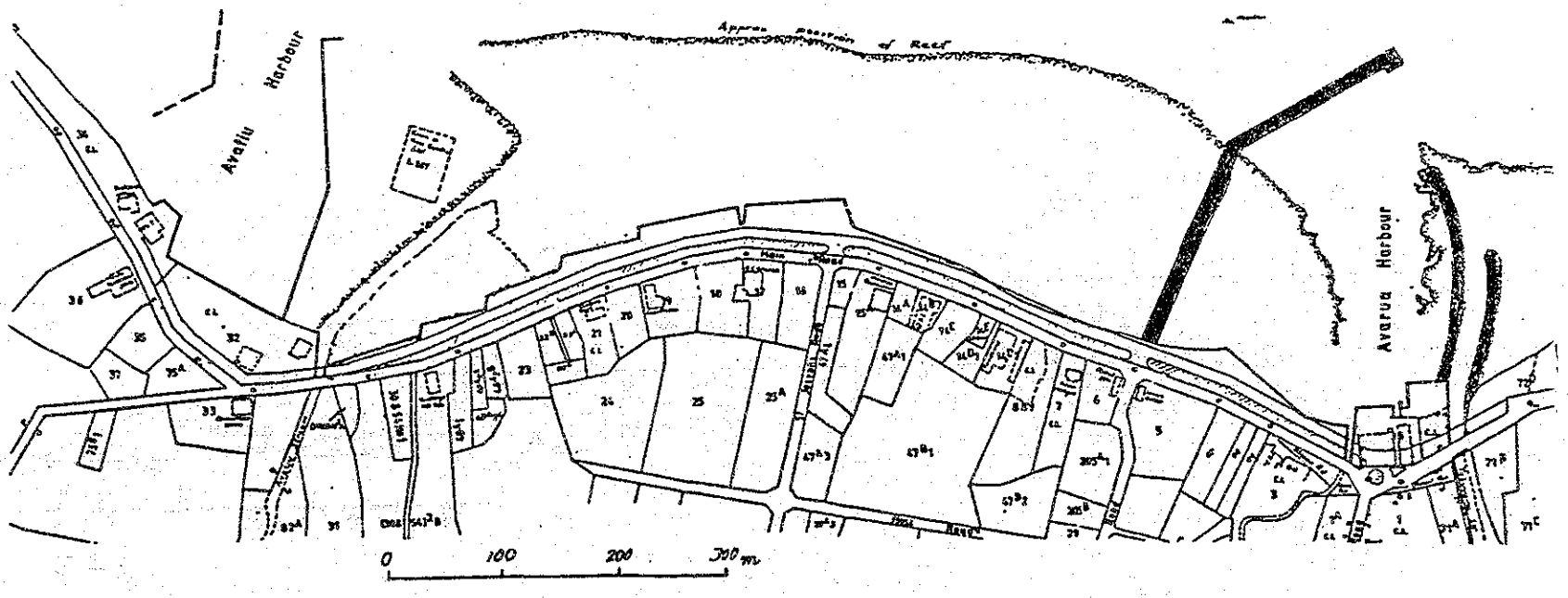


Fig. Ⅲ. 1. 6 Extensive Breakwater Plan

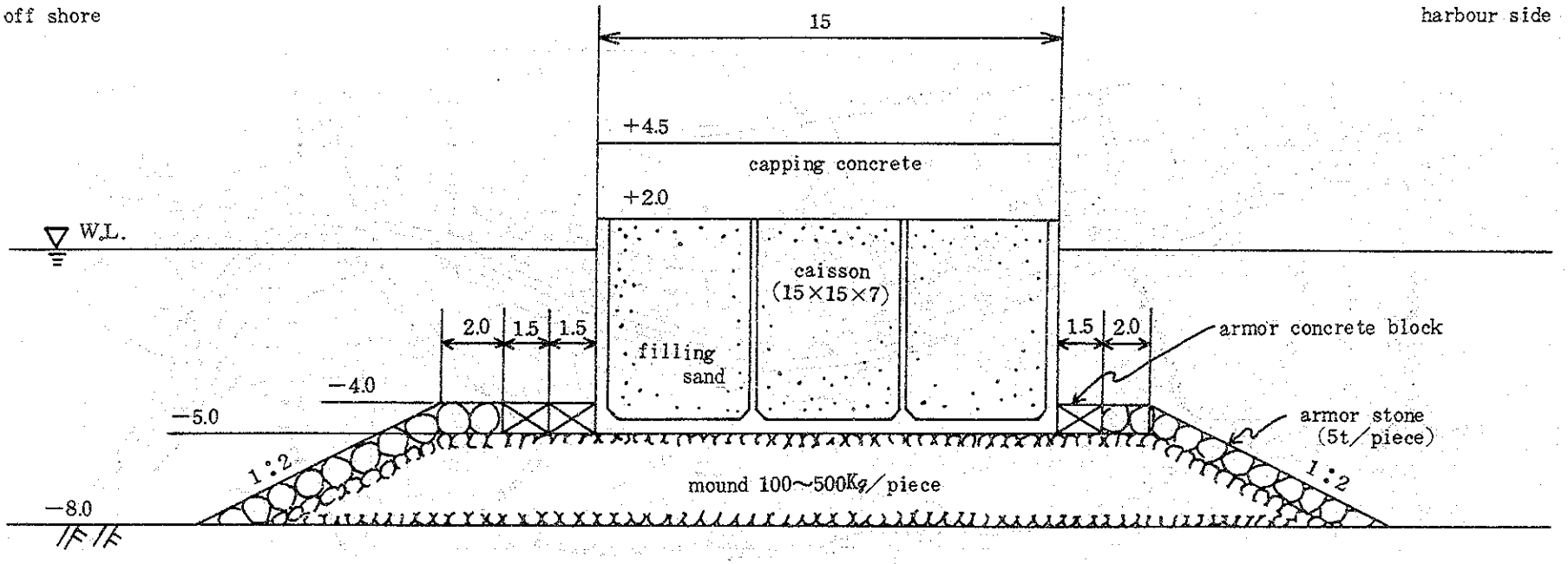


Fig. Ⅲ. 1. 6 Cross Section of Deep−water Breakwater

Scale 1 : 200

Unit m

