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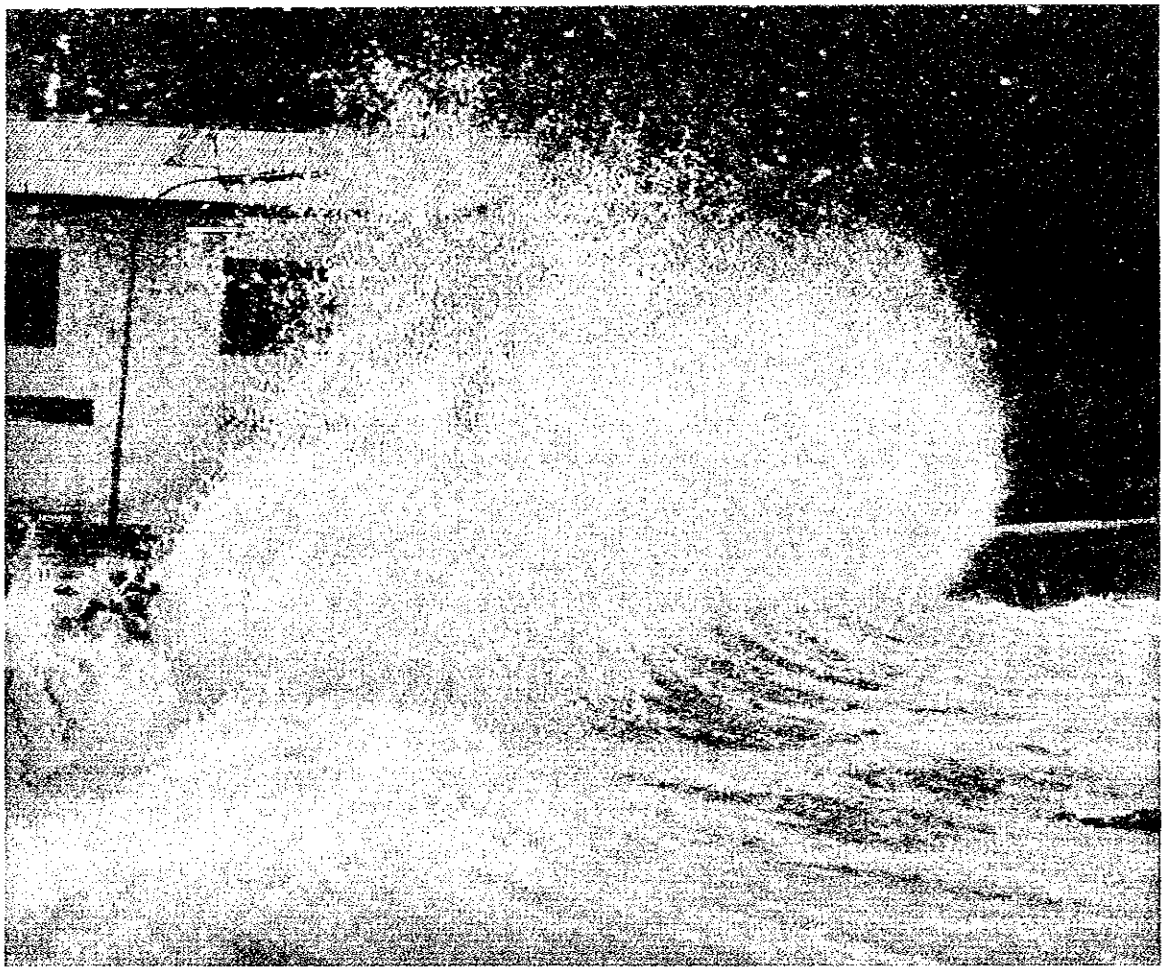
No. 52

THE DEVELOPMENT STUDY ON THE SEAWALL CONSTRUCTION PROJECT FOR MALE' ISLAND IN THE REPUBLIC OF MALDIVES

MAIN REPORT II



DECEMBER 1992

JAPAN INTERNATIONAL COOPERATION AGENCY

THE DEVELOPMENT STUDY
ON
THE SEAWALL CONSTRUCTION PROJECT
FOR
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MAIN REPORT II

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Composition of the Report

This report consists of six volumes as follows;

①	Summary Report	:	Summary
②	Main Report I	:	Report for Male'
③	Main Report II	:	Report for Funadhoo
④	Supporting Report	:	Supplementary Study Report
⑤	Supporting Data I	:	Topo/Hydrographic Maps
⑥	Supporing Data II	:	Oceanographic Survey Data

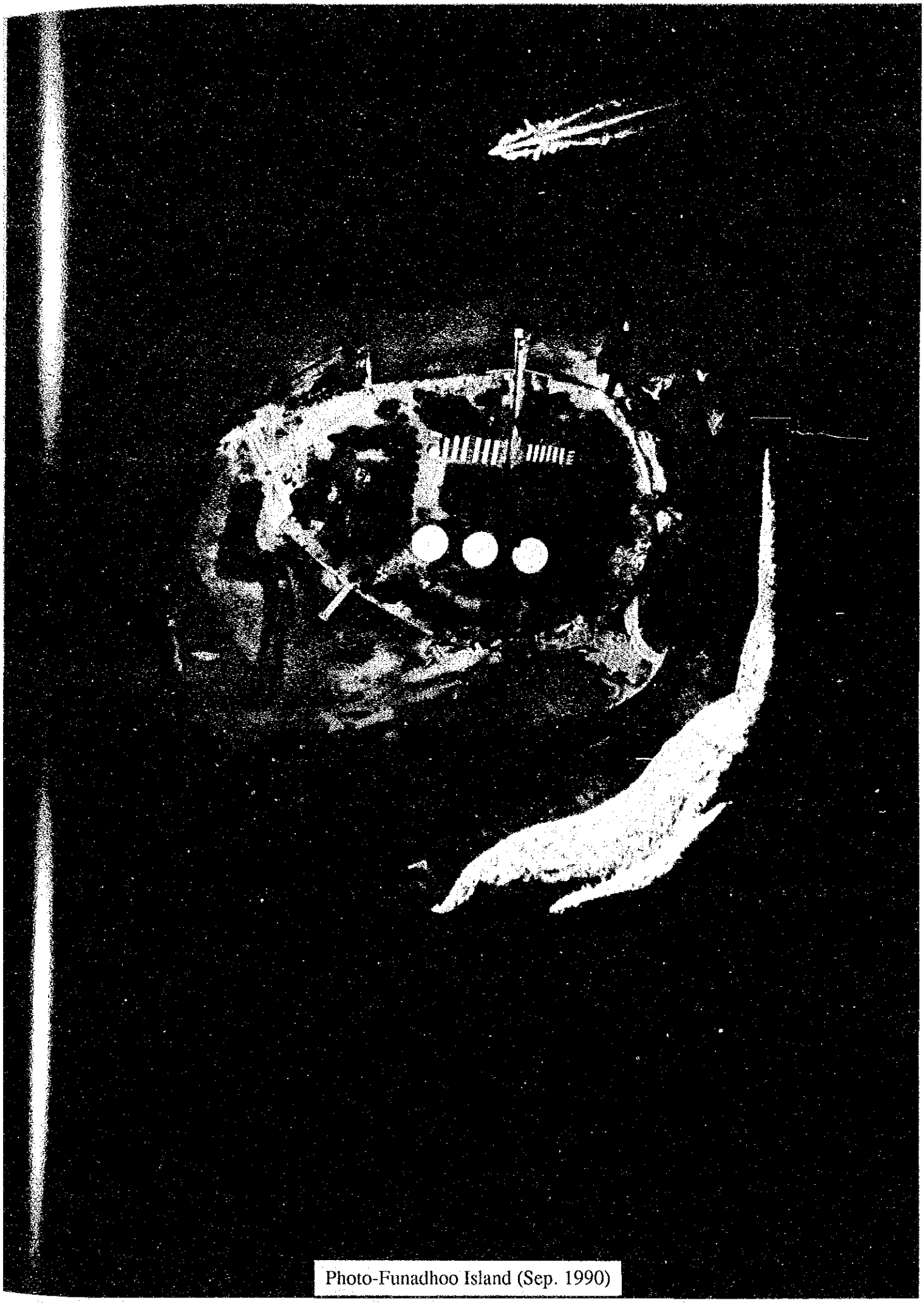

Photo-Funadhoo Island (Sep. 1990)

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1. General

Funadhoo Island is situated at the northern side near Male' Island. Funadhoo Island is very important for import of oil to the Maldives. The port for unloading imported oil is situated at the northern coast of this island, and the southern coast is used as a harbor for boats in connection with Male' and other islands.

The various kinds of shore protection facilities such as seawalls, quaywall and a breakwater are constructed around this island. The structures of the existing shore protection facilities are made of accumulated coral rocks of 10 to 20 cm in diameter with their surface mortared or plastered. Accordingly, these facilities have been damaged seriously by waves, especially on the south east coast.

From the above situation, the Government of Maldives requested a suitable countermeasure plan to arrest further damage to the study team.

2. Shore Protection Plan

2.1 Basic Policy of Planning

The basic policy of planning for the layout of structures is as follows:

(1) The alignment of all facilities, excluding the port facilities on the north coast is set up inside the reef edge or on the existing breakwater line.

(2) The locations of structures are chosen on the flat part of the lagoon so as to secure their foundations.

(3) Considering the disposition, design, material quality of the present structures, solid structures of semi-permanent type are proposed as countermeasure works, while all the damaged existing facilities will be removed.

(4) Taking into account the condition of waves and tides around the island, the shape of the new facilities will be proposed to be almost the same as those in Male' Island.

2.2 Design Conditions

Design conditions at Funadhoo island are decided based on the design conditions at Male' island.

(1) Tide

H.W.L. = D.L. +1.34 m
M.S.L. = D.L. +0.64 m
L.W.L. = D.L. +0.06 m

(2) Design Waves (refer to Figure 2.1)

a) A and B Area
Offshore Waves Ho = 1.2 m, T = 4.6 sec
Waves in front of Seawall: H = 1.2 m, T = 4.6 sec

b) C Area
Offshore Waves Ho = 3.0 m, T = 16 sec
Waves in front of Seawall: H = 1.3 m, T = 16 sec

c) Area
Offshore Waves Ho = 3.0 m, T = 16 sec
Waves in front of Seawall: Ho = 1.7 m, T = 16 sec

(3) The Elevation of Facilities

1) Crown Elevation: D.L. +3.00 m
2) Foundation Elevation: D.L. +0.00 m

2.3 Shore Protection Planning

(1) South and Southeast Coast

a) The harbor area in the south to be extended for the convenience of boat's activities.

b) For the purpose of protecting the harbor area from ocean waves incident from the south east direction, the seawall of the south-east is bent westwards.

c) The front of the vertical wall breakwater is protected by wave dissipation works consisting of concrete armour units, while the slope of seawall inside the harbor is designed to be perpendicular.

(2) West and South West Coast

a) The alignment of seawall in the south-west is bent along the distribution of reef edge as seen in the Figure 2.2.

b) The sandy beach located in the north-west is planned to enable a land reclamation programme with landfill in the future.

(3) East Coast

a) The seawall is arranged curving along the distribution of reef edge.

b) The seawall is planned to enable reclamation with landfill inside the seawall.

(4) The Port Facilities

a) The facilities in the port are the same as those proposed on the north coast of Male' island.

