1.5 List of References

(1/2)

Title	Source	Year
1. General		
1) 1988 Census of Population and Housing (Preliminary Results)	Office of Planning and Statistics	1988
2) Marshall Islands Statistical Abstracts	Office of Planning and Statistics	1987
3) Table of Income Distribution of Public and Private Sector in Majuro	Office of Revenue and Taxation	1987
4) A Bill for an Act cited as the Marshall Islands Marine Resources Authority (MIMRA) Acts 1988	NITIJELA of the Marshall Islands	1988
5) Organization Chart of R & D and MIMRA	Ministry of Resources and Development	1988
2. Development Plan		
1) First Five Year Development Plan (1985-89), Rephased for 1986/87-1990/91	Office of Planning and Statistics	1987
3. Fisheries		
1) Record of Fishing Participation Count (Majuro)	Marshall Islands Marine Resources Authority (MIMRA)	Nov. 1988 - Feb. 1989
2) Monthly Purchase Record of Fresh Fish	Majuro Fishermen's Cooperative Association (MFCA)	1978-1982
3) Daily Sales Record of Fresh Fish	MFCA	1978-1982
4. Construction		
1) Regulation Concerning the Control of Earthmoving and Sedimentation in the Trust Territory of the Pacific Islands - Preliminary -	Environmental Protection Authority (EPA)	1989

Title	Source	Year
5. Natural Conditions		
1) Pilot Chart of the North Ocean	Defense Mapping Agency, U.S.A.	1989
2) Tide Table, Central and Western Pacific Ocean and Indian Ocean	National Oceanic and Atmospheric Administ-ion, National Ocean Service, U.S. Depart-ment of Commerce	1980-1989
3) Majuro Tide Curve in 1989 by Tropical Ocean Global Atmosphere Project	TOGA Sea Level Center, University of Hawaii	
4) Local Climatological Data, Annual Summary with Comparative Data, Majuro, Marshall Islands	National Climatic Data Center, U.S. Department of Commerce	1987
5) Local Climatological Data, Monthly Summary, Majuro, Marshall Islands	National Climatic Data Center, U.S. Department of Commerce	1988

Title	Source	Year
5. Natural Conditions		
1) Pilot Chart of the North Ocean	Defense Mapping Agency, U.S.A.	1989
2) Tide Table, Central and Western Pacific Ocean and Indian Ocean	National Oceanic and Atmospheric Administ-ion, National Ocean Service, U.S. Depart-ment of Commerce	1980-1989
3) Majuro Tide Curve in 1989 by Tropical Ocean Global Atmosphere Project	TOGA Sea Level Center, University of Hawaii	
4) Local Climatological Data, Annual Summary with Comparative Data, Majuro, Marshall Islands	National Climatic Data Center, U.S. Department of Commerce	1987
5) Local Climatological Data, Monthly Summary, Majuro, Marshall Islands	National Climatic Data Center, U.S. Department of Commerce	1988

APPENDIX 2

2-1 TABLES

Appendix 2

2 - 1 Tables

TABLE 2.1 POPULATION AND AVERAGE ANNUAL GROWTH RATE BY ATOLLS/ ISLANDS (1980-1988) AND PROJECTED POPULATION FOR 2000

Atolls	Population 1980	Population 1988	Percent of each atoll to 1988 population	Average annual growth rate (%)	Projected[1)] population 2000
1. Ailinglaplap	1,385	1,716	4.0	2.68	2,830
2. Ailuk	413	488	1.1	2.09	861
3. Arno	1,487	1,653	3.8	1.32	3,086
4. Aur	444	431	1.0	-0.37	926
5. Bikini	-	30	0.1	-	-
6. Ebon	887	741	1.7	-2.25	1,757
7. Enewetak	542	714	1.6	3.45	1,184
8. Jabat Island	72	112	0.3	5.52	151
9. Jaluit	1,450	1,693	3.9	1.94	3,046
10. Kili	489	593	1.4	2.41	1,019
11. Kwajalein	6,624	9,254	21.4	4.18	14,016
12. Lae	237	319	0.7	3.71	510
13. Lib Island	98	116	0.3	2.11	229
14. Likiep	481	482	1.1	0.03	942
15. Majuro	11,791	19,695	45.5	6.41	25,145
16. Maloelap	614	796	1.8	3.25	1,330
17. Mejit Island	325	445	1.0	3.93	665
18. Mili	763	854	2.0	1.41	1,579
19. Namorik	617	814	1.9	3.46	1,279
20. Namu	654	801	1.8	2.53	1,450
21. Rongelap	235	-	-	-	454
22. Ujae	309	448	1.0	4.64	660
23. Ujelang	-	-	-	-	-
24. Utrik	336	404	0.9	2.30	675
25. Wotho	85	90	0.2	0.71	160
26. Wotje	535	646	1.5	2.36	1,108
Total	30,873	43,335	100	4.24	65,062

Source: 1980 and 1988 Census, Office of Planning and Statistics
Remarks 1) Population projection from Census 1980

TABLE 2.2 COPRA PRODUCTION BY ATOLLS AND ISLANDS, 1983-1987

Unit: Short Tons 1)

	1983	1984	1985	1986	1987 (US $) 2)
1. Ailinglaplap	981	427	433	958	679 (115,247)
2. Ailuk	164	162	50	89	201 (32,047)
3. Arno	917	708	753	1,096	941 (141,315)
4. Aur	320	134	157	252	265 (34,252)
5. Ebon	479	315	371	684	432 (49,869)
6. Jabat	42	19	23	48	29 (6,140)
7. Jaluit	361	169	386	664	352 (55,513)
8. Kili	21	53	3	1	-
9. Kwajalein	8	12	15	13	29
10. Lae	65	44	62	78	58 (10,661)
11. Lib	72	25	21	77	43 (6,556)
12. Likiep	185	237	121	82	74 (10,257)
13. Majuro	291	262	260	209	172 (43,298)
14. Maloelap	319	209	238	287	268 (45,603)
15. Mejit	204	172	60	150	208 (38,546)
16. Mili	671	411	586	746	588 (88,936)
17. Namorik	325	280	257	447	247 (44,982)
18. Namu	322	162	132	482	239 (37,583)
19. Rongelap	47	63	18	-	-
20. Ujae	63	63	43	81	66 (12,755)
21. Ujelang	22	57	33	14	-
22. Utrik	130	102	33	52	81 (12,803)
23. Wotho	27	25	23	32	40 (6,057)
24. Wotje	455	372	223	380	390 (65,517)
	6,490	4,483	4,301	6,922	5,401 (946,873)

Source: Office of Planning and Statistics

Remarks 1) - 1 short ton = 907.2 kg (0.9072 metric ton)

2) - Estimated value based on per capita copra production income by atolls and islands.