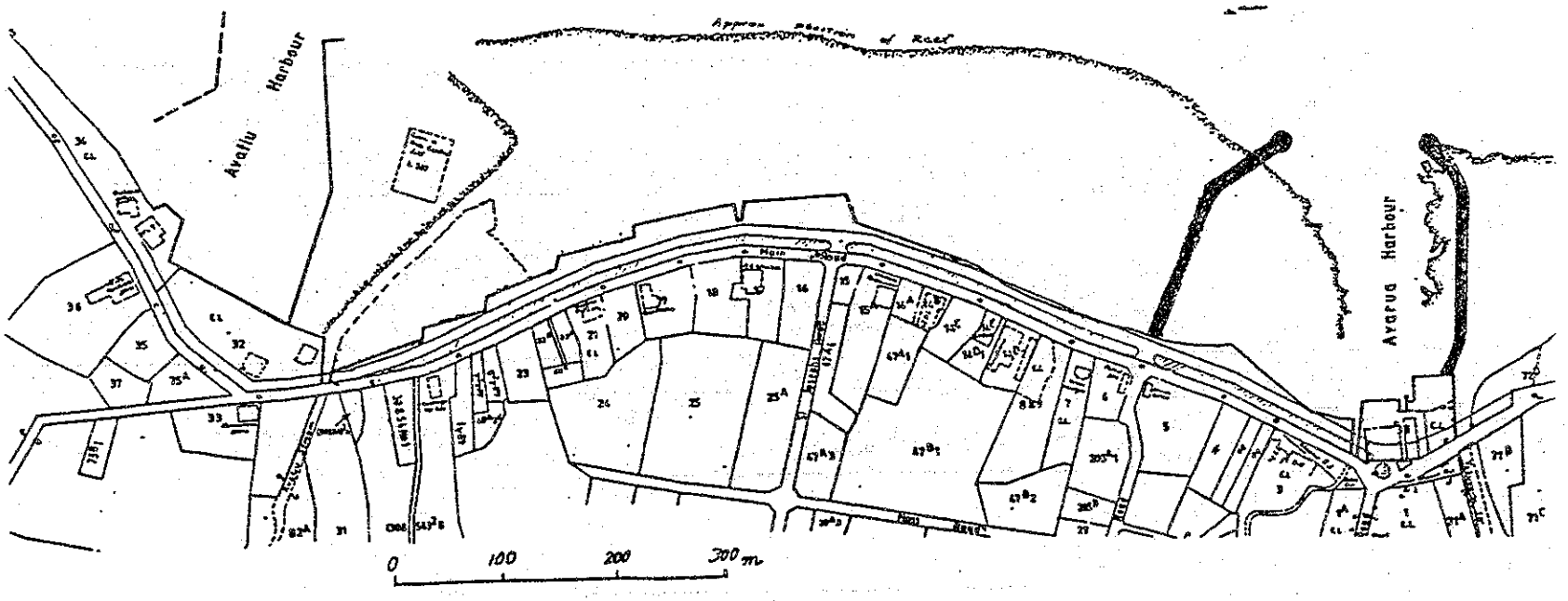


Fig. Ⅲ. 1. 7 Planned Extensive Breakwater

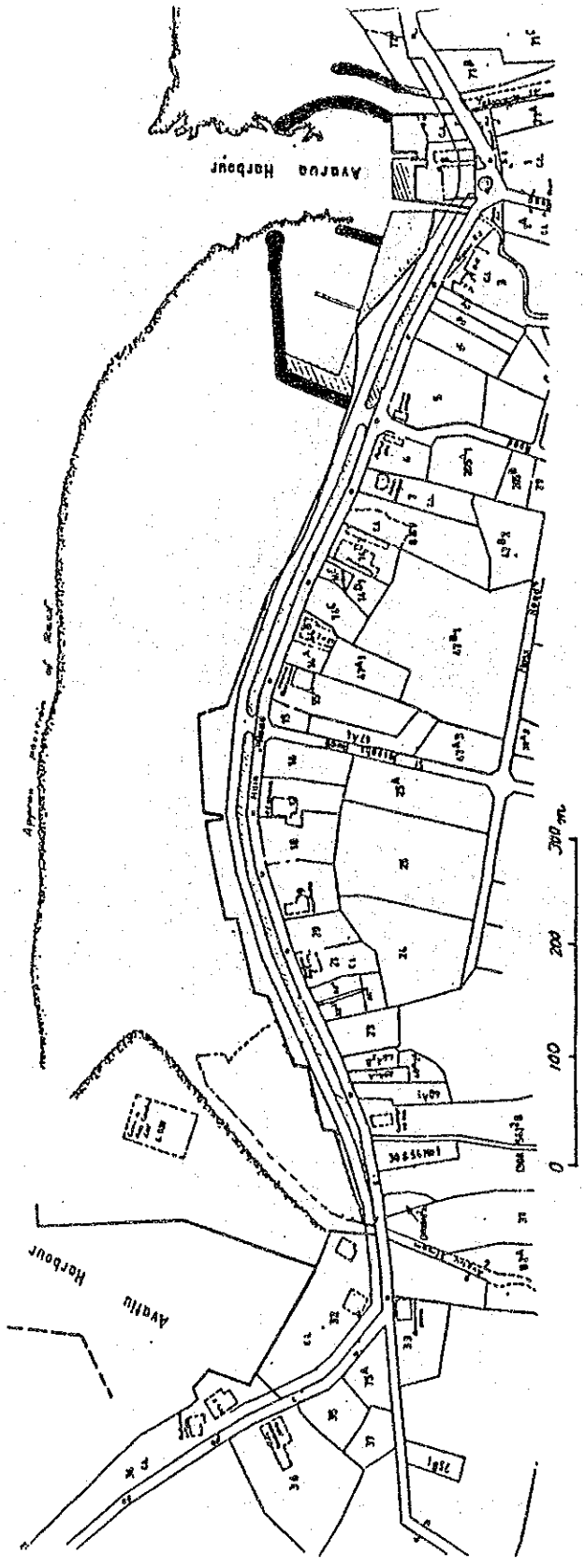
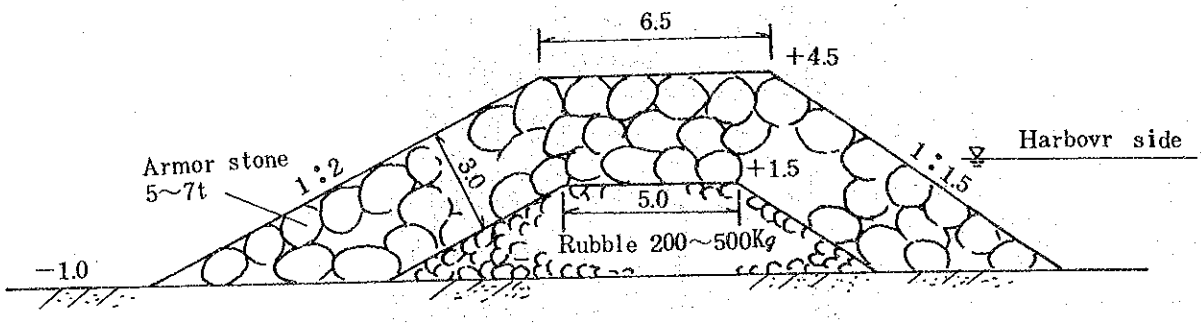
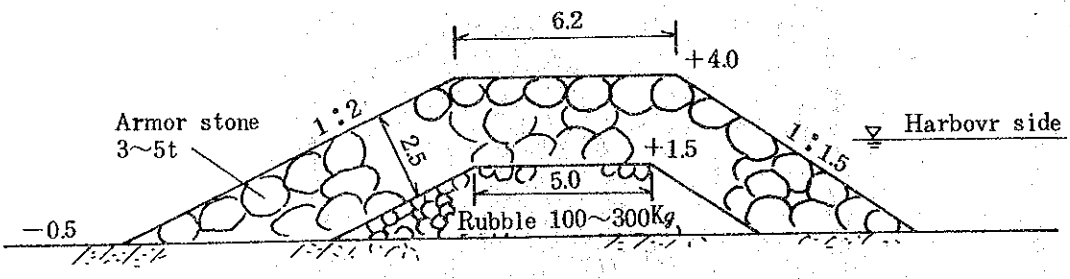