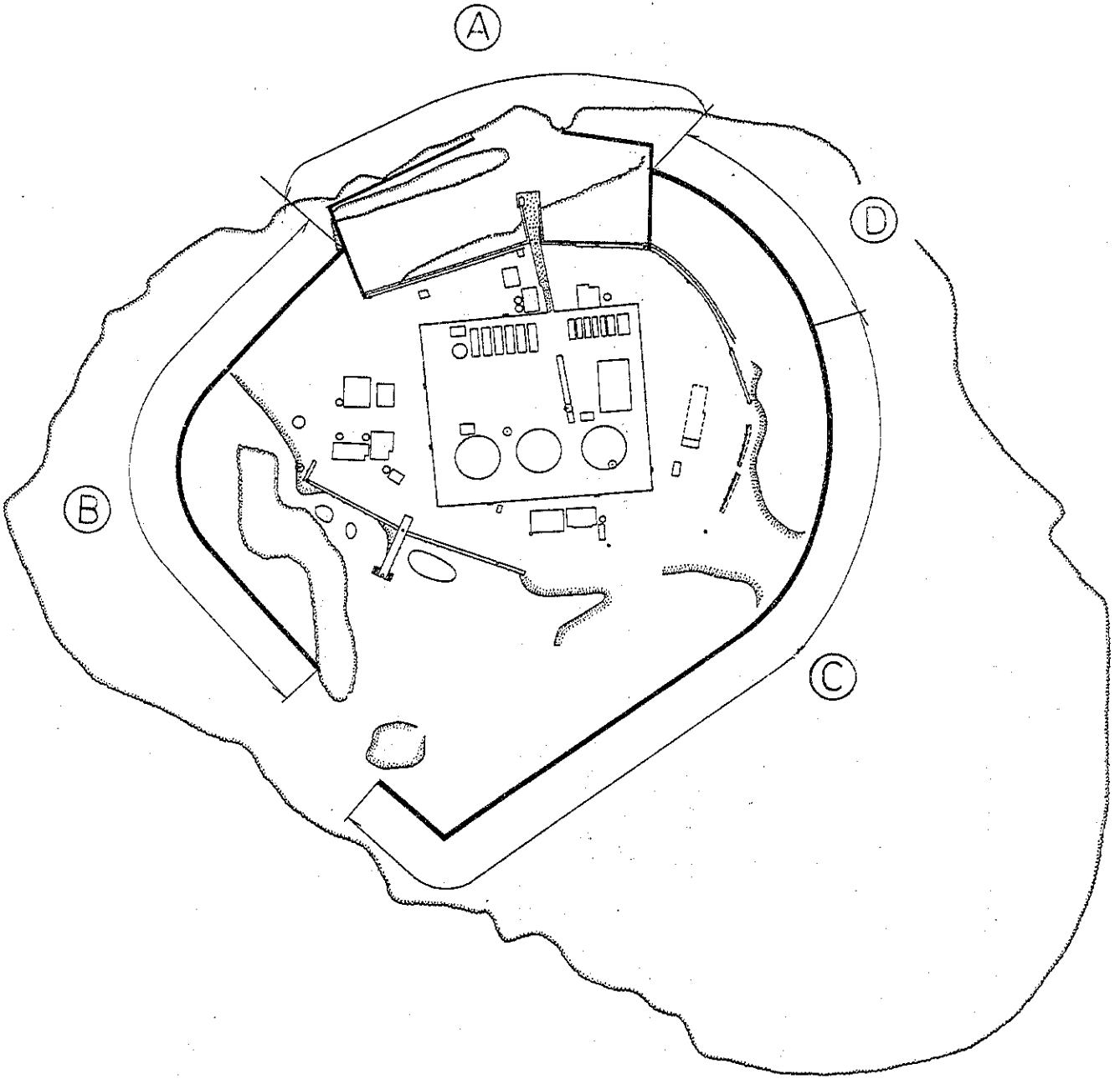


Figure 2.1 Classification of Funadhoo Island

3. Preliminary Design

3.1 Layout Plan

Shore protection facilities to be designed are indicated in Fig. 2.1. The facilities in the north and south harbours area are excluded in this study. The length of the shore protection facilities is tabulated in Table 3.1 and the plan of shore protection facilities are shown in Fig. 3.1.

Table 3.1 Total Length of Shore Protection Facilities

Coast	Sector	Length (m)
North	Breakwater	151
	Quaywall	61
East	Seawall	254
South	East Breakwater	215
	West Breakwater	167
West	Breakwater	79
Total		927

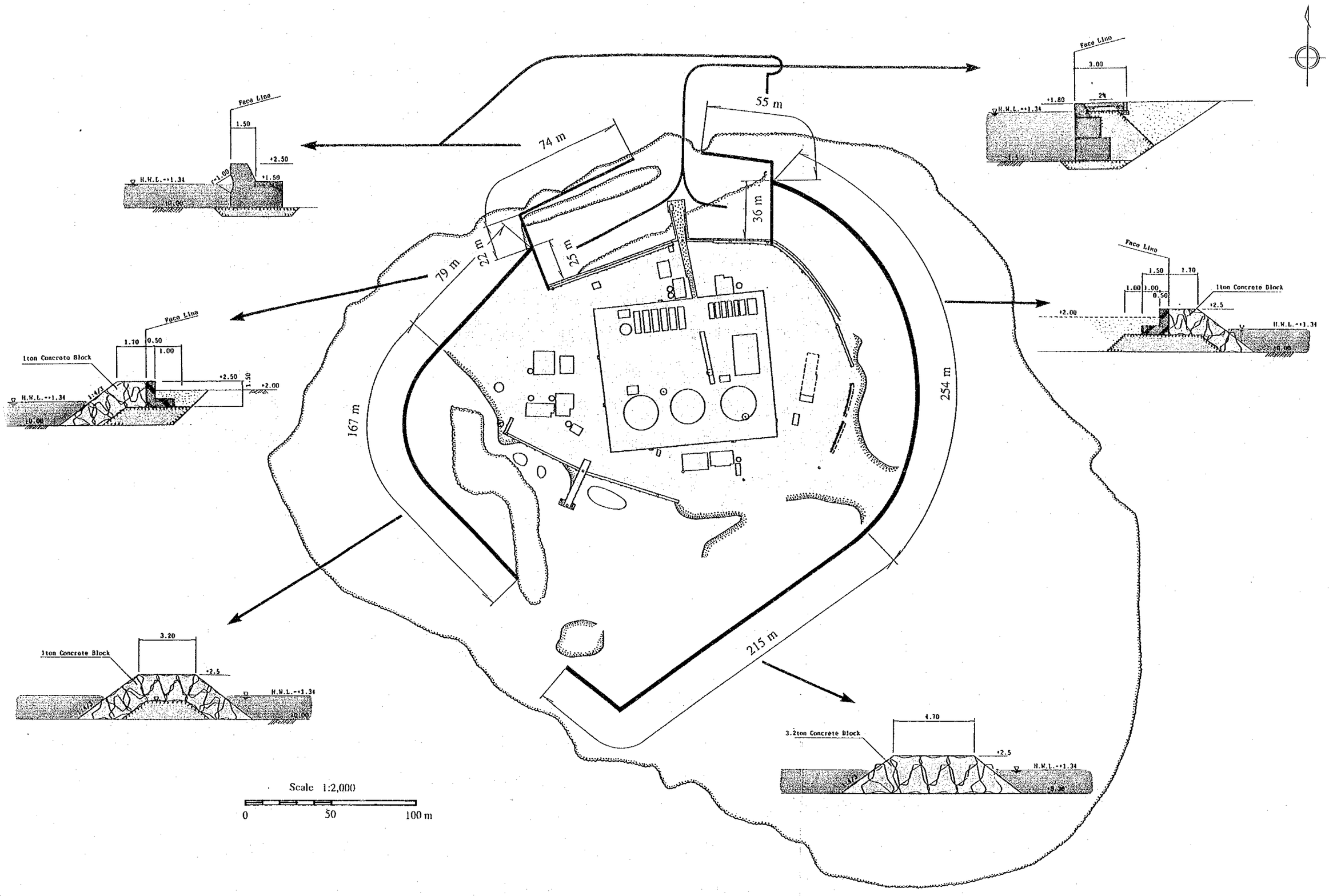


Figure 3.1 Plan of Shore Protection Facilities

3.2 Shore Protection Facilities

Based on the results described in the previous paragraph and the Main Report I, the proposed facilities are shown in Figs. 3.2 to 3.7.

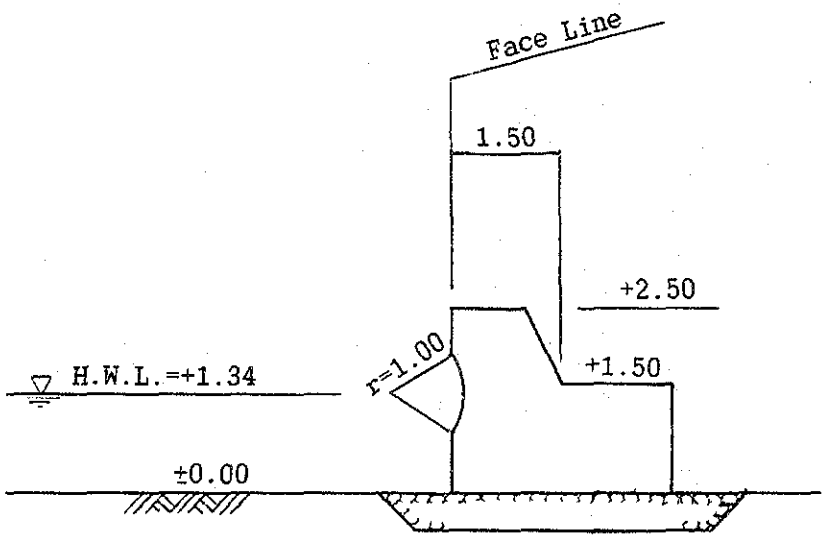


Figure 3.2 Typical Section of North Coast : Breakwater (S=1:100)

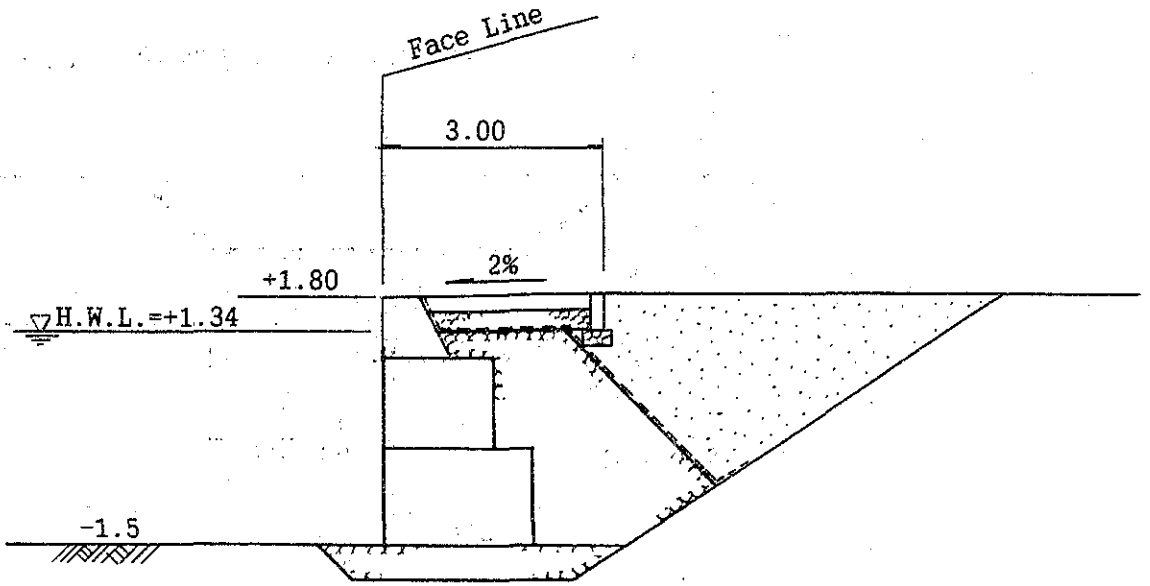


Figure 3.3 Typical Section of North Coast : Quaywall (S=1:100)

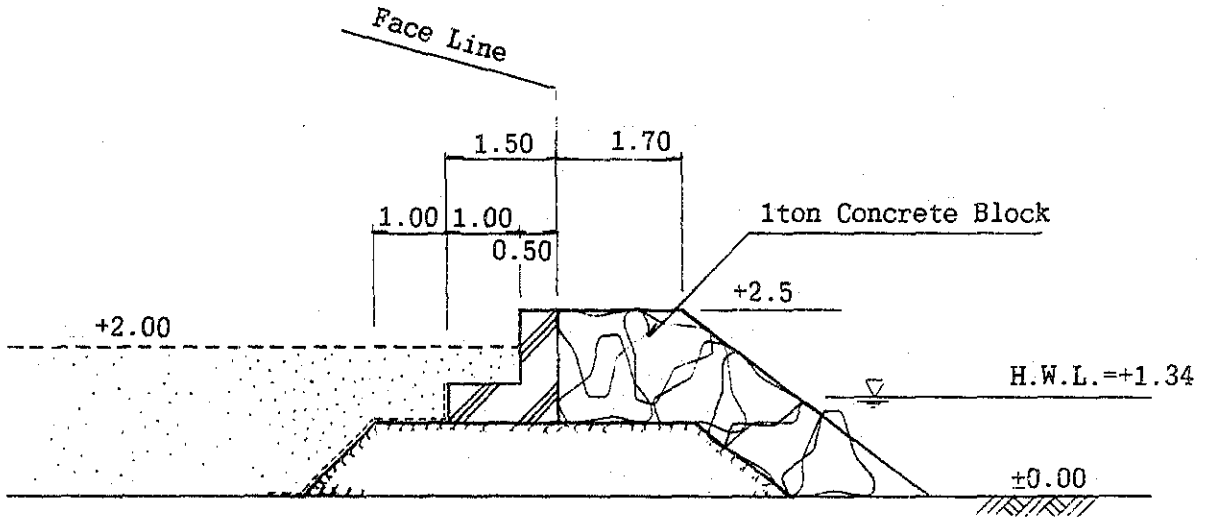


Figure 3.4 Typical Section of East Coast : Seawall (S=1:100)