TABLE 2.3 GROSS DOMESTIC PRODUCT, 1981-1984

Unit: (US$Million)

	1981	1982	1983	1984
Compensation of Employees	16.80	20.99	22.27	23.54
Operating Surplus	11.21	10.78	14.45	16.51
Net Domestic Product at factor cost	28.01	31.77	36.72	40.05
Consumption of Fixed Capital	1.15	1.57	1.73	1.83
Gross Domestic Product at factor cost	29.16	33.34	38.45	41.88
Indirect taxes less subsidies	2.74	2.76	3.72	4.48
Gross Domestic Product (GDP)	31.90	36.10	42.17	46.36
Population (mid-year) (numbers)	31,176	33,015	34,727	36,116
Per capita GDP at market prices (US$)	1,004	1,093	1,214	1,284

SOURCE: Office of Planning and Statistics

TABLE 2.4 BALANCE OF TRADE, 1980-1985

Unit: (US$ 1000)

	1980	1981	1982	1983	1984	1985
Imports	17,155	22,208	18,777	17,503	22,608 1)	29,176 1)
Exports	2,577	2,968	2,225	3,143	5,233	2,450
Trade deficit	-14,578	-19,240	-16,552	-14,360	-17,373	-26,726

Source: First Five Year Development Plan, Rephased for 1986/87-1990/91 (Ministry of Finance; Office of Planning and Statistics;

Remarks 1) Commercial imports for Majuro only, source: Customs and Taxation Division, Ministry of Finance)

TABLE 2.5 FUNDING REQUIREMENTS BY MAJOR SECTOR (FY 1986/87-1990/91)

Unit: (US$ 1000)

Sector	1986/87	1987/88	1988/89	1989/90	1990/91	Total (%)
Economic	660	1,544	1,129	1,934	3,869	9,136 (6.9)
Social	4,666	5,768	5,560	6,496	4,413	26,903 (20.4)
Infrastructure	17,255	28,890	18,502	7,423	7,565	79,635 (60.5)
Government	3,367	8,232	1,446	1,814	1,209	16,068 (12.2)
TOTAL	25,948	44,434	26,637	17,667	17,056	131,742

Source: First Five Year Development Plan, Rephased for 1986/87-1990/91

TABLE 2.6 FUNDING REQUIREMENTS BY SUB-SECTOR (FY 1986/87-1990/91)

Unit: (US$ 1000)

Sub-sector	1986/87	1987/88	1988/89	1989/90	1990/91	Total (%)
Agriculture (inc.forestry)	160	513	495	425	450	2,043 (22.4)
Fisheries	500	710	456	830	1,620	4,116 (45.0)
Manufacturing	–	275	150	679	1,799	2,903 (31.8)
Tourism	–	46	28	–	–	74 (0.8)
TOTAL	660	1,544	1,129	1,934	3,869	9,136

Source: First Five Year Development Plan, Rephased for 1986/87-1990/91

TABLE 2.7 REVENUE (FY 1986/87-1990/91)

Unit: (US$ 1000)

	1986/87	1987/88	1988/89	1989/90	1990/91	Total
Compact	42.8	41.5	42.3	43.2	44.0	213.8
Domestic	13.7	14.0	14.7	15.4	16.2	74.0
U.S.federal grants	11.7	8.0	4.8	1.6	1.6	27.7
Capital Improvement Programs	9.0	7.5	1.9	–	–	18.4
Investment Development Fund	6.0	–	4.0	–	–	10.0
Four Atoll Other Fund	2.5	2.5	2.5	2.5	2.5	12.5
TOTAL	85.7	73.5	70.2	62.7	64.3	356.4

Source: First Five Year Development Plan, Rephased for 1986/87-1990/91

TABLE 2.8 NUMBER OF FISHING BOATS IN MAJURO

Area	Number of fishing boats
Darrit	25
Uliga	10
Dalap	15
Laura	15
Others	5
Total	70

Source: The Basic Design Study on the Majuro Fishing Boat Channel Project in Marshall Islands, 1982, JICA

TABLE 2.9 NUMBER OF FISHERMEN AND LANDING VOLUME BY FISHING METHODS (FOR TWO YEARS)

Fishing Method	Number of Fishermen	Individual Fish Landing (kg) Maximum	Average
Trolling	92 (50)	64,132	1,951
Spear	172 (58)	4,866	195
Hook	152 (85)	3,866	130
Net	161 (84)	4,339	149

Remarks: 1) Estimated from fish landings by individual fishermen by fishing methods during two years from September 1977 to August 1979, obtained from Majuro Fishermen's Cooperative Association.
2) Figures in parenthesis show the number of fishermen who engaged in plural fishing methods. The net number of fishermen during the the period was 353 in total.