Fig. Ⅲ. 1. 8 Yacht Harbour Plan

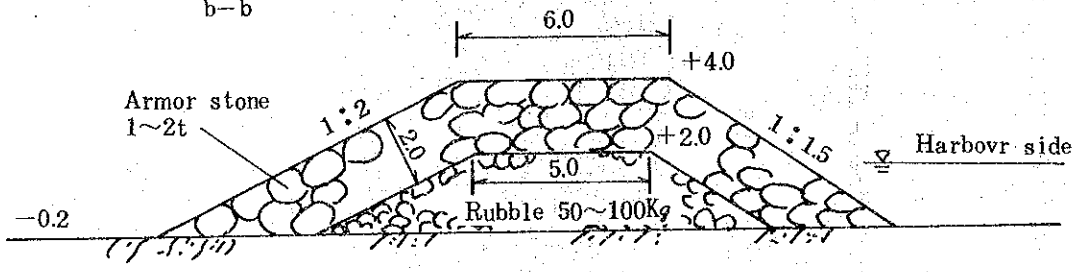


a—a Breakwater head section

S＝1／200



b—b



c—c

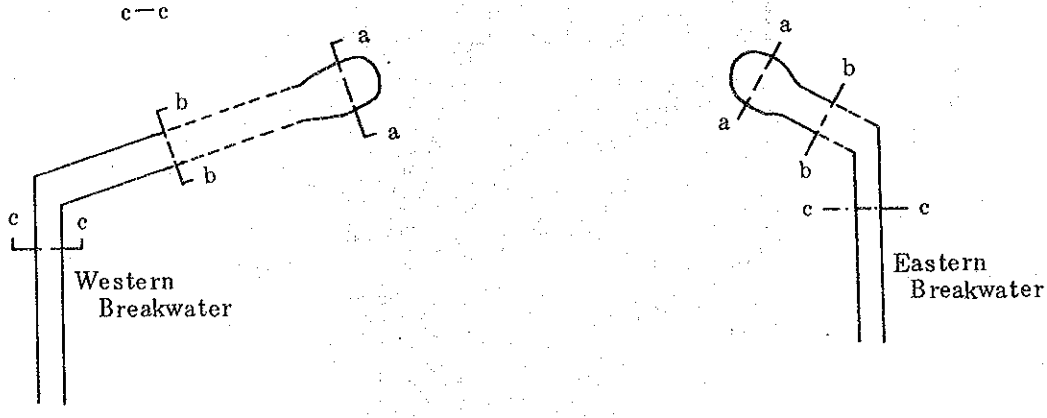