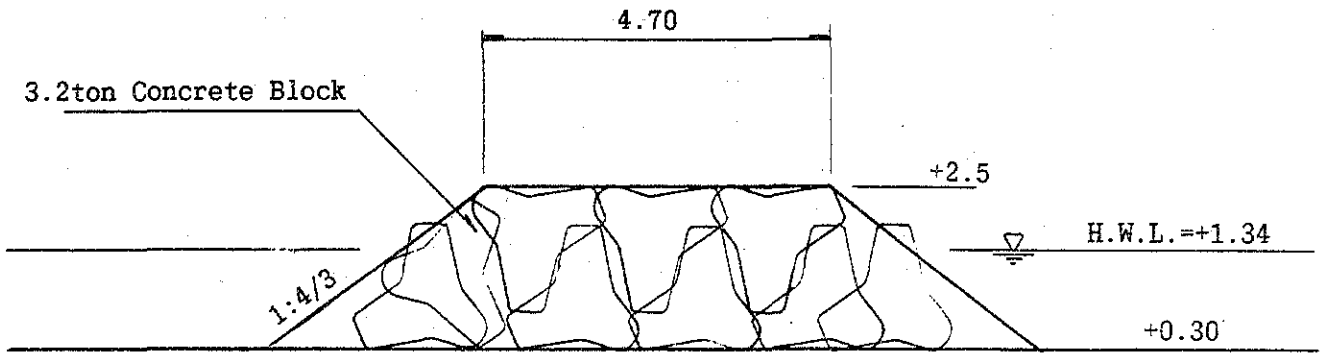


Figure 3.5 Typical Section of South Coast : East Breakwater (S=1:100)

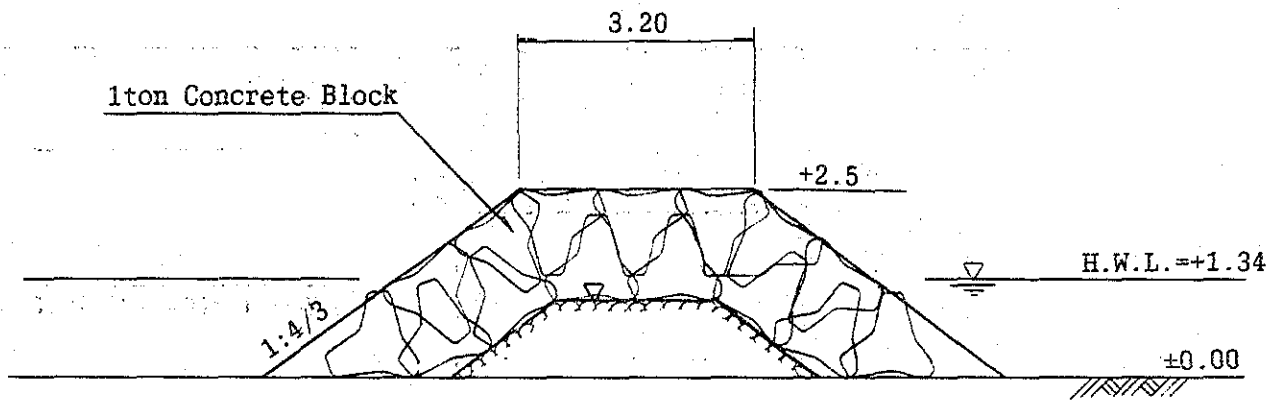


Figure 3.6 Typical Section of South Coast : West Breakwater(S=1:100)

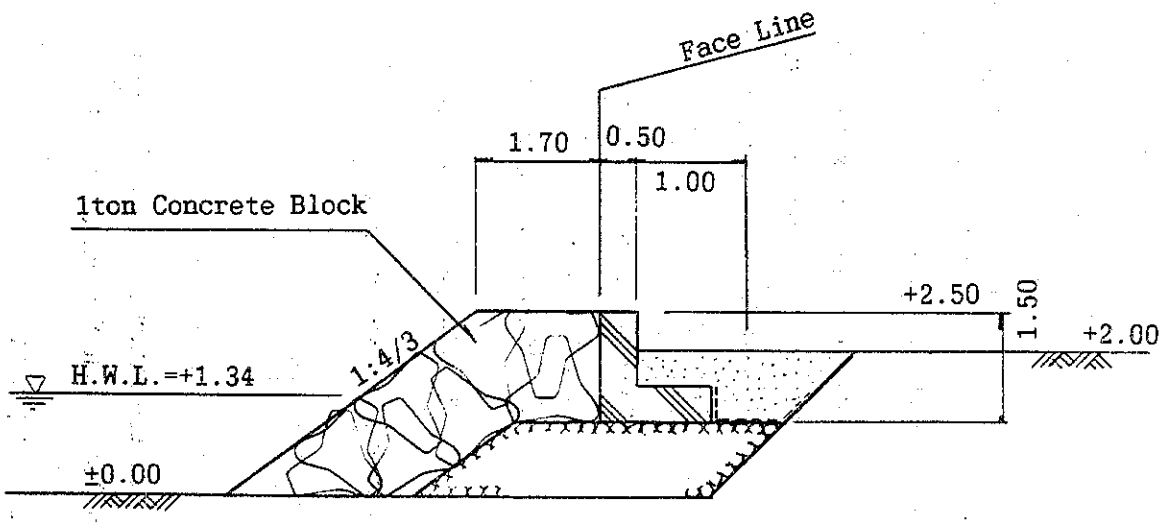


Figure 3.7 Typical Section of West Coast : Breakwater (S=1:100)

4. Cost Estimates

Project cost for each coast in Funadhoo Island is summarized in Table 4.1 based on the shore protection facilities explained in the previous chapter. The unit cost for each facility is shown in Table 4.2 to 4.7. The project cost is estimated by dividing into the following items.

(1) Direct Construction Cost : based on the unit prices as of December 1991, direct construction cost was calculated with the shore of foreign currency and local currency portions.

(2) Indirect Construction Cost : Indirect cost is estimated at 55 % of the Direct Construction Cost.

(3) Engineering Services : Cost for engineering services is divided into two stages, namely detailed design and construction supervision. The cost for each stage is estimated at 2 % and 7 % of (1) + (2) above respectively.

(4) Physical Contingency : Physical contingency is divided into two parts; one is for construction, 10 % of (1) + (2) above, and the other is for Engineering services, 5 % of (3) above.

(5) Price Escalation : Price escalation is excluded.

The estimate was based on the following conditions:

(1) Exemption from taxation and duties

(2) Exchange Rate

The exchange rate for cost estimation is computed at an average of daily TTS rate during six months from March 16 to September 15, 1992.

1 US$ = ¥129.53
1 MRf = ¥11.99

Table 4.1 COST ESTIMATE/F

Funadhoo Island 8.10.92

Work Item			Unit	Quantity	Japanese Yen Equivalent Jpn (¥)	
					Unit Price	Amount
CONSTRUCTION COST						
1. Direct Construction Cost						426,056,632
	North Coast	Breakwater	l.m.	151.00	502,945	75,944,695
	-do-	Quaywall	l.m.	61.00	565,172	34,475,492
	East Coast	Seawall	l.m.	254.00	446,104	113,310,416
	South Coast	East B/W	l.m.	215.00	721,896	155,207,640
	-do-	West B/W	l.m.	167.00	69,944	11,680,648
	West Coast	Breakwater	l.m.	79.00	448,579	35,437,741
2. Indirect Cost				55%		234,331,148
3. Total Construction Cost						660,387,780
ENGINEERING SERVICES						59,434,900
1. Detailed Design				2%		13,207,756
2. Supervision				7%		46,227,145
CONTINGENCY	Construction			10%		66,038,778
	Engineering Services			5%		2,971,745
TOTAL PROJECT COST						788,833,203

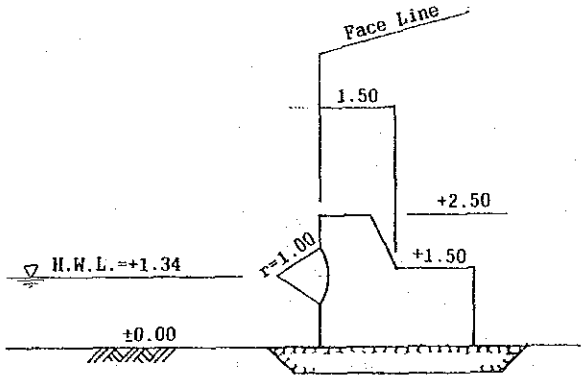


Table 4.2 Unit Cost of North Coast : Breakwater

DIRECT CONSTRUCTION COST (per linear meter)						
North Breakwater (Concrete Block Type)				10/8/92	Unit : JPN Yen	
WORK ITEM	SIZE/SPEC.	UNIT	QUANTITY	UNIT PRICE	AMOUNT	REMARKS
Cast-in-situ Concrete		c.m.	0.00	0	0	
Formwork		s.m.	0.00	0	0	
Joint Filling		s.m.	0.00	0	0	
Precast Concrete Block		no.	1.00	275,938	275,938	
	Transpo/Installation	no.	1.00	78,884	78,884	
Rubble Stone		c.m.	2.25	23,400	52,650	
Levelling		s.m.	5.00	13,422	67,110	
Back Filling		c.m.			0	
Levelling		s.m.			0	
Reclamation		c.m.			0	
Geotextile Sheet		s.m.			0	
Excavation		c.m.	2.25	3,074	6,917	
Pavement		s.m.			0	
Demobilization of Exist. Structure		L.S.	1.00	21,446	21,446	
TOTAL					502,945	

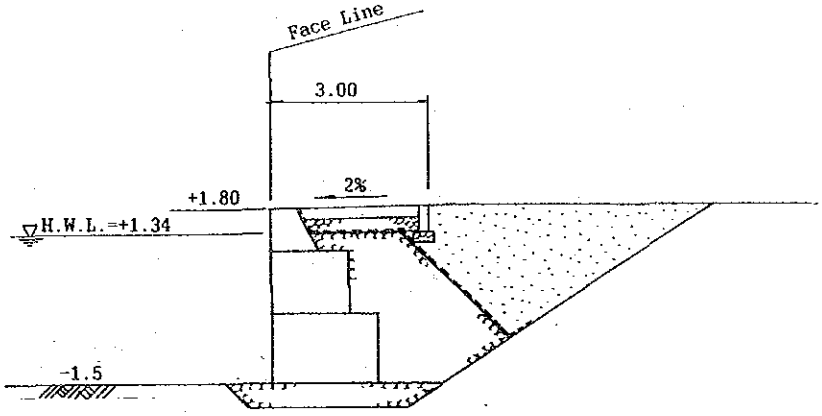


Table 4.3 Unit Cost of North Coast : Quaywall

DIRECT CONSTRUCTION COST (per linear meter)						
Quaywall (F)				10/8/92	Unit : JPN Yen	
WORK ITEM	SIZE/SPEC.	UNIT	QUANTITY	UNIT PRICE	AMOUNT	REMARKS
Cast-in-situ Concrete		c.m.	0.96	43,623	41,878	Coping
Formwork		s.m.	2.73	2,837	7,751	
Joint Filling		s.m.	0.19	2,875	552	
Precast Concrete Block		no.	0.00	0	0	
Fabrication	1.5*1.25*2.0	no.	0.50	180,511	90,256	
Transportation/Installation		no.	0.50	22,733	11,367	
Fabrication	2.0*1.25*2.0	no.	0.50	236,696	118,348	
Transportation/Installation		no.	0.50	22,733	11,367	
Rubble Stone		c.m.	1.81	21,893	39,626	
Levelling		s.m.	2.50	13,422	33,555	
Back Filling		c.m.	5.48	21,893	119,974	
Levelling		s.m.			0	
Reclamation		c.m.	5.41	909	4,918	
Geotextile Sheet		s.m.	5.71	2,291	13,082	
Excavation		c.m.	3.90	2,239	8,732	
Pavement		s.m.	2.50	18,927	47,318	
Demobilization of Exist. Structure		L.S.	1.00	16,451	16,451	
TOTAL					565,172	