TABLE 2.10-1 MONTHLY CATCH BY MAJOR FISH GROUP AT MFCA IN 1978

Month	Pelagic fishes		Reef fishes		Bottom fishes		Lobster		Total	
	Q'ty (1bs)	Value ($)	Q'ty (1bs)	Value ($)	Q'ty (1bs)	Value ($)	Q'ty (1bs)	Value ($)	Q'ty (1bs)	Value ($)
Jan.	5,533	3,209	5,640	3,328	1,841	1,086	0	0	13,014	7,623
Feb.	19,844	11,655	3,745	2,215	1,727	1,026	122	98	25,438	14,994
Mar.	26,611	15,745	6,410	3,802	1,620	985	9	8	34,650	20,540
Apr.	14,964	8,360	4,975	2,955	2,329	1,417	12	10	22,280	12,742
May	16,400	9,860	6,365	3,539	1,126	635	5	4	23,896	14,038
June	12,132	5,913	7,107	3,685	1,385	678	0	0	20,622	10,276
July	23,215	11,762	8,653	4,555	728	338	80	63	32,666	16,718
Aug.	19,298	9,857	4,830	2,344	1,379	679	73	73	25,580	12,953
Sept.	20,255	10,284	6,707	3,196	2,644	1,221	25	21	29,631	14,722
Oct.	17,315	8,987	7,140	3,489	4,508	2,094	45	41	29,008	14,611
Nov.	19,515	10,463	4,101	2,047	1,969	965	15	14	25,600	13,489
Dec.	13,122	7,952	1,992	1,247	2,148	1,184	29	29	17,291	10,412
Total	208,204	114,047	67,665	36,402	23,402	12,308	405	361	299,676	163,118
Total(kg)	94,316		30,652		10,601		183		135,753	

TABLE 2.10-2 MONTHLY CATCH BY MAJOR FISH GROUP AT MFCA IN 1979

Month	Pelagic fishes		Reef fishes		Bottom fishes		Lobster		Total	
	Q'ty (1bs)	Value ($)	Q'ty (1bs)	Value ($)	Q'ty (1bs)	Value ($)	Q'ty (1bs)	Value ($)	Q'ty (1bs)	Value ($)
Jan.	15,010	9,694	4,516	2,992	4,100	2,736	4	4	23,630	15,426
Feb.	20,601	13,948	4,245	2,843	3,217	2,090	0	0	28,063	18,883
Mar.	45,699	28,719	3,303	2,059	2,042	1,185	0	0	51,044	31,963
Apr.	18,043	11,053	4,090	2,635	1,457	865	0	0	23,590	14,553
May	31,588	19,165	6,502	4,083	2,351	1,375	0	0	40,441	24,623
June	44,076	24,318	3,322	1,840	2,323	1,321	3	3	49,724	27,482
July	36,860	19,858	8,202	4,672	5,581	2,591	11	10	50,654	27,131
Aug.	34,034	17,925	10,157	5,651	4,294	2,354	48	44	48,533	25,974
Sept.	17,882	9,413	3,869	2,410	824	444	56	50	22,631	12,317
Oct.	19,030	10,156	1,888	1,055	519	206	0	0	21,437	11,417
Nov.	14,895	7,840	3,036	1,819	557	310	0	0	18,488	9,969
Dec.	1,912	1,054	781	519	191	104	0	0	2,884	1,677
Total	299,630	173,143	53,911	32,578	27,450	15,583	122	111	381,119	221,415
Total(kg)	135,732		24,421		12,435		55		172,647	

TABLE 2.10-3 MONTHLY CATCH BY MAJOR FISH GROUP AT MFCA IN 1980

Month	Pelagic fishes		Reef fishes		Bottom fishes		Lobster		Total	
	Q'ty (lbs)	Value ($)	Q'ty (lbs)	Value ($)	Q'ty (lbs)	Value ($)	Q'ty (lbs)	Value ($)	Q'ty (lbs)	Value ($)
Jan.	2,291	1,590	1,294	869	364	234	0	0	3,949	2,693
Feb.	4,571	3,344	1,313	971	487	332	0	0	6,371	4,647
Mar.	1,120	892	1,544	1,207	245	181	4	4	2,913	2,284
Apr.	1,262	1,044	2,140	1,717	288	224	0	0	3,690	2,985
May	10,811	9,242	2,641	1,989	703	528	0	0	14,155	11,759
June	1,039	425	4,168	3,210	839	526	4	4	6,050	4,165
July	17,091	13,996	9,688	7,075	1,940	1,325	27	27	28,746	22,423
Aug.	13,078	7,696	5,890	4,033	1,239	754	61	61	20,268	12,544
Sept.	9,053	5,095	3,304	2,302	1,714	1,090	77	67	14,148	8,554
Oct.	22,473	12,002	1,374	1,012	486	309	6	6	24,339	13,329
Nov.	5,424	2,859	1,779	1,419	228	132	0	0	7,431	4,410
Dec.	3,952	2,073	352	240	74	60	0	0	4,368	2,373
Total	92,155	60,258	35,487	26,044	8,607	5,695	179	169	136,428	92,166
Total(kg)	41,746		16,076		3,899		81		61,802	

TABLE 2.10-4 MONTHLY CATCH BY MAJOR FISH GROUP AT MFCA IN 1981

Month	Pelagic fishes		Reef fishes		Bottom fishes		Total	
	Quantity (lbs)	Value ($)	Quantity (lbs)	Value ($)	Quantity (lbs)	Value ($)	Quantity (lbs)	Value ($)
Jan.	7,829	5,085	1,052	856	277	215	9,158	6,156
Feb.	2,934	1,885	590	490	1,531	1,374	5,055	3,749
Mar.	2,812	2,514	1,474	1,159	944	534	5,230	4,207
Apr.	5,713	4,688	1,736	1,409	330	234	7,779	6,331
May	9,736	6,898	4,079	3,070	943	594	14,758	10,562
June	1,039	637	4,168	3,210	839	526	6,046	4,373
July	4,545	3,716	5,317	3,760	1,378	870	11,240	8,346
Aug.	9,217	6,626	7,337	5,446	2,222	1,921	18,776	13,993
Sept.	8,609	6,896	4,088	2,535	1,265	728	13,962	10,159
Oct.	4,049	3,180	7,166	6,309	1,555	1,038	12,770	10,527
Nov.	16,721	13,786	2,865	1,936	1,358	981	20,944	16,703
Dec.	6,446	5,456	1,102	1,015	237	199	7,785	6,670
Total	79,650	61,367	40,974	31,195	12,879	9,214	133,503	101,776
Total(kg)	36,081		18,561		5,834		60,477	