Fig. Ⅲ. 1. 8 Breakwater Cross Section for Yacht Harbour

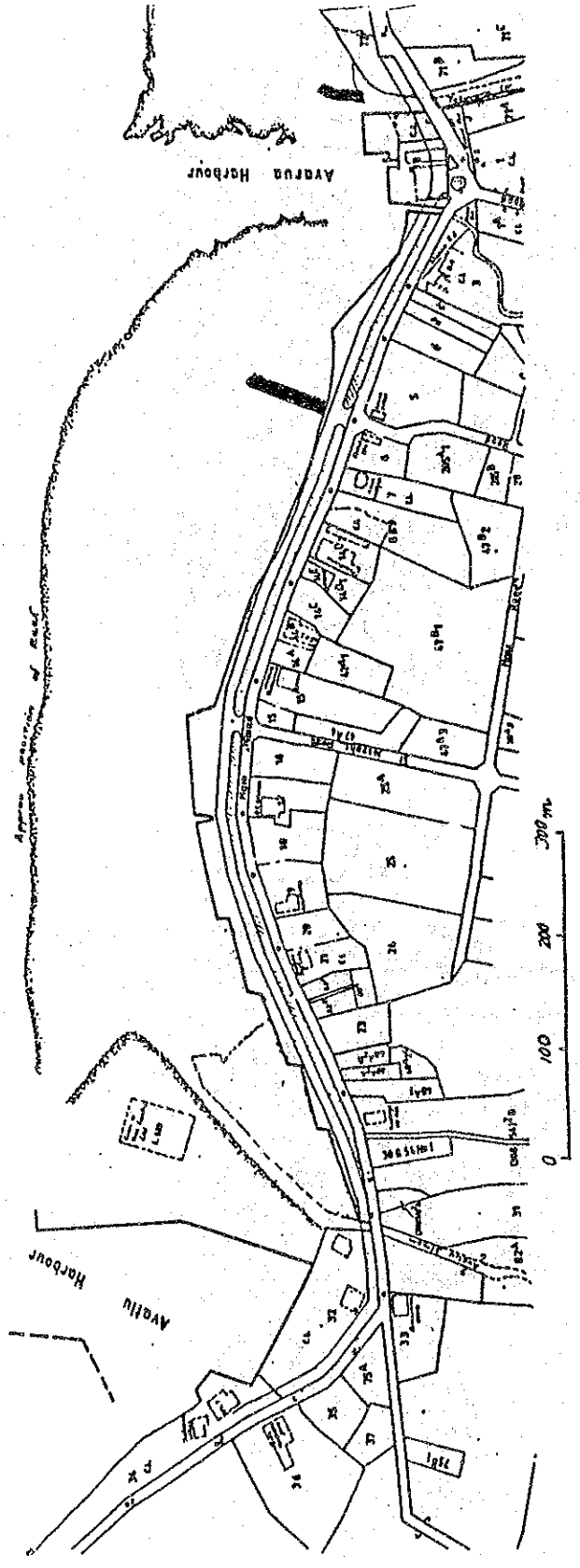


Fig. Ⅲ. 1. 9 Existing Breakwater

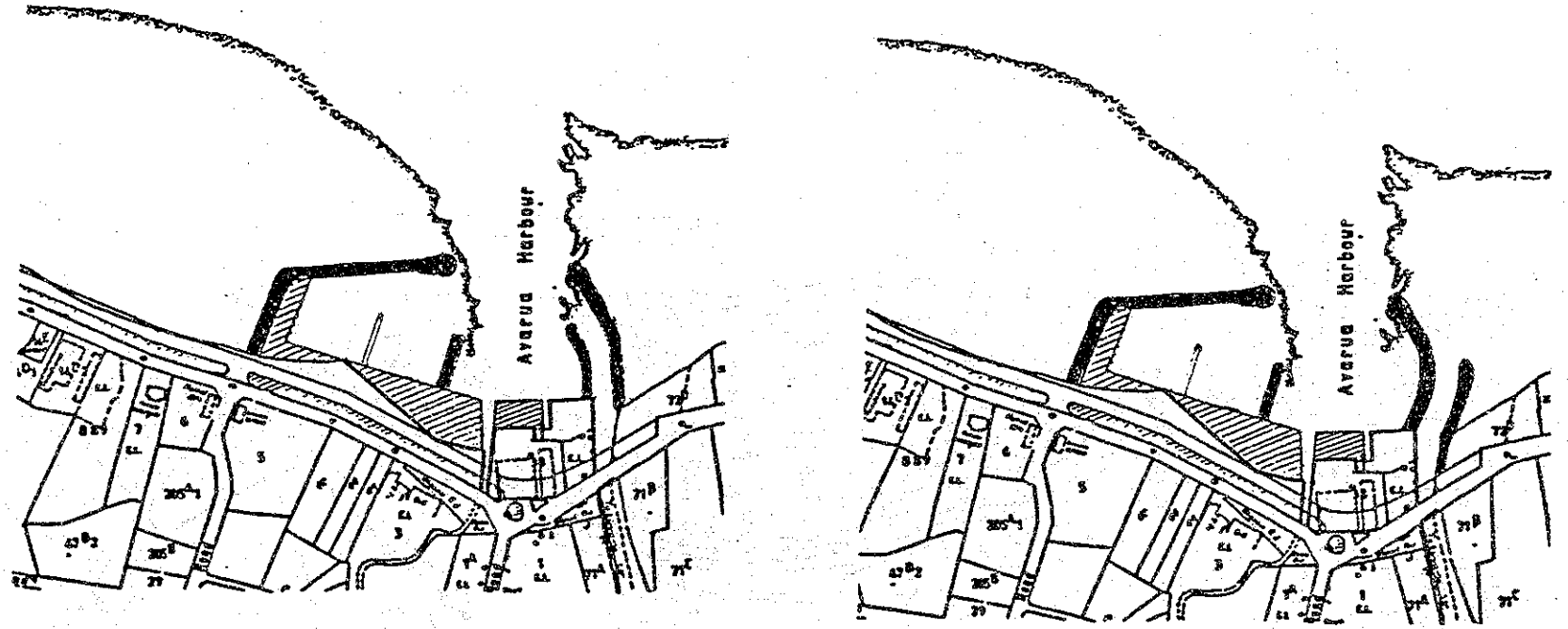


Fig. Ⅲ. 1. 10 Comparison of Mouth Trainning