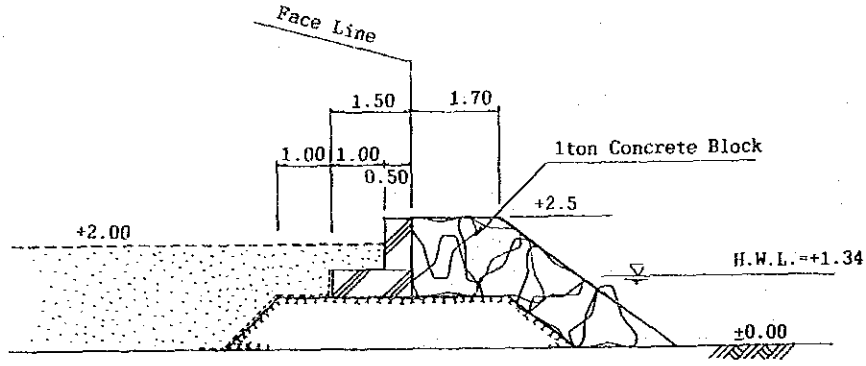


Table 4.4 Unit Cost of East Coast : Seawall

DIRECT CONSTRUCTION COST (per linear meter)						
East Seawall (F)				10/8/92	Unit : JPN Yen	
WORK ITEM	SIZE/SPEC.	UNIT	QUANTITY	UNIT PRICE	AMOUNT	REMARKS
Cast-in-situ Concrete		c.m.	1.25	43,623	54,529	Coping
Formwork		s.m.	3.25	2,837	9,220	
Re-bar		ton	0.06	99,810	6,238	
Joint Filling		s.m.	0.25	2,875	719	
Precast Concrete Block	1 ton Tetrapod	no.	8.20	32,573	267,099	
		no.				
		no.				
Rubble Stone		c.m.	4.87	21,893	106,619	
Levelling		s.m.	4.16	404	1,681	
Back Filling		c.m.				
Levelling		s.m.				
Reclamation		c.m.				
Geotextile Sheet		s.m.				
Excavation		c.m.				
Pavement		s.m.				
Demobilization of Exist. Structure		L.S.				
TOTAL		l.m.			446,104	

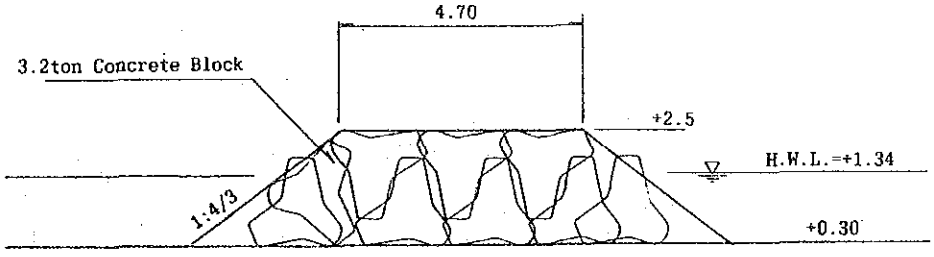


Table 4.5 Unit Cost of South Coast : East Breakwater

DIRECT CONSTRUCTION COST (per linear meter)						
South East Breakwater				10/8/92	Unit : Jpn Yen	
WORK ITEM	SIZE/SPEC.	UNIT	QUANTITY	UNIT PRICE	AMOUNT	REMARKS
Cast-in-situ Concrete		c.m.			0	
Precast Concrete Block	3.2 ton Tetrapod	no.	6.72	104,234	700,450	
Rubble Stone		c.m.			0	
Levelling		s.m.			0	
Back Filling		c.m.			0	
Levelling		s.m.			0	
Reclamation		c.m.			0	
Geotextile Sheet		s.m.			0	
Excavation		c.m.			0	
Pavement		s.m.			0	
Demobilization of Exist. Structure		L.S.	1.00	21,446	21,446	
TOTAL					721,896	

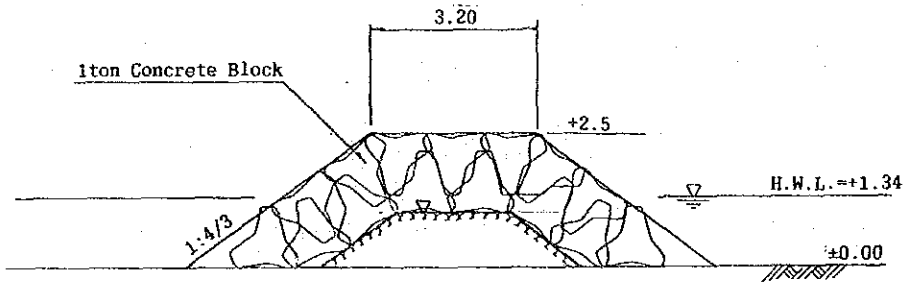


Table 4.6 Unit Cost of South Coast : West Breakwater

DIRECT CONSTRUCTION COST (per linear meter)						
South West Breakwater				10/8/92	Unit : Jpn Yen	
WORK ITEM	SIZE/SPEC.	UNIT	QUANTITY	UNIT PRICE	AMOUNT	REMARKS
Cast-in-situ Concrete		c.m.			0	
Precast Concrete Block	1 ton Tetrapod	no.	16.00	32,573	521,168	
Rubble Stone		c.m.	3.53	23,400	82,602	
Levelling		s.m.	5.53	13,422	74,224	
Back Filling		c.m.			0	
Levelling		s.m.			0	
Reclamation		c.m.			0	
Geotextile Sheet		s.m.			0	
Excavation		c.m.			0	
Pavement		s.m.			0	
Demobilization of Exist. Structure		L.S.	1.00	21,446	21,446	
TOTAL					699,440	

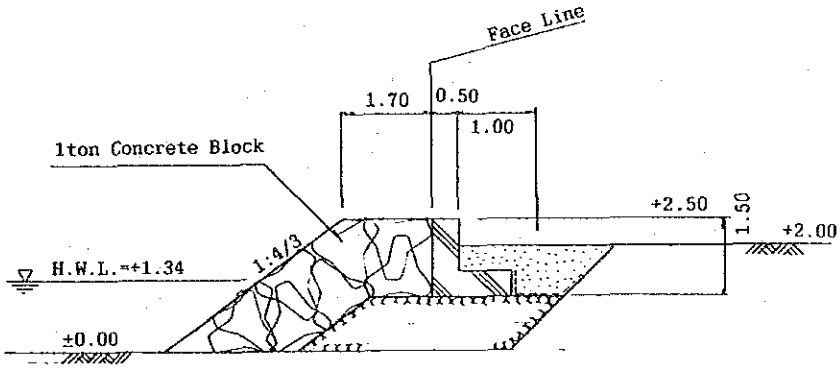


Table 4.7 Unit Cost of West Coast : Breakwater

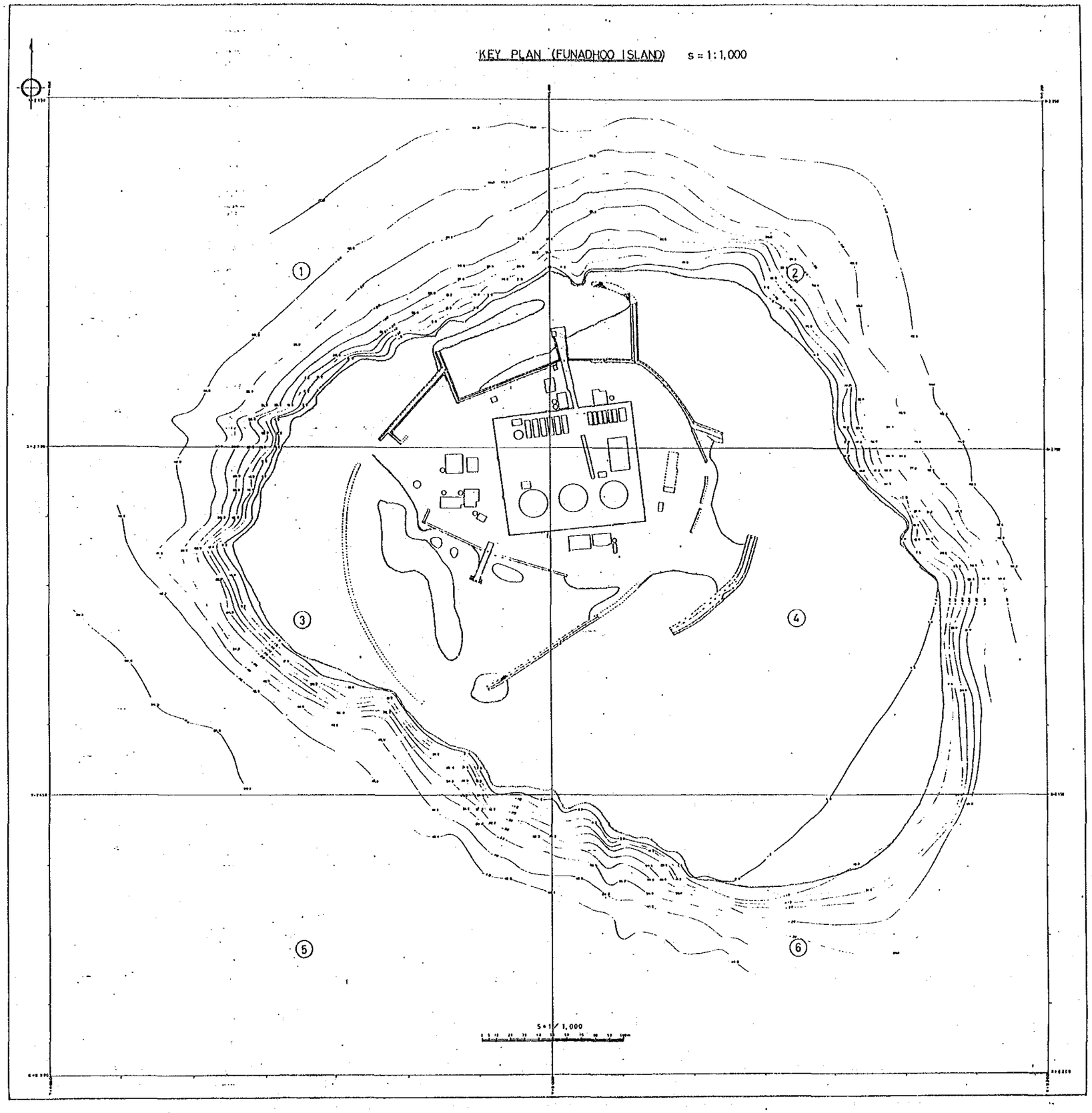
DIRECT CONSTRUCTION COST (per linear meter)						
West Seawall				10/8/92	Unit : JPN Yen	
WORK ITEM	SIZE/SPEC.	UNIT	QUANTITY	UNIT PRICE	AMOUNT	REMARKS
Cast-in-situ Concrete		c.m.	1.25	43,623	54,529	
Formwork		s.m.	3.25	2,837	9,220	
Re-bar		ton	0.06	99,810	6,238	
Joint Filling		s.m.	0.25	2,875	719	
Precast Concrete Block	1 ton Tetrapod	no.	8.20	32,573	267,099	
		c.m.	0.00	0	0	
		no.	0.00	0	0	
Rubble Stone		c.m.	3.87	21,893	84,726	
Levelling		s.m.	5.87	404	2,371	
Back Filling		c.m.	2.00	924	1,848	
Levelling		s.m.	2.00	404	808	
Reclamation		c.m.			0	
Geotextile Sheet		s.m.	2.00	2,285	4,570	
Excavation		c.m.		0	0	
Pavement		s.m.		0	0	
Demobilization of Exist. Structure		L.S.	1.00	16,451	16,451	
TOTAL		l.m.			448,579	