TABLE 2.10-5 MONTHLY CATCH BY MAJOR FISH GROUP AT MFCA IN 1982

Month	Pelagic fishes		Reef fishes		Bottom fishes		Total	
	Quantity (lbs)	Value ($)	Quantity (lbs)	Value ($)	Quantity (lbs)	Value ($)	Quantity (lbs)	Value ($)
Jan.	6,527	5,809	1,601	1,403	768	668	8,896	7,880
Feb.	3,643	3,455	1,182	1,060	3,043	2,697	7,868	7,212
Mar.	6,820	6,186	3,312	2,685	216	155	10,348	9,026
Apr.	8,714	6,192	2,400	2,187	167	109	11,281	8,488
May	820	818	1,183	984	355	278	2,358	2,080
June	3,919	3,192	3,605	3,384	250	179	7,774	6,755
July	6,618	5,890	3,291	2,941	476	334	10,385	9,165
Aug.	3,908	3,512	5,031	4,446	590	407	9,529	8,365
Sept.	2,840	2,544	3,837	3,366	441	303	7,118	6,213
Oct.	1,337	1,203	3,784	3,472	221	154	5,342	4,829
Nov.	721	549	2,677	2,490	178	121	3,576	3,160
Dec.	0	0	299	292	0	0	299	292
Total	45,867	39,350	32,202	28,720	6,705	5,405	84,774	73,465
Total(kg)	20,778		14,588		3,037		38,403	

Source for Tables 2.10-1 to 2.10-5: Basic Design Study for the Development of the Infrastructure for a Fishing Base in the Marshall Islands, 1983, JICA.

TABLE 2.11 NUMBER OF LANDINGS BY MAJOR FISH GROUP AT MFCA

	Pelagic fish	Reef fish	Bottom fish	Total
1977				
September	78	378	198	654
October	97	163	68	328
November	62	156	60	278
December	66	125	49	240
1978				
January	34	101	32	167
February	68	67	30	165
March	-	-	-	-
April	57	69	41	167
May	69	78	24	171
June	53	96	35	184
July	-	-	-	-
August	82	62	32	176

Source: Compiled from daily catches by major fish group from September 1977 to August 1978 (data unavailable for March and July 1978) obtained from the Majuro Fishermen's Cooperative Association.

Remarks: Average number of landings for pelagic fishes are 80 per month and 960 per year.

TABLE 2.12 MONTHLY AVERAGE LANDINGS PER OPERATION BY MAJOR FISH GROUP AT MFCA

	Pelagic fish		Reef fish		Bottom fish	
	lbs	kg	lbs	kg	lbs	kg
1977						
September	200.4	90.9	56.0	25.4	57.7	26.2
October	258.7	117.3	63.8	28.9	30.8	14.0
November	234.0	106.0	70.0	31.8	36.4	16.5
December	238.9	108.4	63.4	28.8	51.5	23.4
1978						
January	183.8	83.4	57.4	26.0	57.0	25.9
February	294.0	133.3	56.0	25.4	58.0	26.3
March	-	-	-	-	-	-
April	247.1	112.1	72.4	32.8	56.6	25.7
May	253.5	115.0	81.4	36.9	49.8	22.6
June	232.5	105.5	76.5	34.7	42.0	19.1
July	-	-	-	-	-	-
August	272.5	123.6	89.7	40.7	47.8	21.7

Source: Compiled from daily catches by major fish group from September 1977 to August 1978 (data unavailable for March and July 1978) obtained from the Majuro Fishermen's Cooperative Association.

TABLE 2.13 PRESENT CONDITION OF ARNO FISHERIES BY ISLANDS

	ARNO ISLAND	INE ISLAND	DODO ISLAND	MALEL ISLAND
FISHING BOAT	Canoe: 18-26 (16-28 ft) Crew: 1-2 /small boat 3-4 /larger boat Motorized boat (No.) 1 boat 16ft x 65HP Diesel In-board Engine 1 boat 13ft x 35HP Gasoline Out-board Engine	Canoe: 8-10 (12-22 ft) Motorized boat (No.) 1 boat 13ft x 35HP Gasoline Out-board Engine	Canoe: 7-8 (14-25 ft) Motorized boat (No.) 1 boat 23ft x 12HP Diesel In-board Engine 1 boat 26ft x 20HP Diesel In-board Engine 5 boats 14ft Gasoline Out-board Engine Copra transport vessel	Canoe: 7-8 (14-25 ft) Motorized boat (No.) 3 boats 25~30ft x 25HP Diesel Out-board Engine
FISHING TRIPS	3 - 5 trips/week	3 - 5 trips/week	Almost everyday	3 - 5 trips/week
DAY NIGHT	8:00 - 15:00 20:00 - 24:00 (or till morning)	8:00 - 15:00 20:00 - 24:00	8:00 - 15:00 20:00 - 24:00 (or till morning)	8:00 ~15:00 20:00 ~24:00
CATCH average Maximum Minimum	50 - 60 lb/trip/person 300 lb/trip/person Occassionally some catch	40 - 50 lb/trip/person 250 lb/trip/person	50 - 60 lb/trip/person 200 lb/trip/person	100 lb/trip/person
FISHING METHOD	Bottom line, Gill net, Diving, Drive-in net (5-6 persons), Trolling	Bottom line, Gill net, Diving, Drive-in net (5-6 persons), Trolling	Bottom line, Gill net, Diving, Drive-in net (5-6 persons), Trolling	Diving (mainly at night), Hook & line, Net (seldom used)
SALES TARGET	Dried/salted fish: 3-4 times/month and transported by themselves or by copra boat; 200 pieces/time	To Majuro 3-4 times a month transported by copra boat	Majuro (Stevedor & Terminal Co.) transported by copra vessel	To Majuro by copra boat 4 times a month and sometimes by plane
SALES PRICE	Large $1/pc. medium $5/pc. and small 30-40 cents/pc.	60-80 cents/pc.	80 cents-$1/lb	Average $1/pc. Large $2-3/pc. Small 15-50 cents/pc.
PROCESS METHOD	Salted dried, Salted	Salted dried, Salted	Salted dried, Salted	Salted dried, Salted
OTHERS	Fuel consumption to Majuro 10 gallons per trip (gasoline, diesel). Engines are maintained by boat owners themselves. Necessary spare parts obtained from other engines.		Fishing is only for self consumption. More catch if buyers available. Marketing sometimes difficult. Engines are repaired by owners themselves. Engine trouble is mostly in fuel system. Repaired in Majuro sometimes.	Most fishing only for self-consumption. When more fish are caught, they are processed and shipped to Majuro but not periodical.