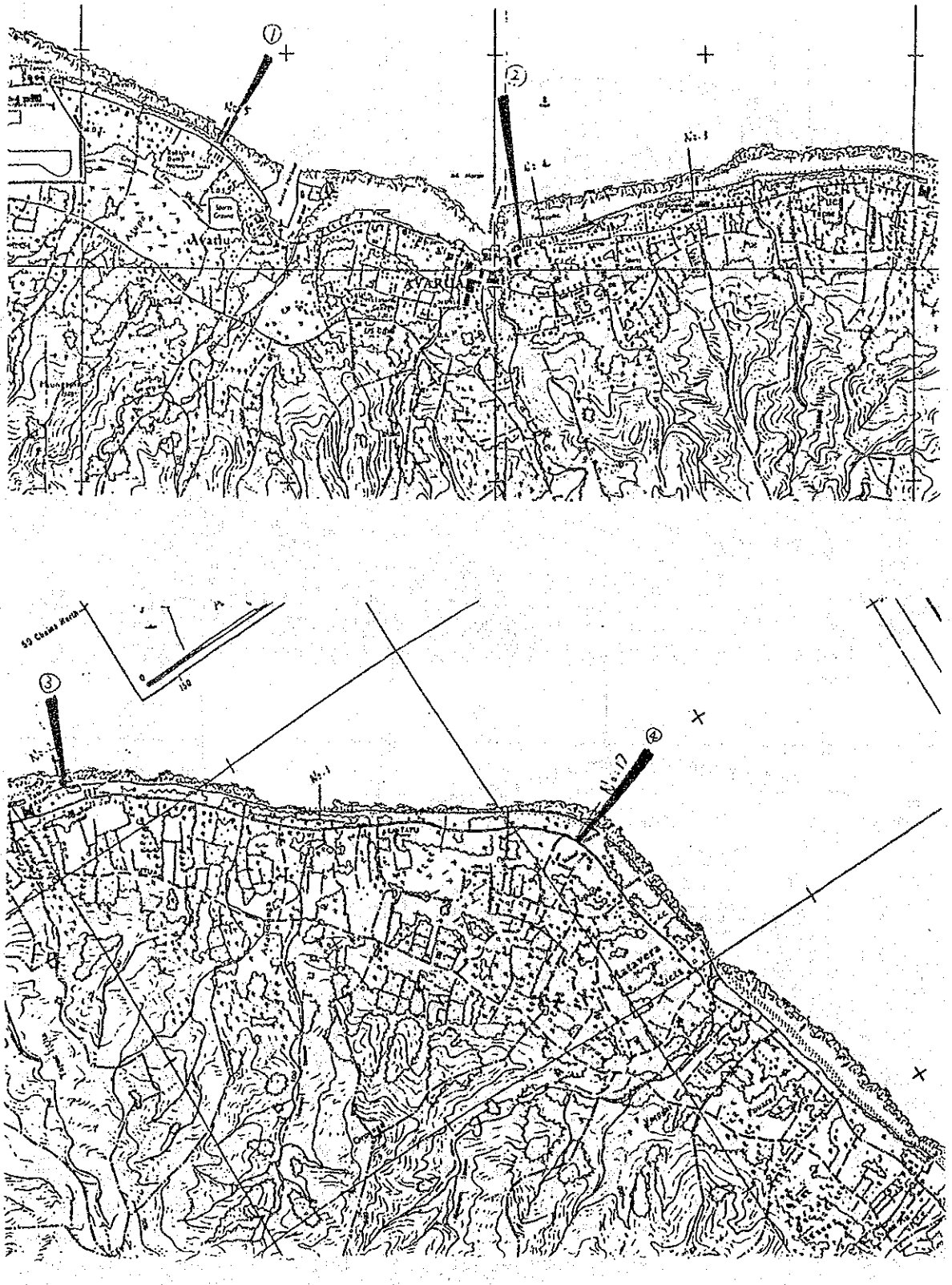
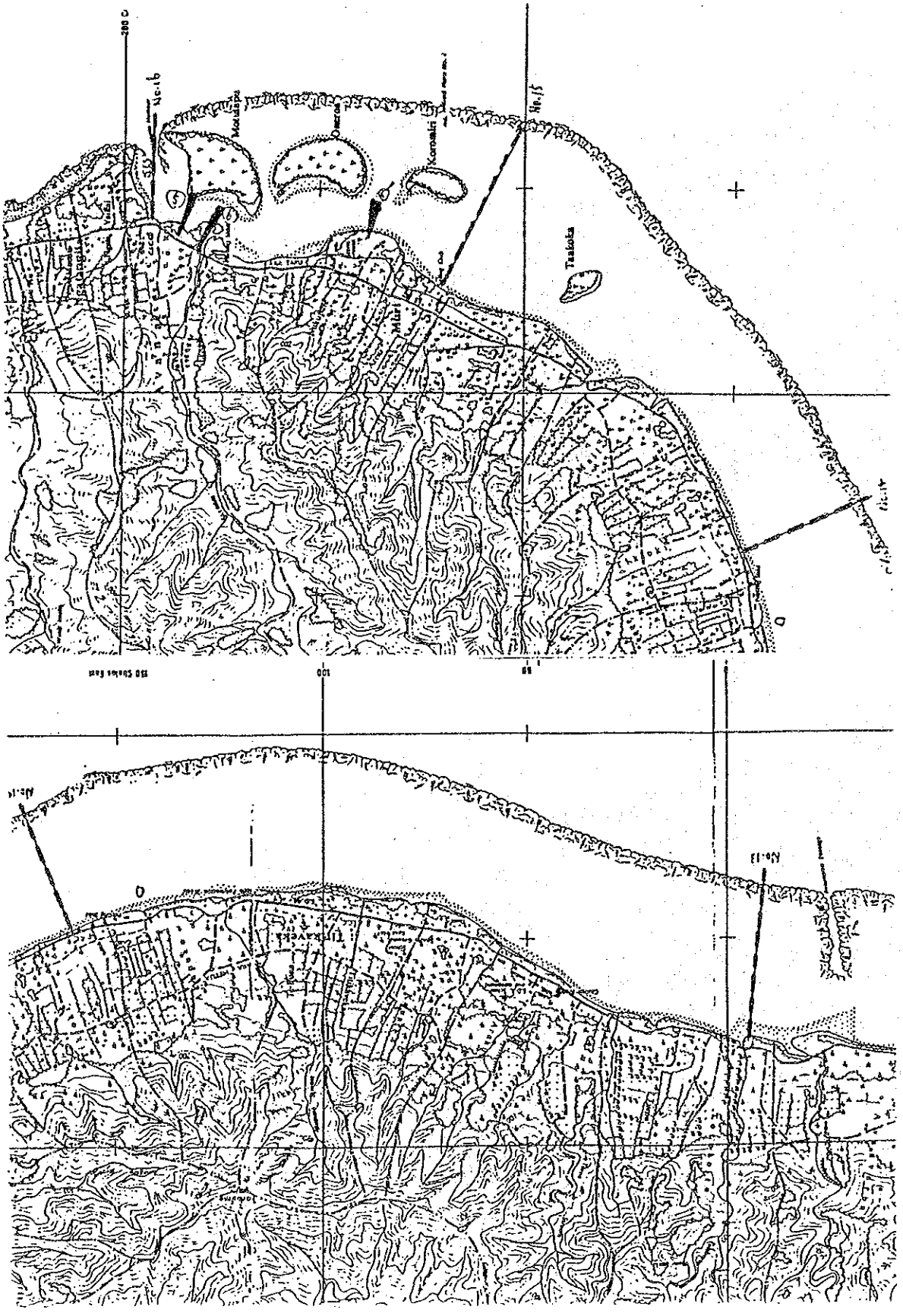
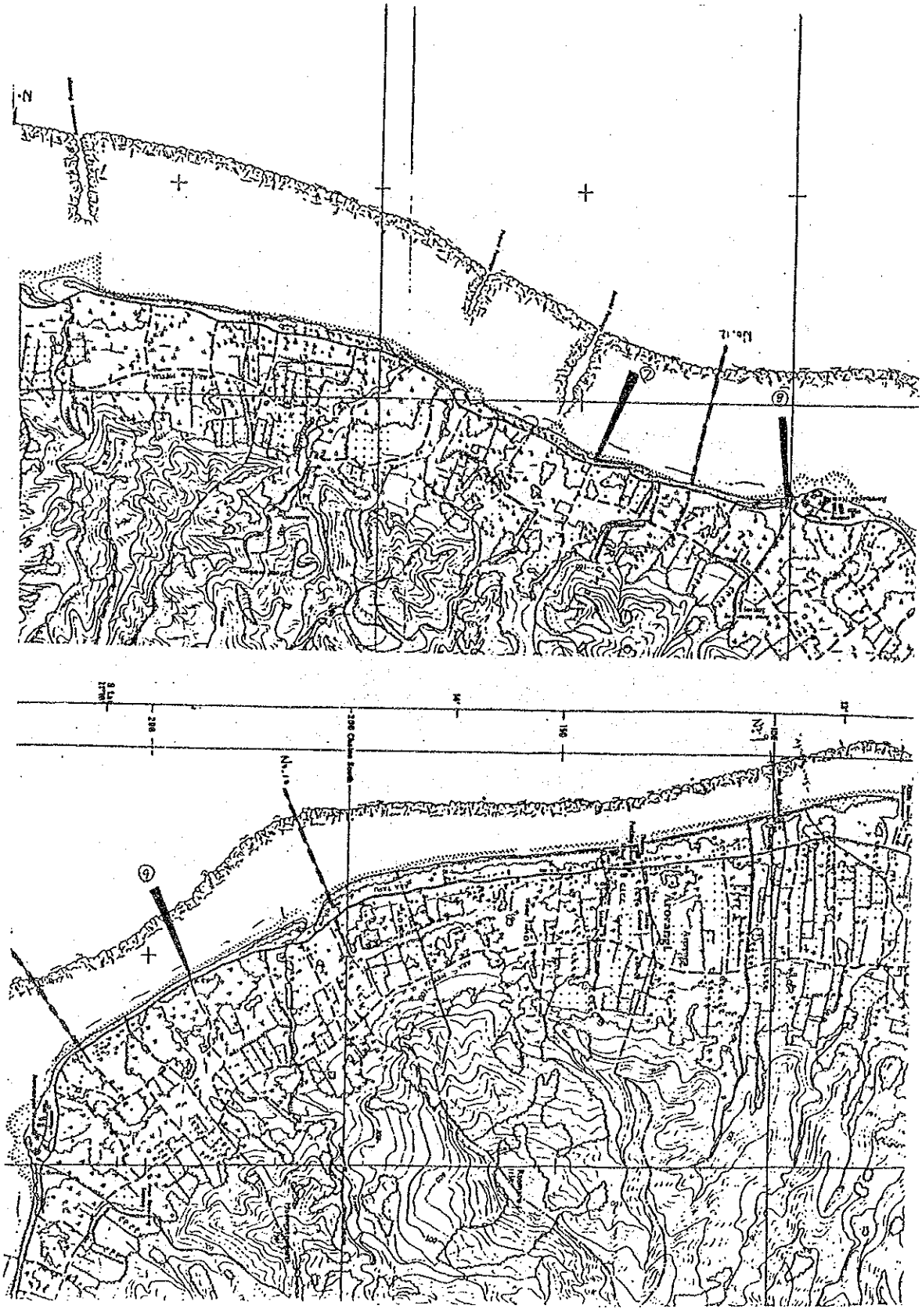
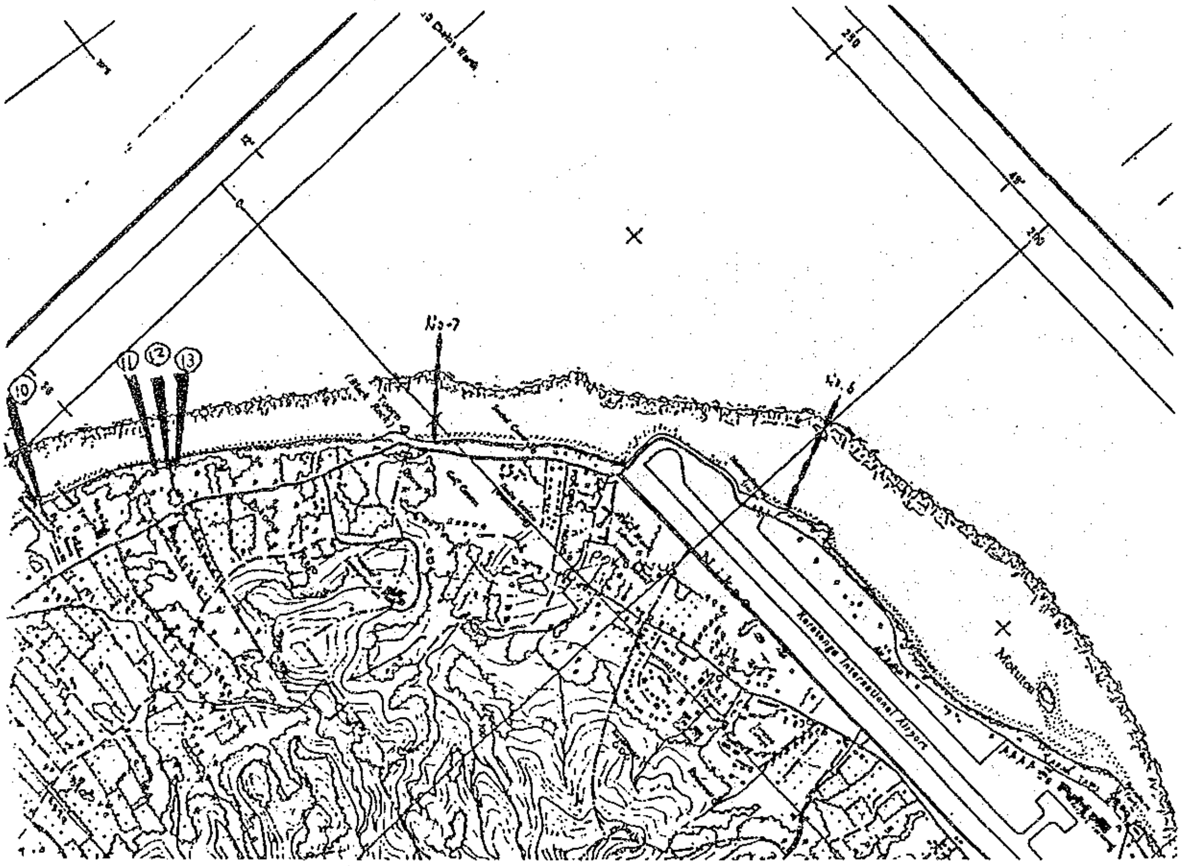