5. Topographic and Bathymetric Survey Maps

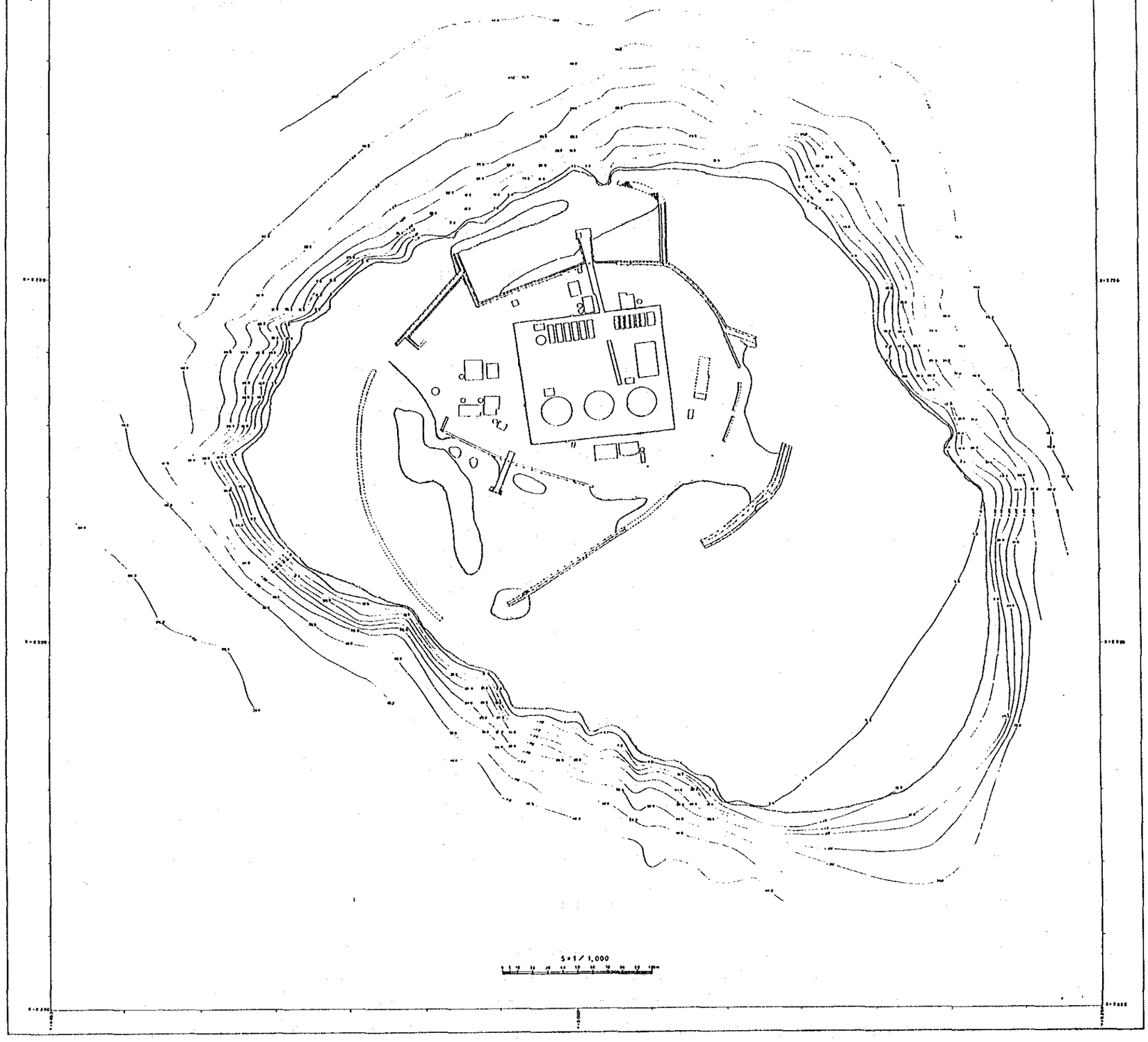
Funadhoo Island

	Original Scale	Reduced Scale	
- Key Plan	1/1,000	(1/2,857)	
- General Map	1/1,000	(1/2,857)	
- Path of Soundings	1/1,000	(1/2,857)	
- Bathymetric Maps	1/500	(1/1,000)	No. 1-------No. 6
- Cross Sections	V = 1/100	(1/200)	
	H = 1/500	(1/1,000)	
			No. N-1
			No. E-1
			No. S-1-------No. S-3
			No. W-1

KEY PLAN (FUNADHOO ISLAND) S = 1:1,000



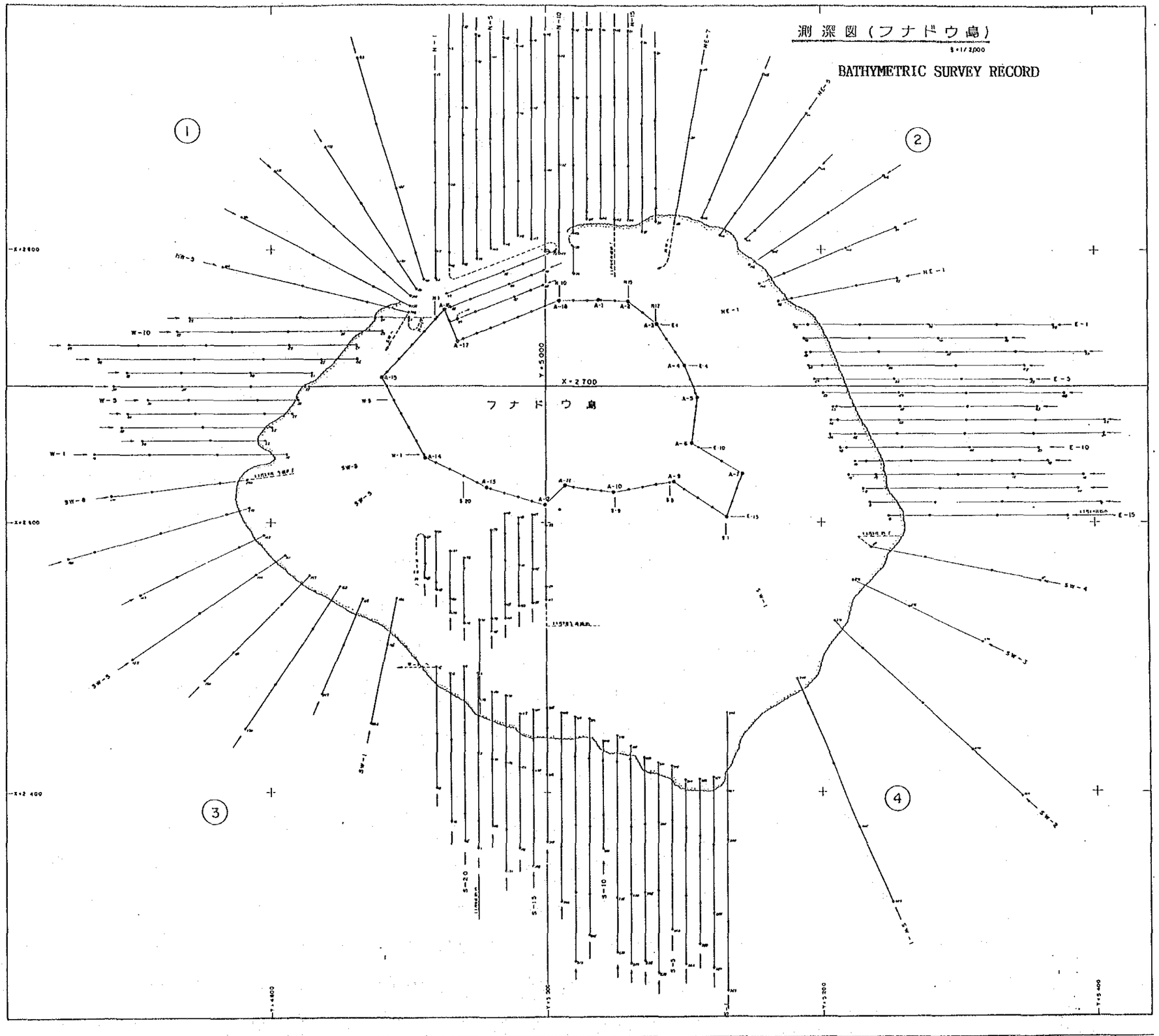
GENERAL MAP OF FUNADHOO ISLAND S = 1:1,000