TABLE 2.14 IDENTIFIED PROJECTS AND FUNDING SOURCES (FY 1986/87-90/91)

Unit: 1000 US$

Development Project	86/87	87/88	88/89	89/90	90/91	Total	Funding[1)] Source
Priority A							
Outer Island Fisheries Dev.	-	20	276	510	930	1,736	Sect. 211
Outer Island Rearing Ponds	-	-	-	70	140	210	Sect. 211
Mariculture Laboratory	-	20	130	200	-	350	Sect. 211
Sub-total	-	40	406	780	1,070	2,296	
Tied Compact							
Patrol Boats	300	-	-	-	-	300	Sect. 216(b)
Project Operation Center	-	200	-	-	-	200	Sect. 216(b)
Air Surveillance Equipment	-	170	50	50	50	320	Sect. 216(b) + a)I
Sub-total	300	370	50	50	50	820	
Priority B							
Patrol Boats	-	-	-	-	500	500	Sect. 211
Sub-total	-	-			500	500	
KADA							
Ebeye Marina	200	300	-	-	-	500	KADA
Sub-total	200	300	-	-	-	500	
TOTAL FISHERIES	500	710	456	830	1,620	4,116	

Remarks: Section name of U.S. Compact Grant

TABLE 2.15 MANPOWER REQUIREMENTS BY CATEGORY (FY 1986/87-90/91)

Project	86/87	87/88	88/89	89/90	90/91
Outer Island Fisheries Development	4	10	10	15	20
Mariculture Laboratory	1	3	3	3	3
Outer Island Rearing Pens	-	8	8	8	8
Surveillance/Monitoring	-	10	10	10	10
Ebeye Development	-	4	6	8	25
Contingencies	-	4	6	6	6
Total Employees 1)	5	39	43	50	72

Source: First Five Year Development Plan, Rephased for 1986/87-1990/91
Remarks: 1) Excluding expatriates

TABLE 4.1 EVALUATION OF SITE SELECTION

Criteria	Arno	Ine	Dono	Malel
1. Suitability as an anchorage to and from ocean side	0 (Facing SW)	0 (Facing SW)	0 (Facing SW)	A (Facing N)
2. Accessibility to Majuro	0	A	A	X
3. Economic potentiality from viewpoint of population and land area	0	0	X	0
4. Accessibility between each island				
Arno	-	0	X (far)	X (far)
Ine		-	X (far)	X (far)
Dodo				X (far)
Malel				-
Ranking	1	2	3	3

Remarks: 0 = Good; A = Less; X = Least
Figures in the column for ranking show the priority for operation

TABLE 5.1 COMPARISON OF STRUCTURAL WORKS REQUIRED FOR CONSTRUCTION OF WHARF

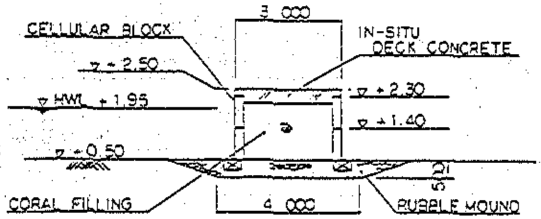
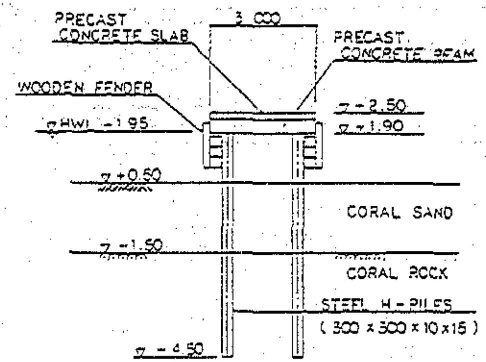
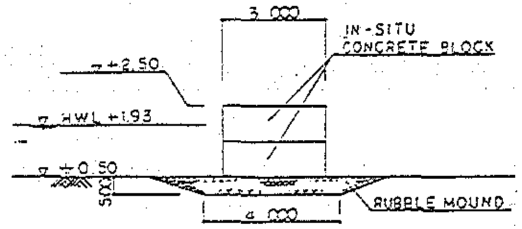
	Gravity Method (Cellular Block)	Gravity Method (Sheet Pile Revetment)	Gravity Method (On-site Concreting)
GENERAL SECTION			
CHARACTERICS OF STRUCTURE (FUNCTION)	①Maintenance free (Longer durability) ②Reclaimed portion needs filter sheet	①Measures to be taken against rusting of steel and maintenance required (Shorter durability)	①Maintenance free (Longer durability) ②Recess type stair will be installed, and it will appear beautiful after construction.
CONSTRUCTION MATERIALS	①Easy construction and definitely possible, however big crane is required. ②Possible to procure materials locally ③Even filling required ④Precast concreting possible in Majuro but requires transportation	①Difficulty expected in steel piling (dummy sheet) ②All sheet material imported have to be imported (sheet piles, waling strip, tie rod) ③All on-site works (RC concreting of upper structure is difficult.) ④Easy handling	①Easy construction and definitely possible ②Possible to procure materials locally
APPROXIMATE QUANTITY	Concrete (200m³) Backfill (coral)) (510m³) Cellular filling (260m³) Crushed stone (60m³) Foundation stone (200m³) Steel bar (24 t) Filter sheet (400m³)	Concrete (140m³) Crushed stone (60 m³) (Upper structure, anchor wall) Steel bar (22 t) Steel pile (III-type) (65 t) Tie rod (29 pcs.) Backfilling (coral) (510m³)	Concrete (340m³) Backfilling (coral) (510m³) Crushed stone (60m³) Foundation stone (150m³)
CONSTRUCTION MACHINES	Machines used for dredging, causeway and jetty can be used but requires also the following machine. ①70t crawler crane: 1	Machines used for dredging, causeway and jetty can be used but requires also the following machine. ①Vibrator hammer : 60kv X 1 unit ②Water jet :150kg / cm² . 325ℓ/min. X 2 units ③Generator :220kVA X 1 unit ④Water jet (Φ100. 5.2kv). Water tank (10 m³). Welder (250A)	Machines used for dredging, causeway and jetty can be used.
CONST. COST	More expensive than on-site concreting	More expensive than on-site concreting	Reasonable
CONST. PERIOD	Can be completed within reasonable period	Takes longer period	Can be completed within reasonable period
EVALUATION	△	△	○