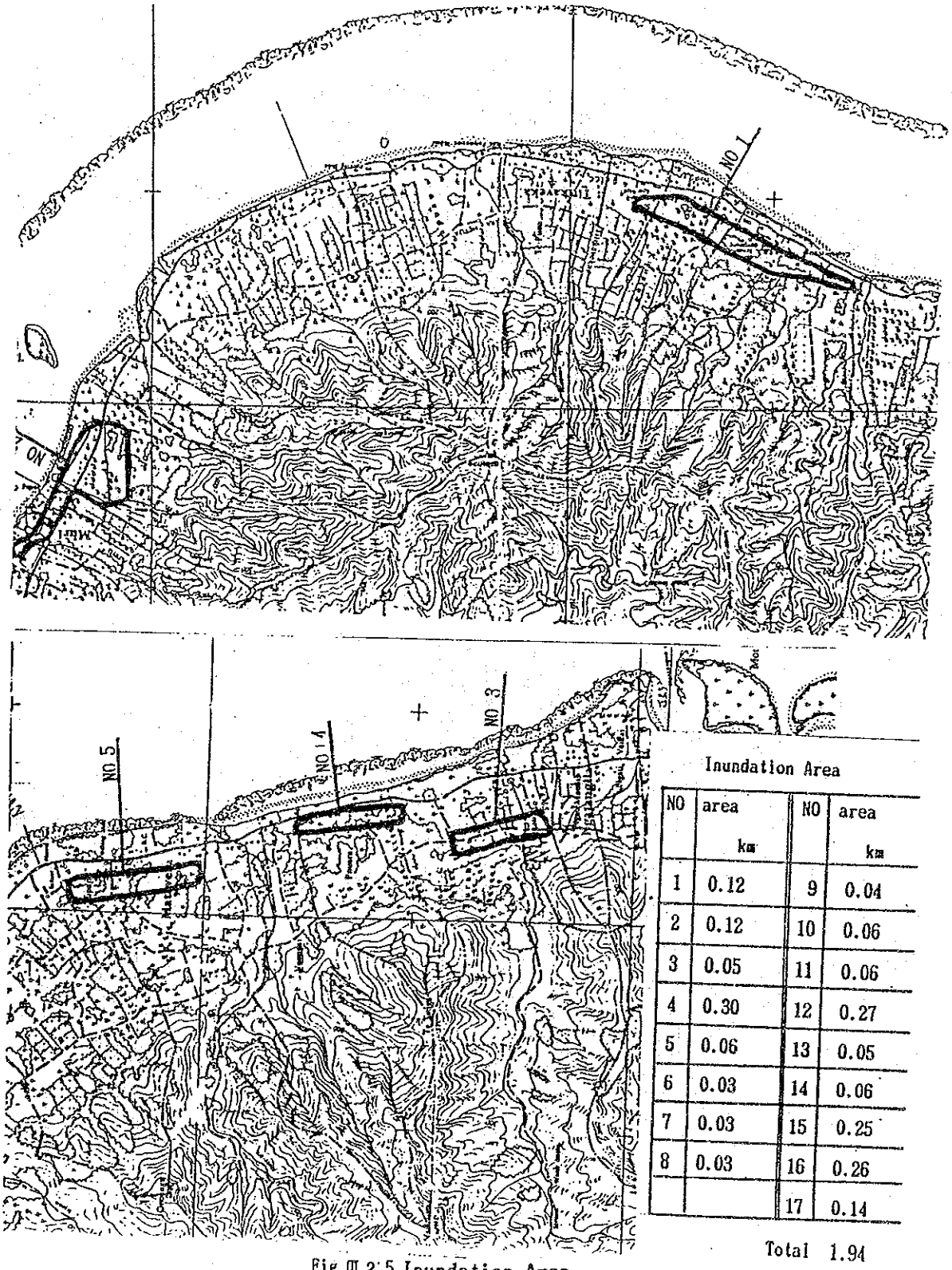
Fig. Ⅲ. 2. 4 Proposed Sites for Coastal Profile Survey