測深図（フナドウ島）

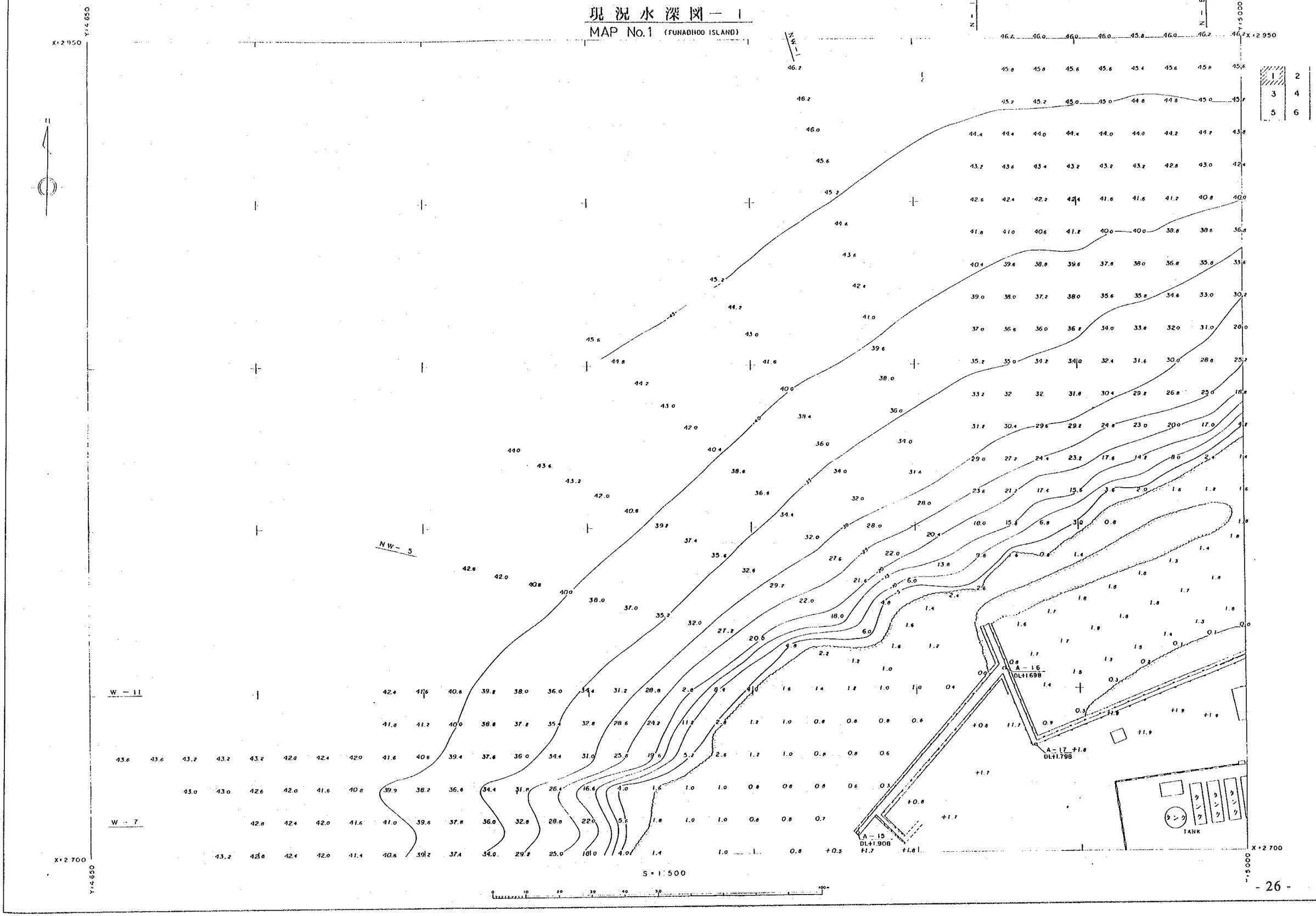
S＝1/2,000

BATHYMETRIC SURVEY RECORD



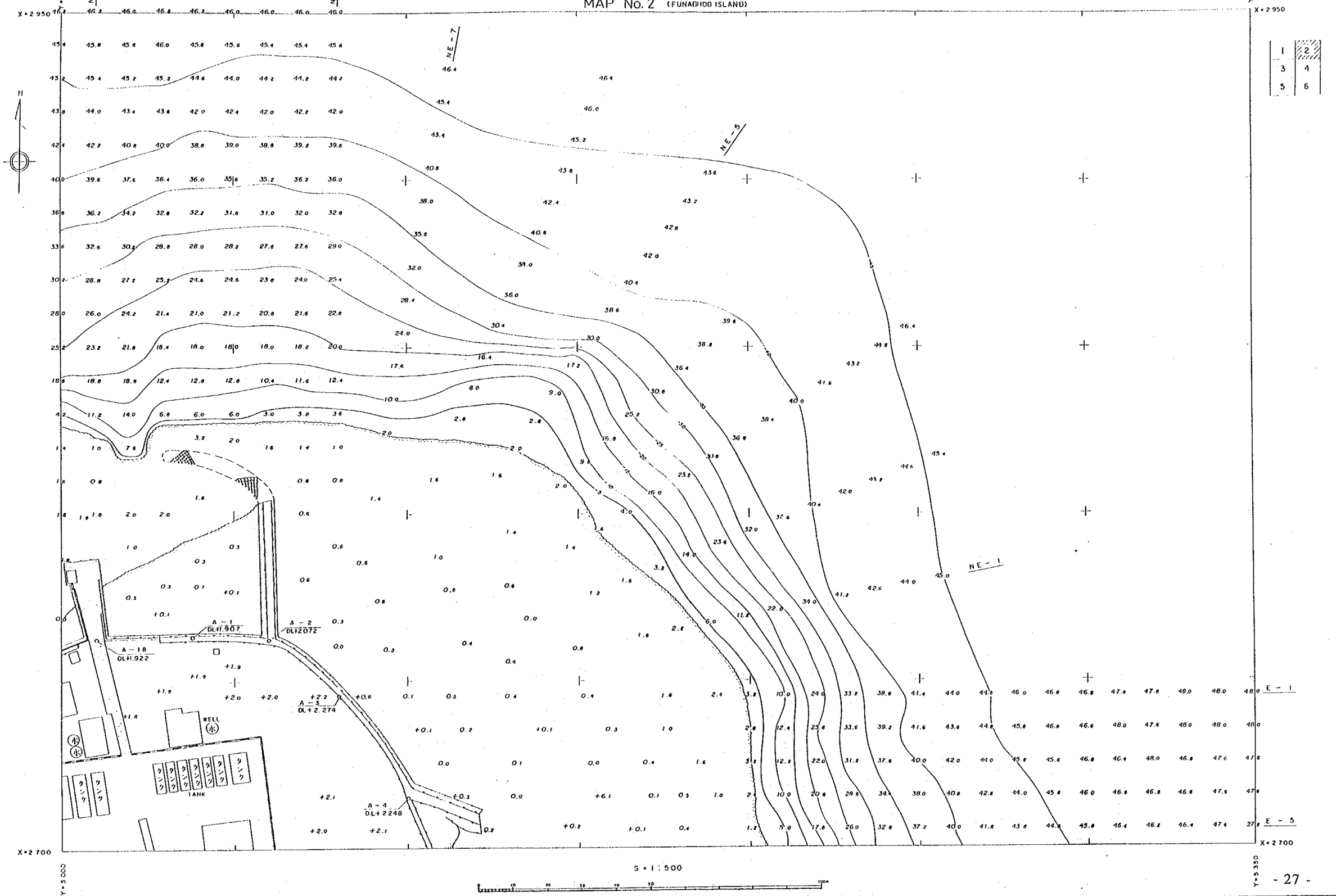
現況水深図－1

MAP No.1 (FUNADHOO ISLAND)



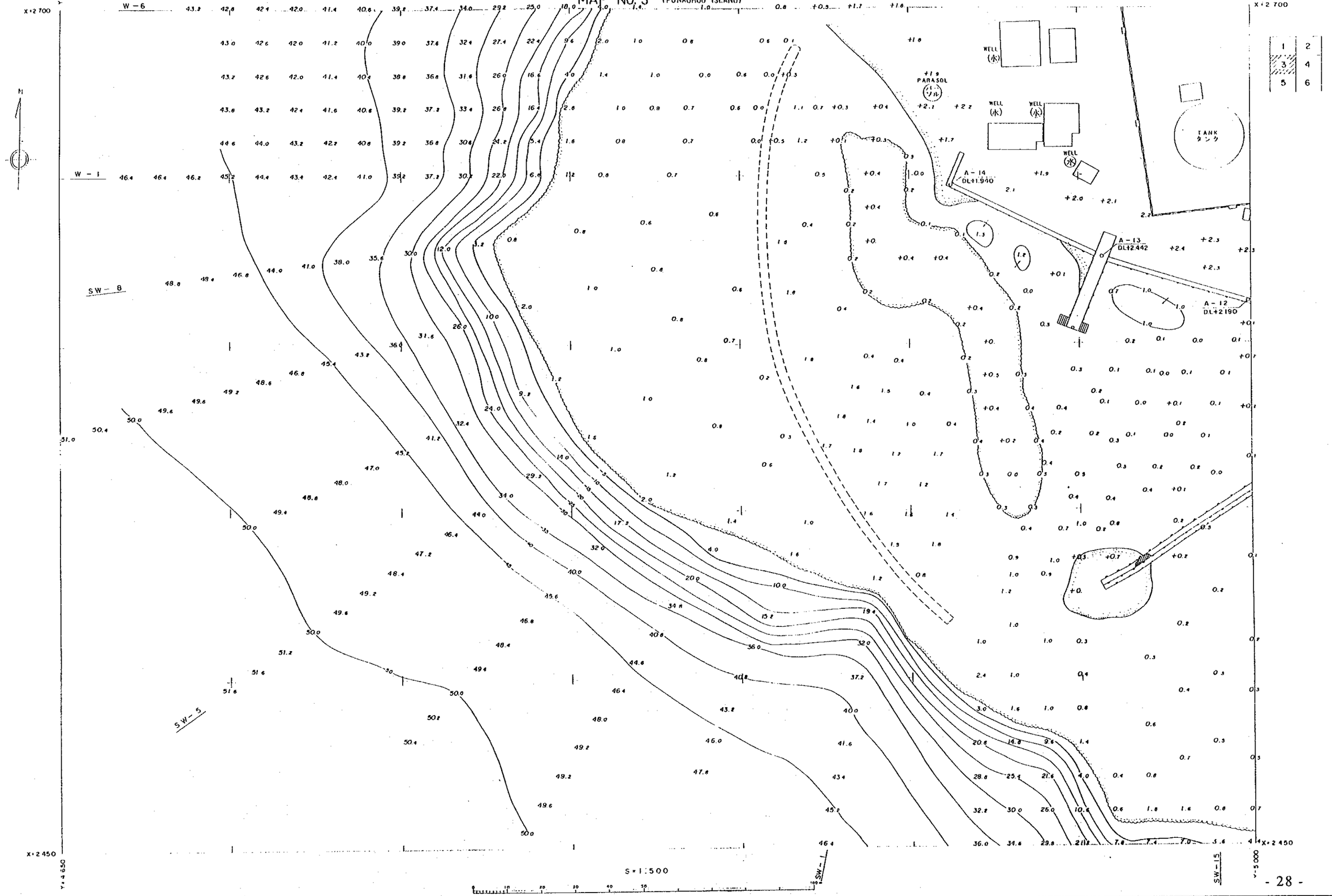
現況水深図－2

MAP No. 2 (FUNADHOO ISLAND)



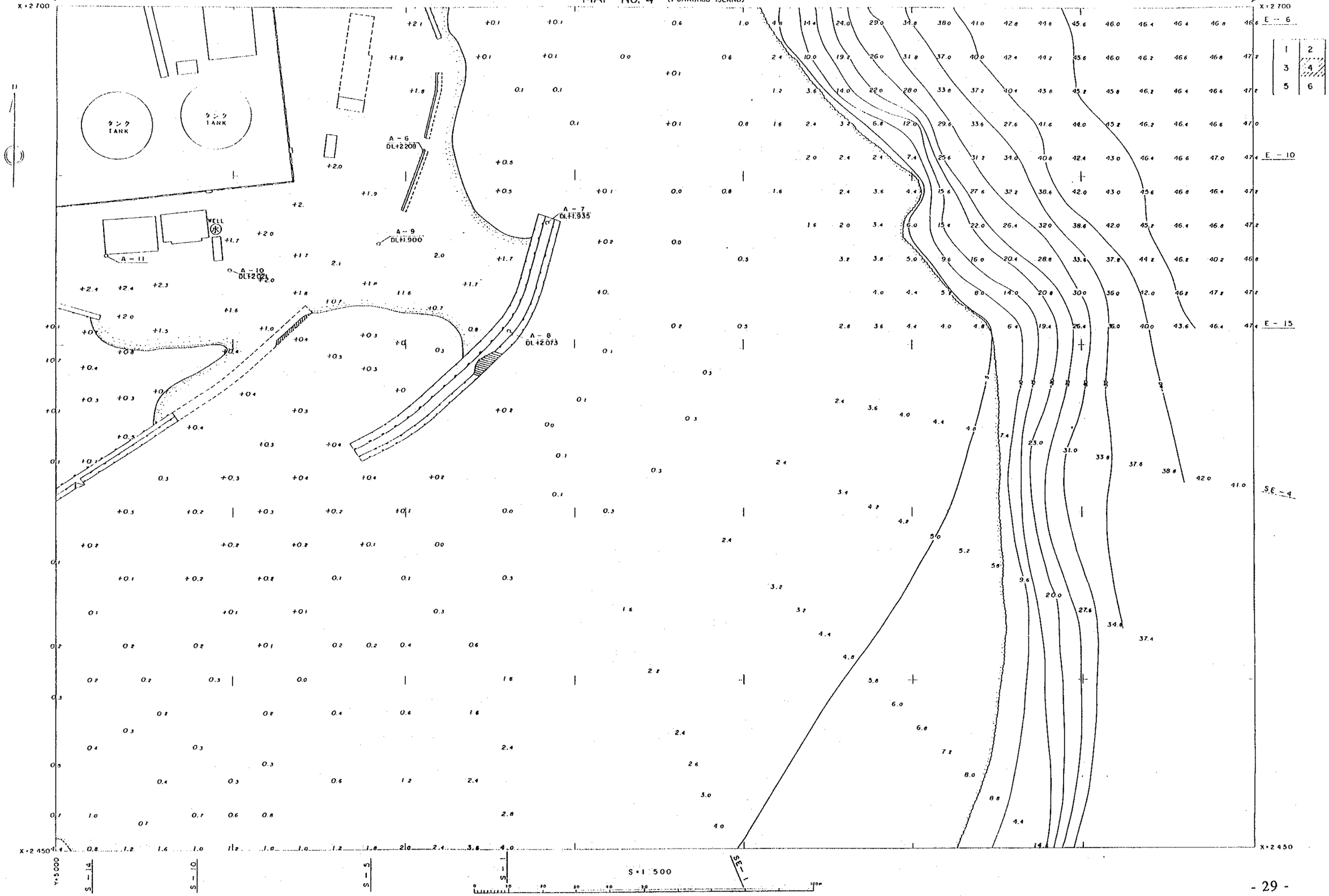
現況水深図－3

MAP No. 3 (FUNAOHOO ISLAND)