TABLE 5.2 COMPARISON OF STRUCTURAL WORKS REQUIRED FOR CONSTRUCTION OF JETTY AT LAGOON SITE

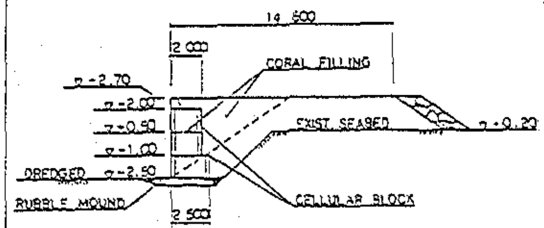
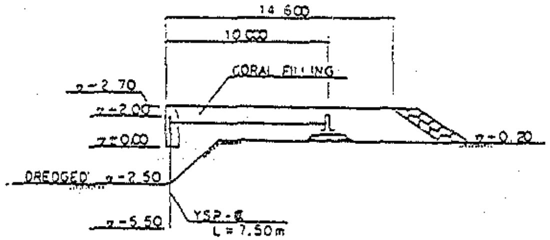
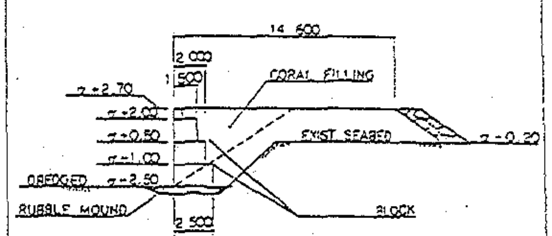
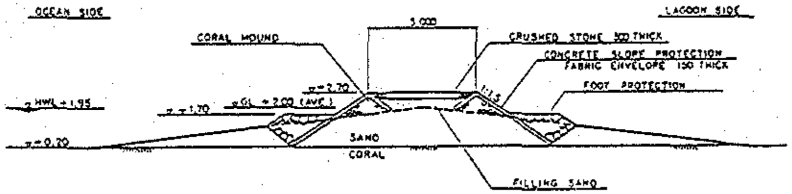
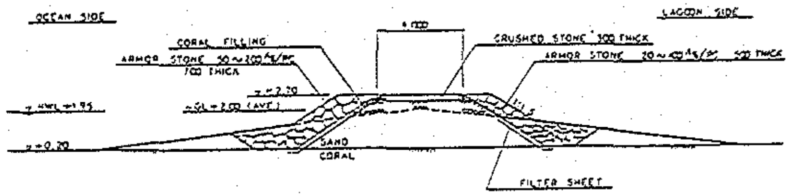
	Gravity Method (Cellular Block)	Jetty Type (H-steel bar)	Gravity Method (On-site concreting)
GENERAL SECTION			
CHARACTERICS OF STRUCTURE (FUNCTION)	①Maintenance free (Longer durability) ②Change in coast line possible.	①Measures to be taken against rusting of steel and maintenance required (Shorter durability) ②No possibility of coast line change	①Maintenance free (Longer durability) ②Change in coast line possible.
CONSTRUCTION MATERIALS	①Easy construction and definitely possible, however big crane is required. ②Possible to procure materials locally ③Even filling required ④Precast concreting possible in Majuro but requires transportation	①Difficulty expected in steel piling (dummy sheet)) ②All sheet material have to be imported ③Partial precast possible (eg. upper structure)	①Easy construction and definitely possible. ②Possible to procure materials locally
APPROXIMATE QUANTITY	Concrete (170m³) Steel bar (24 t) Cellular filling (120m³) Foundation stone (100m³) Filter sheet (420m³)	H-steel bar (32 t) (52 Nos.) Concrete (90m³) Steel bar (13 t)	Concrete (280m³) Backfilling coral (110m³)
CONSTRUCTION MACHINES	Machines used for dredging, causeway and jetty can be used but requires also the following machine. ①70t crawler crane: 1	Machines used for dredging, causeway and jetty can be used but requires also the following machine. ①Vibrator hammer : 60kv X 1 unit ②Water jet :150kg / cm² . 325ℓ/min. X 2 units ③Generator :220kVA X 1 unit; ④Water jet (Φ100. 5.2kv Water tank (10 m³). Welder (250A)	Machines used for dredging, causeway and jetty can be used.
CONST. COST	More expensive	More expensive	Reasonable
CONST. PERIOD	Can be completed within possible period	Can be completed within possible period	Can be completed within possible period
EVALUATION	△	△	○

TABLE 5.3 COMPARISON OF STRUCTURAL WORKS REQUIRED FOR CONSTRUCTION OF CAUSEWAY BETWEEN ARNO AND INE

	Fabric Foam	Armour Stone Type
GENERAL SECTION		
CHARACTERICS OF STRUCTURE (FUNCTION)	①In case of damage, difficult to repair (Generally maintenance free) ②Durable against foundation sinking and erosion ③Compared with armour stone type, waves reach higher elevation and frequency of cross over is high ④Generall this method is adopted when armour stones are available.	①In case of damage, difficult to repair (Generally maintenance free) ②Filter sheet is necessary because of the permeable structure. ③Durable against foundation sinking and erosion
CONSTRUCTION MATERIALS	①Fabric foam has to be imported.	①Materials locally available (except filter sheet) ②Easy construction and less stages of work
APPROXIMATE QUANTITY	Excavation (3,300m³) Backfilling sand (2,300m³) Paving concrete (520m³) Crushed stone (400m³) Fabric foam (6,000m²) Mortar for fabric foam (510m³) Filling sand (600m³) Coral mound & foot protection (1,600m³)	Excavation (3,300m³) Backfilling sand (1,900m³) Paving concrete (520m³) Coral filling (1,100m³) Armour stone (1,000m³) Filter sheet (4,100m²) Crushed stone (400m³)
CONSTRUCTION MACHINES	Machines used for dredging, and jetty can be used but requires also the following machine. ①Concrete pump.10m³/H x 1 unit	Machines used for dredging and jetty can be used.
CONST. COST	Expensive	Cheap
CONST. PERIOD	Longer construction period	Within possible period
EVALUATION	×	○