Tsukoka





No.7
⑩
⑪
⑫
⑬
Rarotonga International Airport
Motutoa

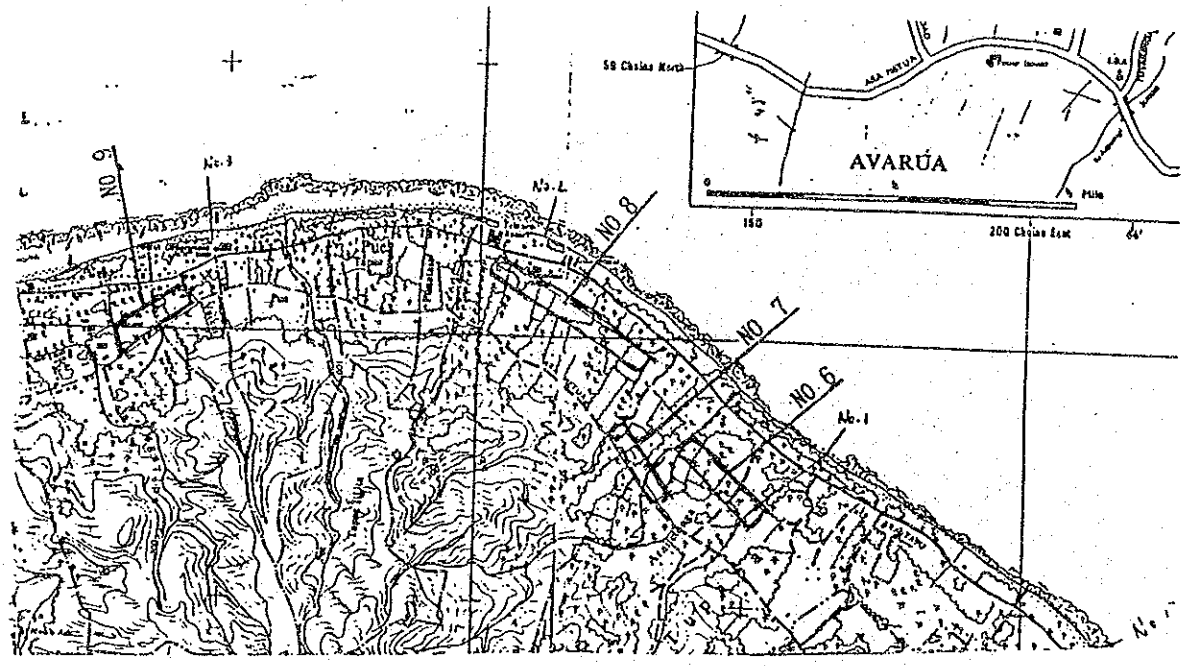


Inundation Area

NO	area km	NO	area km
1	0.12	9	0.04
2	0.12	10	0.06
3	0.05	11	0.06
4	0.30	12	0.27
5	0.06	13	0.05
6	0.03	14	0.06
7	0.03	15	0.25
8	0.03	16	0.26
		17	0.14