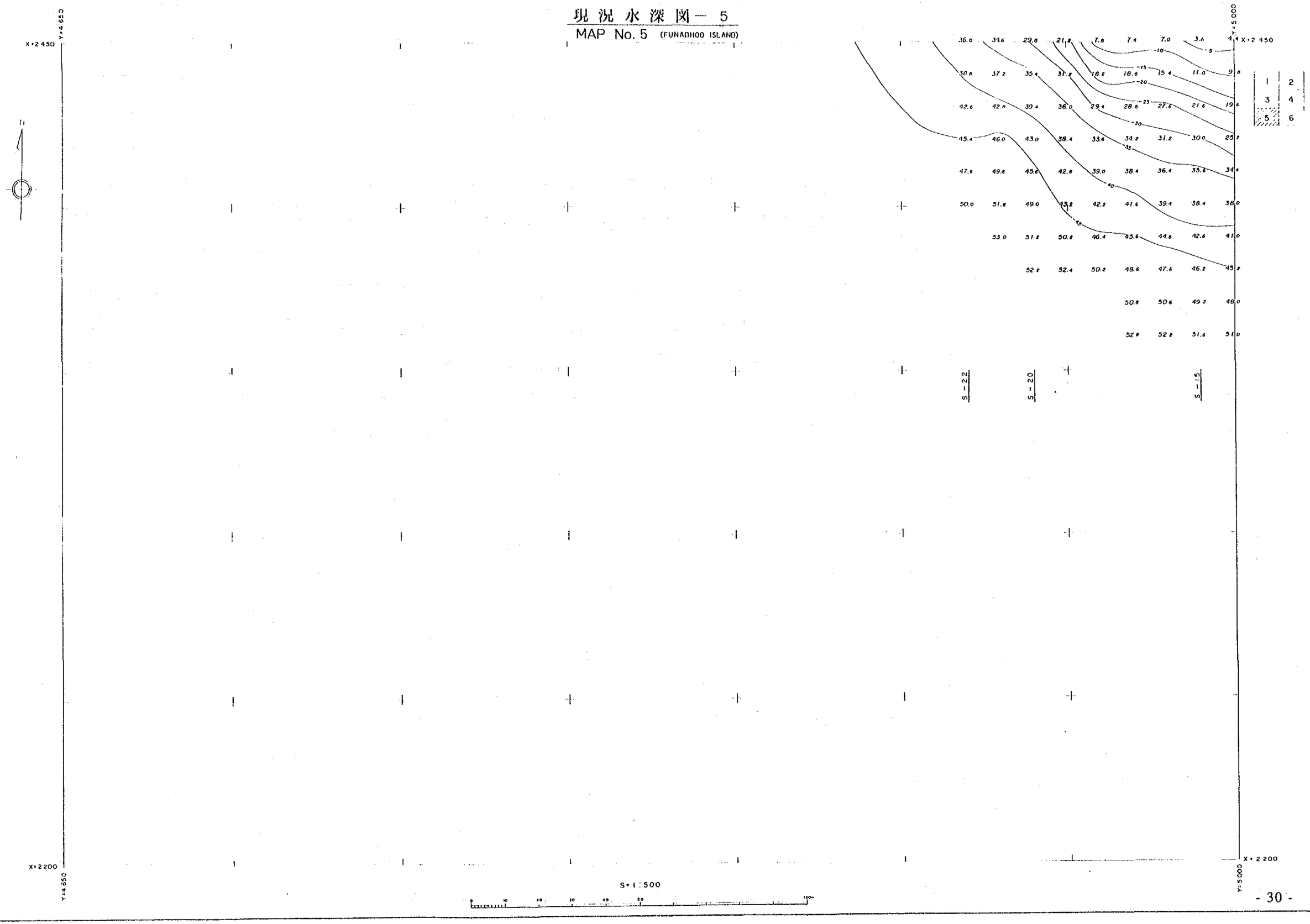


現況水深図－4

MAP No. 4 (FUNADHOO ISLAND)

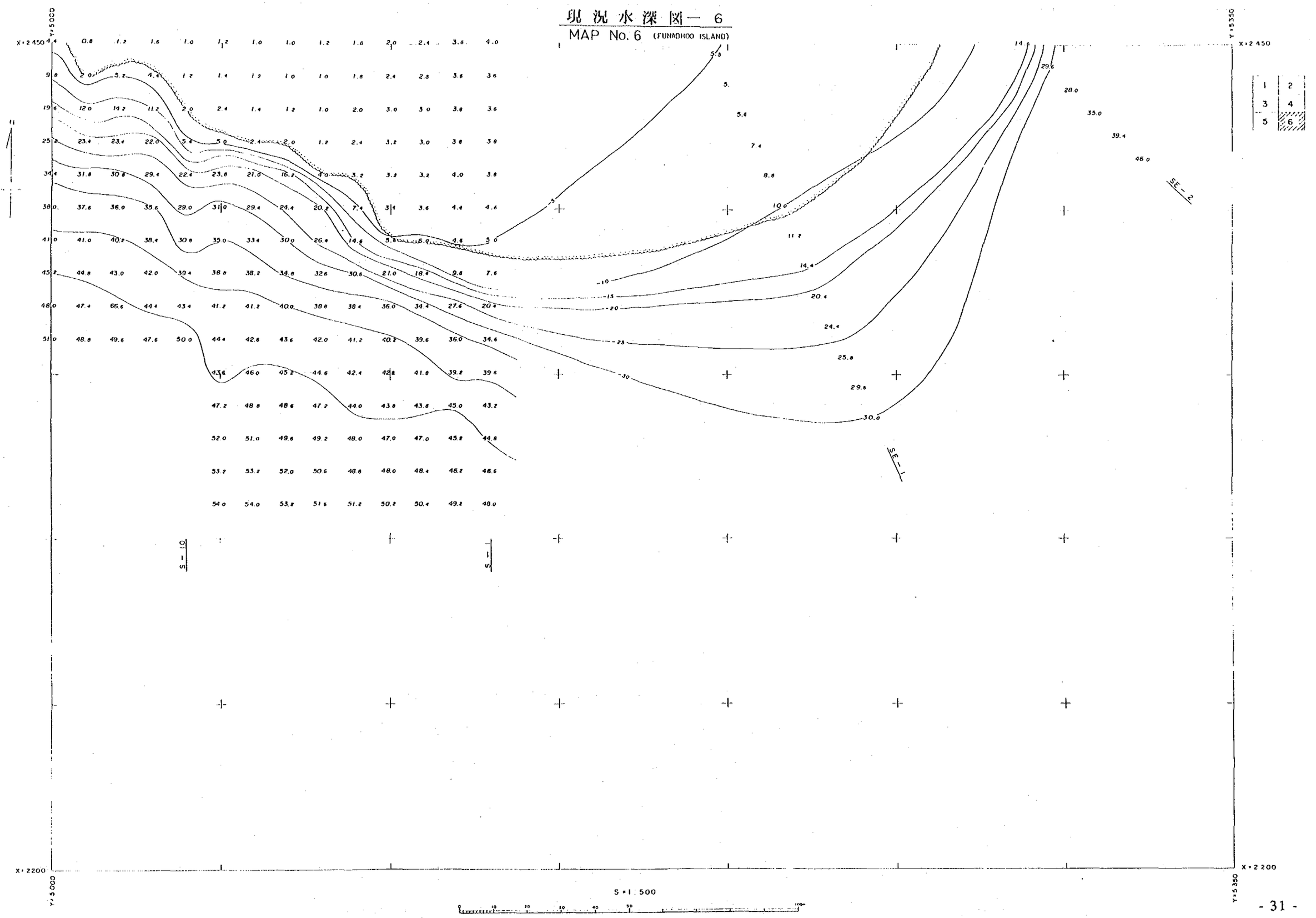


現況水深図－5
MAP No. 5 (FUNAOHOO ISLAND)



現況水深図－6

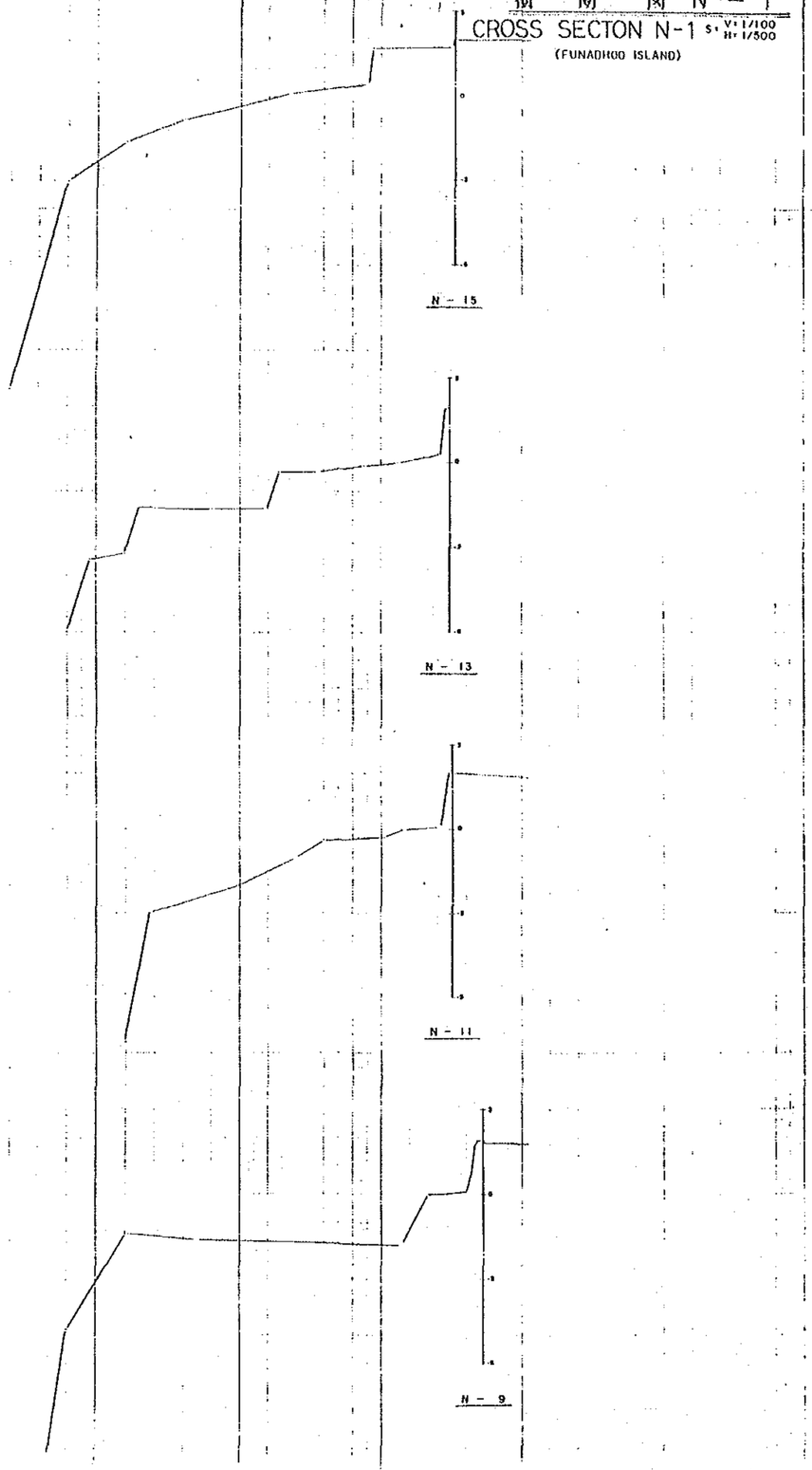
MAP No. 6 (FUNADHOO ISLAND)

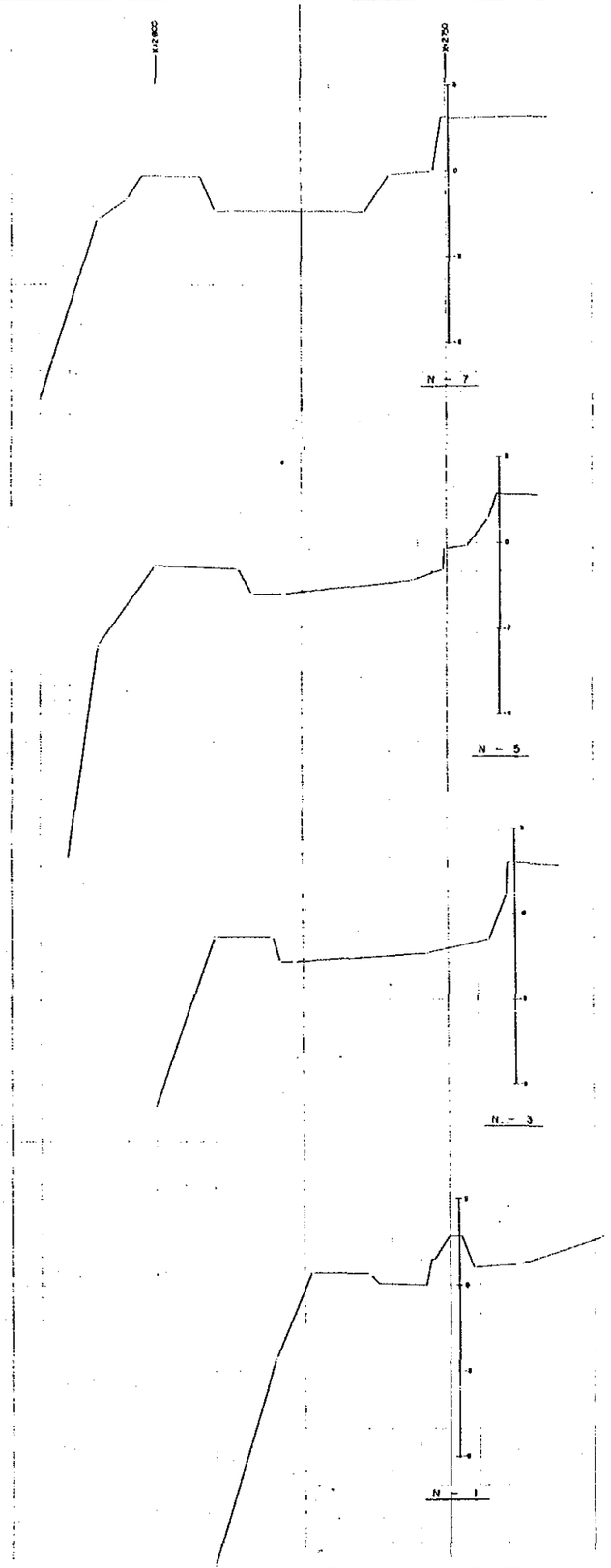


横断図 N－1

CROSS SECTON N-1 S' V: 1/100 H: 1/500

(FUNADHOO ISLAND)