2-2 EXPLANATION NOTES

2.2 Explanation Notes

APPX. 2.2.1

Estimation of Potential Demand in Majuro for Fresh Fish from Arno

The source of protein in Majuro is marketed fresh fish, fresh fish caught for self consumption, and imported foods such as frozen meat, dairy products, and canned foods. The factors which have been taken into consideration in the estimation of fresh fish demand are population, income distribution, fish price elasticity, consumption by protein source, price, etc. However, in the Marshall Islands, statistical data relevant to these factors have not yet been consolidated. Since available data relevant to these factors are the fresh fish sales record (1977 - 1982) by MFCA and the export record of canned fish (1977 - 1982) by a Japanese trading company, the potential demand of fresh fish from Arno in Majuro is estimated by introducing following assumptions and methods.

(1) Basic approach for the estimation

The potential consumption demand of marketable fish (PCMF) is assumed to be the total sales volume of marketed fish and the imported volume of canned sardine and mackerel which is cheaper than fresh fish among imported fishery products. The potential demand of fresh fish from Arno in Majuro is estimated to be the amount minus the fish landing volume by Majuro fishermen from PCMF. In order to calculate this potential consumption demand, the net weight of canned fish has to be converted to fresh fish weight, since the contents of canned fish contains only the edible portion of the fish. The conversion factor of 0.53 (referred to "Japan Food Supply & Demand Table") is used. The converted weight of imported canned fish from Japan in 1977, 1984 and 1988 is shown in the table below.

Units: kg

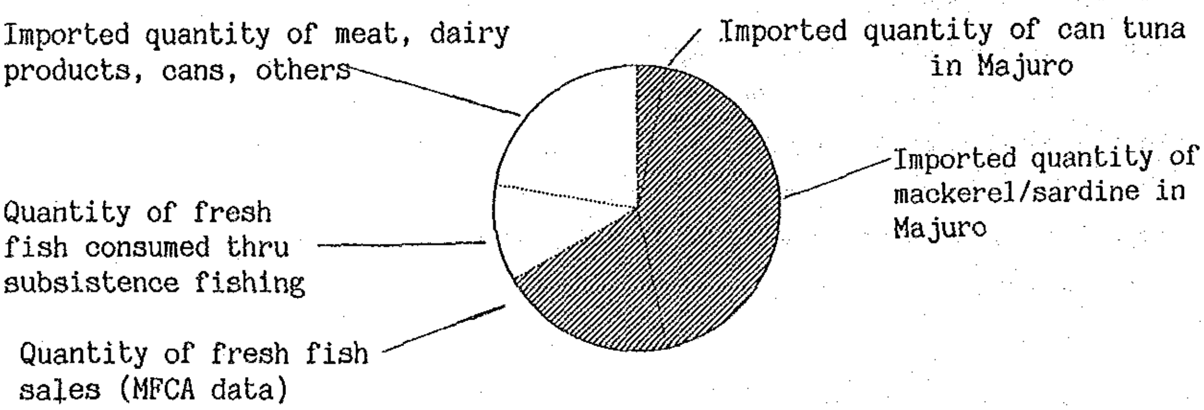
	1977	1984	1988
Canned tuna	17,280 (32,600)	38,400 (72,500)	67,200 (126,800)
Canned mackerel and sardine	224,400 (423,400)	199,920 (377,200)	185,640 (350,300)
Total	241,680 (456,000)	238,320 (449,700)	252,840 (477,100)

Source: Unpublished data obtained from a Japanese exporter in March 1989
Remarks: Figures in parenthesis show converted weight of fresh fish using the conversion factor of 0.53

(2) Assumptions Used for Estimation

1) Per capita consumption of marketable fisheries products

From the protein consumption structure in Majuro as shown in the figure below, the per capita consumption of marketable fisheries products is obtained from the shaded portion representing the consumption base. This per capita consumption is assumed not to have changed even in 1988.



PROTEIN CONSUMPTION PATTERN IN MAJURO IN 1977

2) Annual sales volume of fresh fish in Majuro

The annual sales volume of fresh fish in Majuro is estimated based on the average daily sales volume of MFCA for September 1977. Since the daily fresh fish sales record of MFCA are partially scattered and lost, the average daily sales volume was estimated using only the sales record which contains complete daily sales figures. The following table shows the complete data for daily fish sales volume in September 1977. Average daily sales was estimated to be about 557 kg.

Month/Day	Sales Q'ty (kg)	Month/Day	Sales Q'ty (kg)
9/1	661.59	9/16	793.48
2	648.65	17	625.50
3	*	18	451.96
4	*	19	349.63
5	*	20	464.78
6	394.19	21	512.91
7	472.05	22	471.37
8	457.97	23	677.82
9	*	24	564.66
10	*	25	447.76
11	*	26	352.87
12	*	27	630.91
13	*	28	639.46
14	550.25	29	500.31
15	464.10	30	560.12

Remarks: * - The figures here in sales record were not used for estimation since they were incomplete

3) Consumption of imported fisheries products in Majuro

The total import of fishery products in 1977 is estimated to be the imported volume of canned tuna, mackerel and sardines from Japan. The transferred volume of imported canned fish to the other islands is estimated by the transferred volume to Kawjalein which is based on proportional distribution of the population between Majuro and Kawjalein. Since the population of Majuro in 1977 is not available, the census data of 1980 is used for the estimation. Majuro's population in 1980 was 11,791 while Kawjalein's was 6,624. Hence 64 percent of imported fishery products is consumed in Majuro.