Total 1.94

Fig.Ⅲ 2.5 Inundation Area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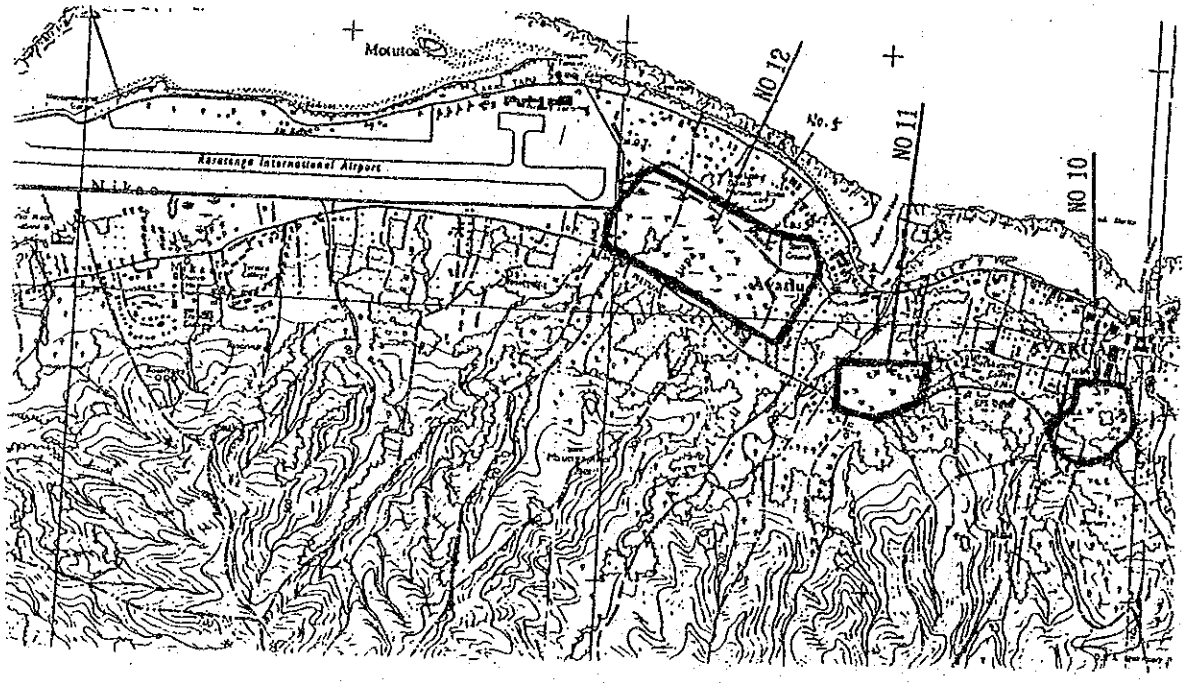
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Rarotonga International Airport
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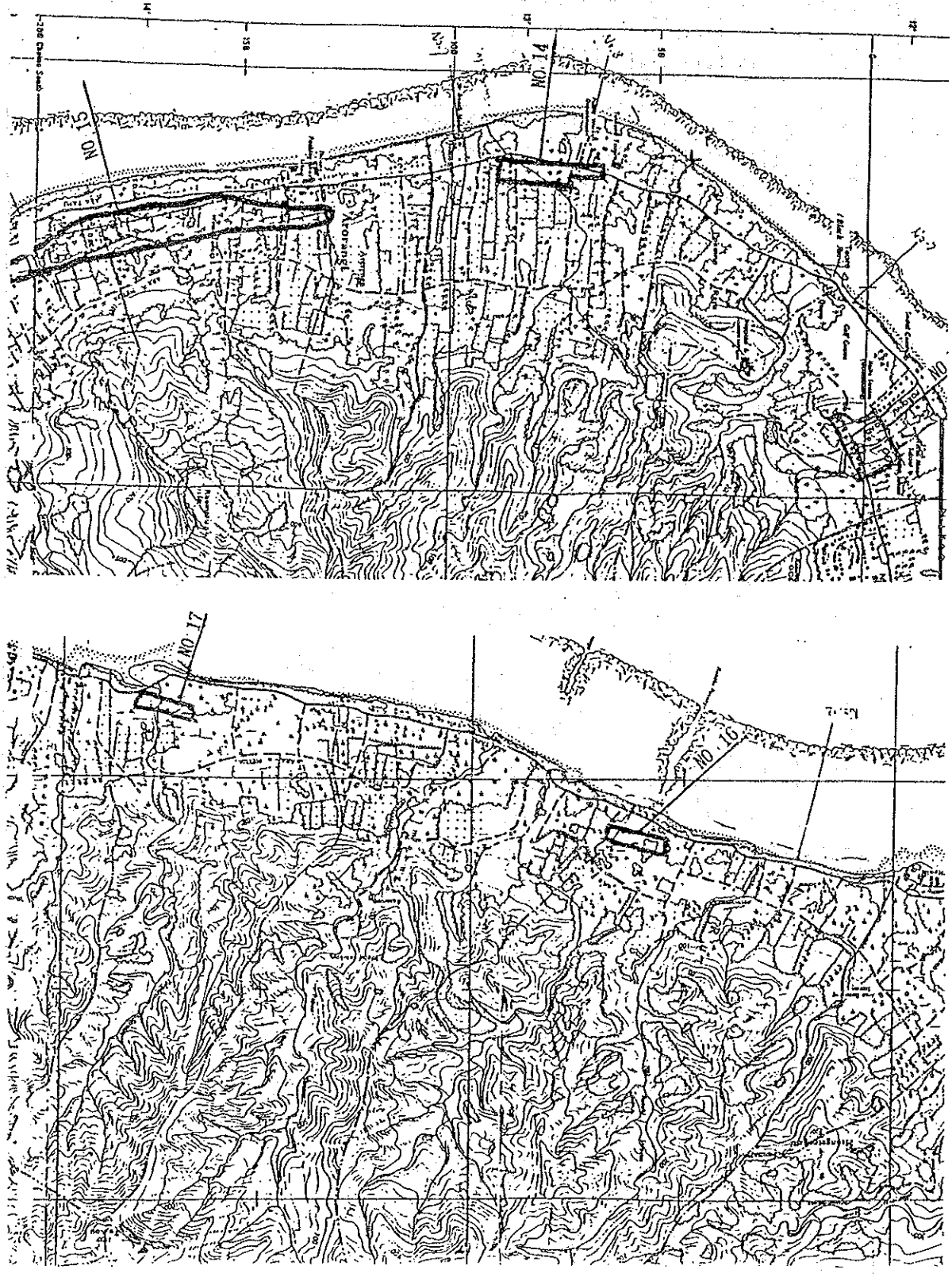
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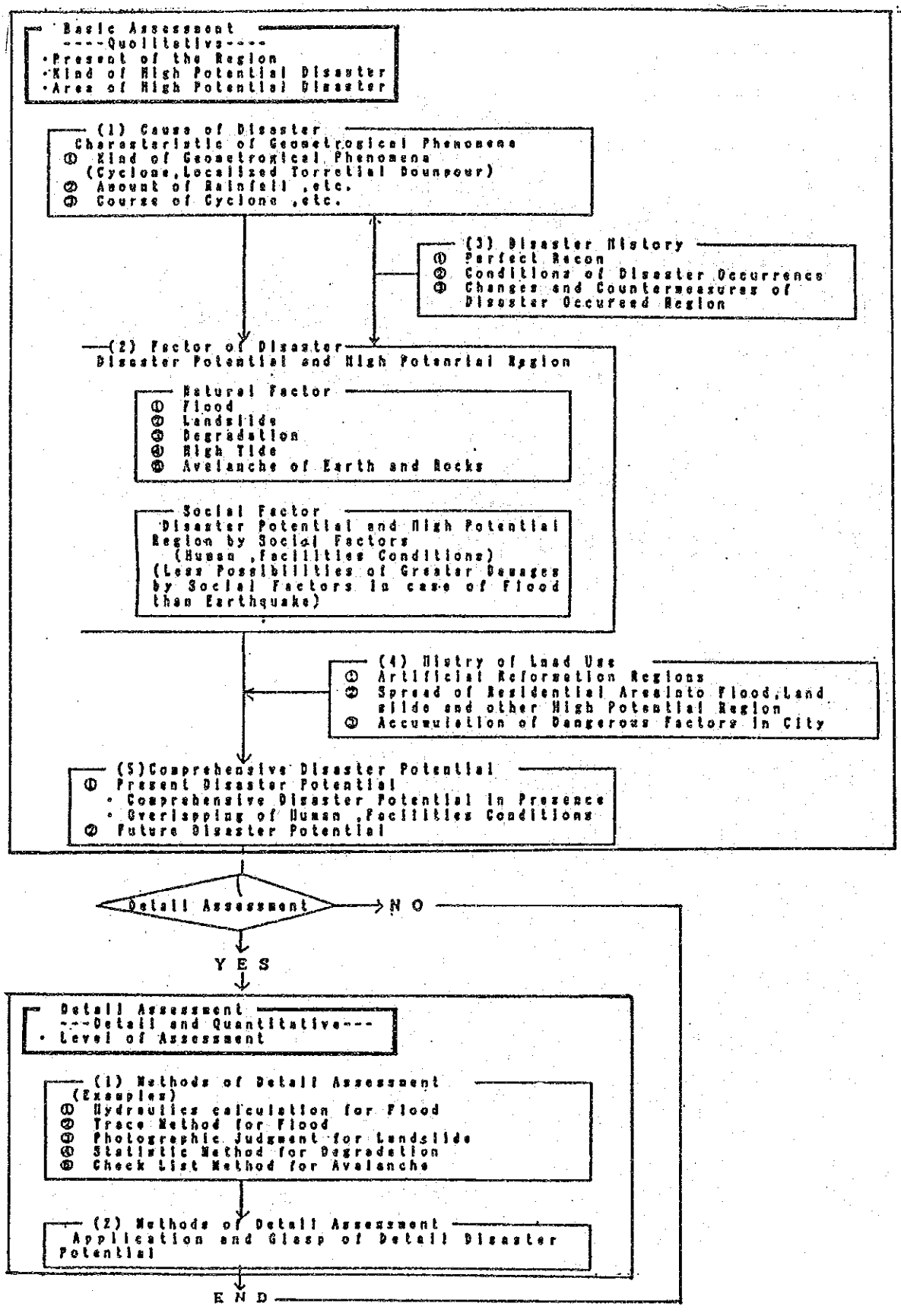

Fig. Ⅲ. 3. 1 Flow Chart of Disaster Assessment