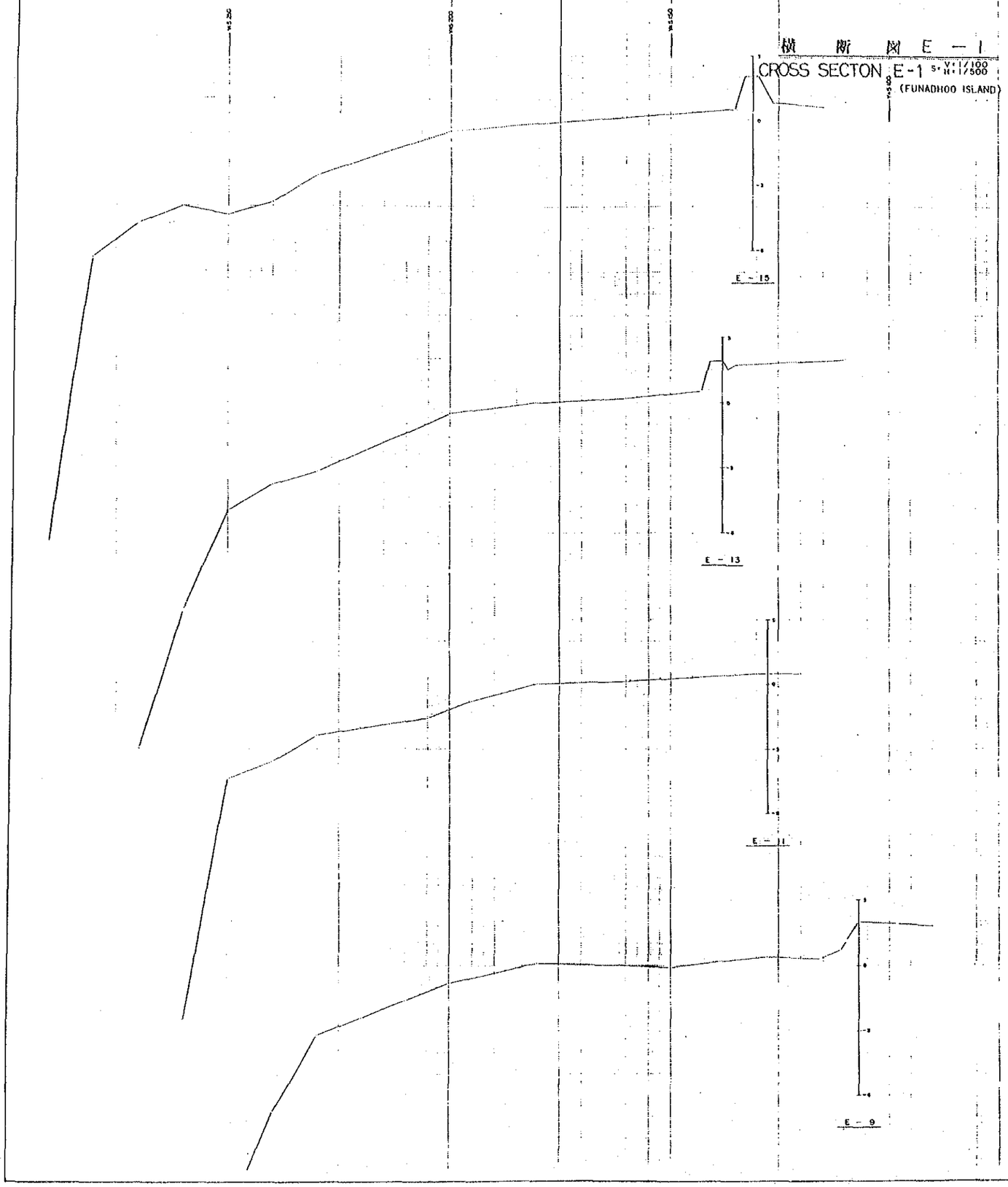




横 断 図 E - 1

CROSS SECTON E-1 S= V:1/100 H:1/500

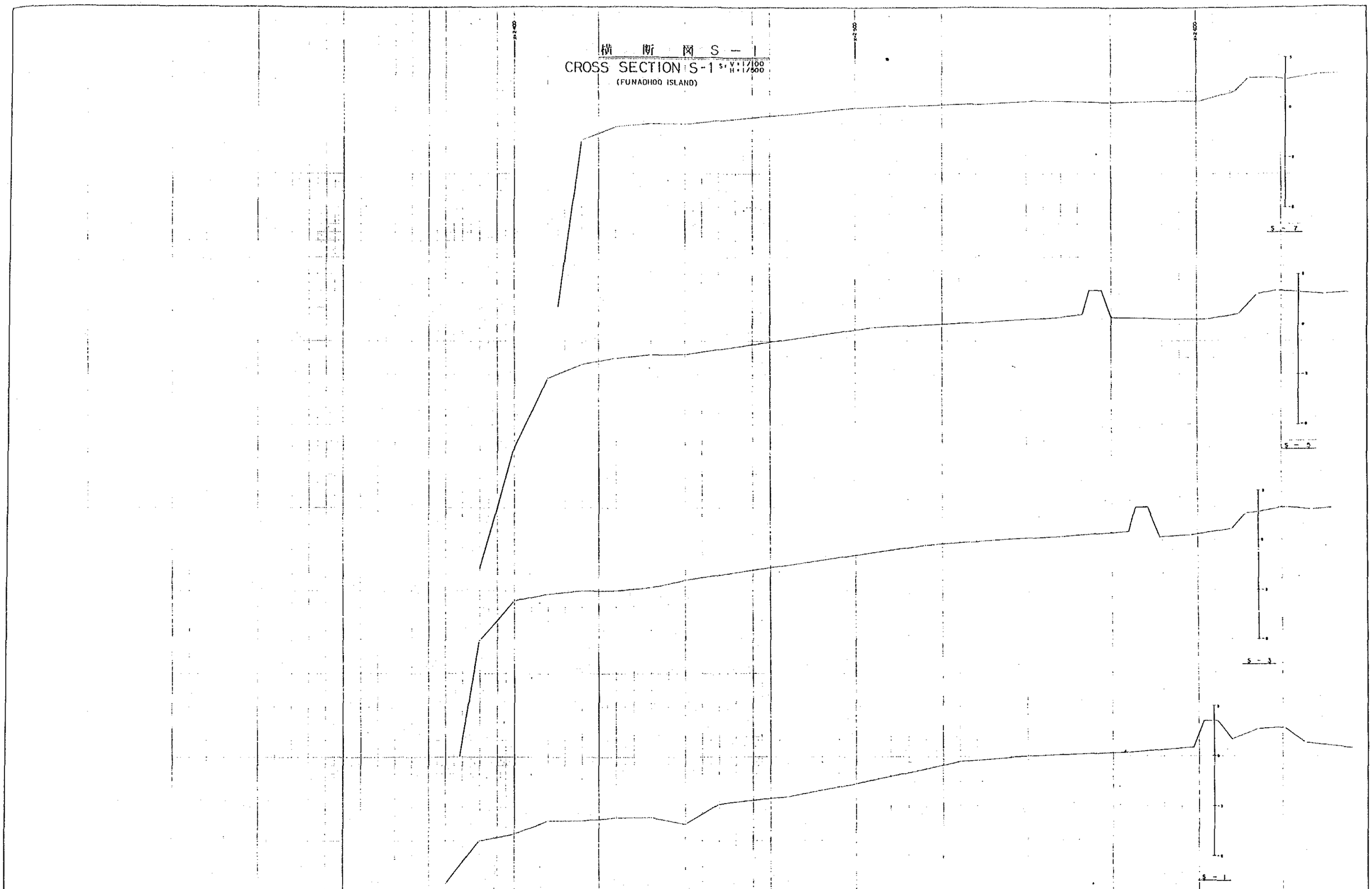
(FUNADHOO ISLAND)



横断図 S－1

CROSS SECTION S-1 $^{S:\ V:1/100}_{H:1/500}$

(FUNADHOO ISLAND)



別 図 S - 2

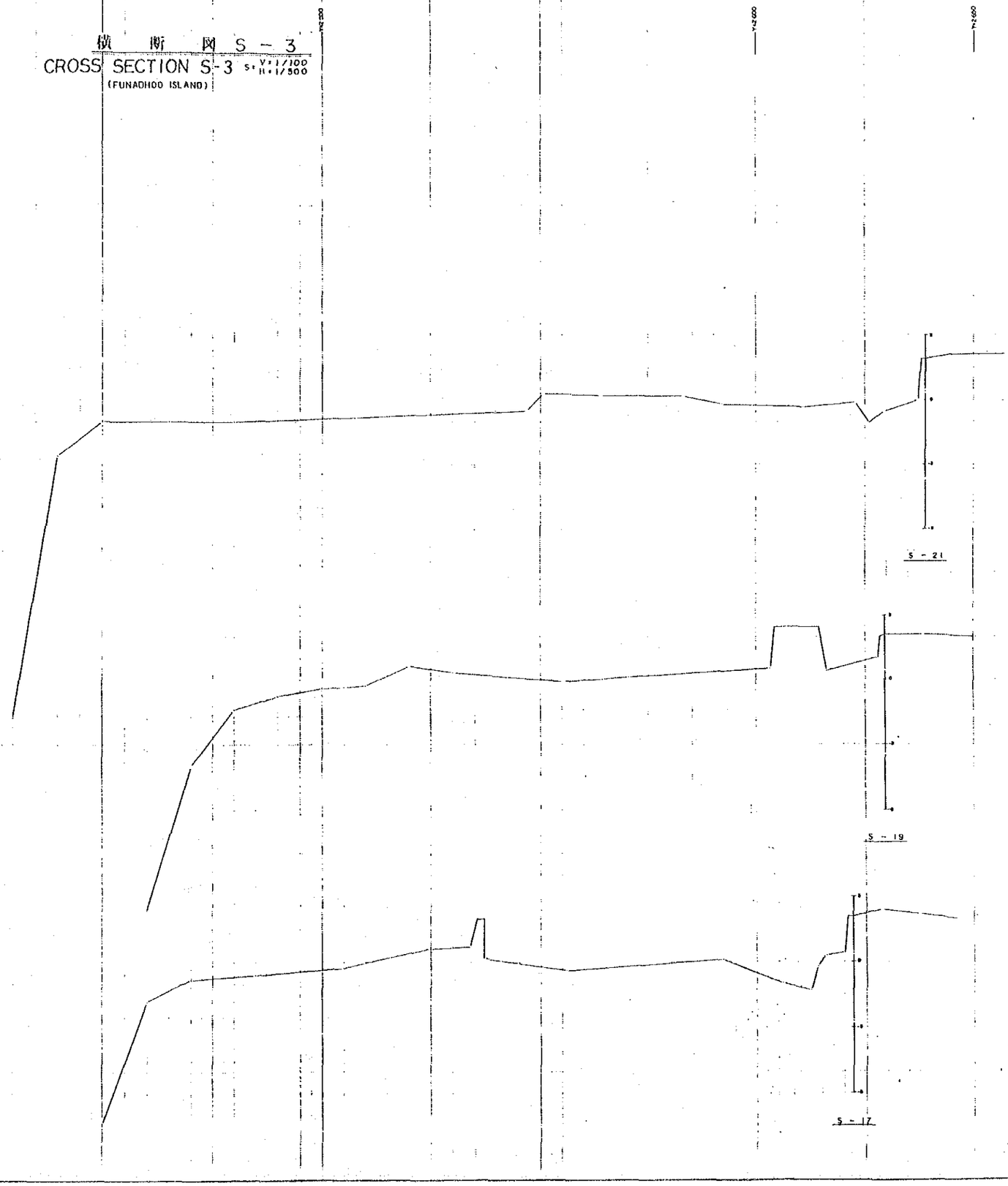
CROSS SECTION S-2 S:V 1/100 H 1/500

(FUNADHOO ISLAND)

横断図 S－3

CROSS SECTION S-3 V=1/100 H=1/500

(FUNADHOO ISLAND)



横 断 図 W － 1

CROSS SECTION W-1

S: V:1/100 H:1/500

(FUNADHOO ISLAND)