4) Annual fresh fish supply by Majuro fishermen in 1988

The volume of fresh fish supply in 1988 by Majuro fishermen was estimated by multiplying the per capita consumption of marketed fish estimated in 1977 by Majuro's population in 1988.

5) Price of fresh fish transported from Arno

The price of fresh fish caught by Majuro fishermen is comparatively higher than that of canned fish. Therefore the price of fish caught in Arno, where the income level of the people is lower than that of Majuro, can be set at same price as canned mackerel and sardines which is the cheapest among canned fish.

6) Fresh fish from Arno to substitute total import of canned mackerel and sardines

If fish from Arno is priced at the same cost as imported mackerel and sardine, it is estimated that it will replace imported mackerel and sardine by 50%.

7) Influence of the sales of fresh fish from Arno on canned tuna imports

Since the preference for canned tuna is strong, its import will not be influenced by the sales of fresh fish from Arno.

(3) Estimation of Potential Demand in Majuro for Fresh Fish from Arno

Based on the above assumptions, the potential demand (D_A) can be obtained from the following formula.

$$D_A = D_M - (S_M + C_T + 0.5C_{M.S})$$

where,

D_M = Total demand of marketable fisheries products in Majuro 1988 (Converted to fresh fish volume)

= [Per capita consumption of marketable fisheries products in 1977 (converted to fresh fish volume)] x (Majuro's population in 1988)

$$= \frac{\text{(1977 sales volume of fresh fish) + (1977 imported volume in Majuro)}}{\text{(Majuro's population in 1977)}} \times \text{(Majuro's population in 1988)}$$

S_M = Annual fresh fish supply by Majuro Fishermen in 1988
= (Per capita consumption of fresh fish in 1977)
x (Majuro's population in 1988)
= (1977 sales volume of fresh fish/Majuro's population in 1977)
x (Majuro's population in 1988)

C_T = Consumption of imported canned tuna in Majuro in 1988
(converted to fresh fish volume)

$C_{M.S}$ = Consumption of imported canned sardine and mackerel in 1988 (converted to fresh fish)

Notes 1) Conversion ratio of canned fish weight to fresh fish weight is 0.53 (Japan Food Supply & Demand Table)
2) Distribution ratio of imported canned food in Majuro; 0.64 in 1977 and 0.68 in 1988

Accordingly,

$$D_M = \frac{[(194,000 \text{ kg/year} + 241,680 \text{ kg/year}) \times 0.64]/0.53}{11,791 \text{ persons}} \times 19,680 \text{ persons}$$

= 41.2 kg/year (per capita consumption marketable fisheries product 1977) x 19,680 persons
= 810,900 kg/year

$$S_M = \frac{194,000 \text{ kg/year}}{11,791 \text{ persons}} \times 19,680 \text{ persons}$$

= 16.5 kg/year (per capita consumption of fresh fish in 1977 x 19,680 persons)
= 323,799 kg/year

As shown in the aforementioned table, total imported volume of canned fish tuna and mackerel/sardine fish in 1988 was 67,200 kg/year and 185,640 kg/year, respectively.
Accordingly,

C_T = (67,200 kg/year x 0.68)/0.53
= 86,218 kg/year

$0.5C_{M.S}$ = (0.5 x 185,640 kg/year x 0.68)/0.53
= 119,089 kg/year

Accordingly the potential demand in Majuro for fresh fish from Arno is,

D_A = 810,900 - (323,799 + 86,218 + 119,089) = 281,794 kg/year

As a result the required daily supply of fresh fish from Arno (S_A) is,

$S_A = D_A/365$ days
$= 281{,}794$ kg/365 days
$=$ Approximately 772 kg/day.

APPX. 2.2.2

Estimated Daily Fish Catch in Arno by a Fishing Boat and Required Number of Fishing Boats

(1) Estimated Daily Fish Catch by a Fishing Boat in Arno

Since there is no fish catch statistical data of existing fishing boats in Arno, and the samplings in the interview survey conducted this time were insufficient, the estimation of fish catch by existing fishing boats could not be obtained. In this study it is assumed that there is not much difference in the marine conditions and fisheries resources between Arno and Majuro, and hence the estimation can be done based on the fish landing data of MFCA during its initial operation from September 1977 to August 1978, which has higher reliability than the data of other periods. The relation between average catch per boat per trip and average landings per month is shown below.

Items	Fish Catch by Fish Type		
	Pelagic	Reef	Bottom
Catch/boat/trip (kg/trip)	111.6	29.5	22.6
Number of landings (trips/month)	66.6	129.5	56.9
Average monthly catch (kg/month)	7,432	3,820	1,286

Fishing boats are used for pelagic and bottom fishes. About 70% of reef fish is landed by spearing and the remaining 30% are caught by cast nets, surrounding net, or gill nets on the reef, where the use of fishing boats is limited. Therefore the catch per boat per trip is estimated by weighted average catches of only pelagic and reef fish. Accordingly,

$$\text{Catch/boat/trip} = \frac{\text{Average monthly catch of pelagic and bottom fish}}{\text{Average monthly number of landings of pelagic \& bottom fish}}$$

$$= \frac{8{,}718 \text{ kg/month}}{123.5 \text{ trips/month}}$$

$$= 70.6 \text{ kg/trip}$$

(2) Required Number of Fishing Boats in Arno

To achieve commercialization of Arno fishery, it is necessary to supply good quality fish at cheaper prices than the fish in Majuro. In order to satisfy these conditions, only fish caught by fishing boats provided for in the implementation of the Project will be transported to Majuro. The required number of boats to be provided in Arno is estimated as shown below.

$$\text{Number of boats} = \frac{\text{Daily potential demand in Majuro for fresh fish from Arno}}{\text{Catch/boat/trip x Operating ratio of fishing boat}}$$

$$= \frac{\text{772 kg/landing}}{\text{70.6 kg/month/boat} \times 2/3}$$

$$= 16.4 \text{ boats}$$

i.e. 16 boats

Currently in Arno and Ine there are 4 fishing boats introduced by OFCF, and therefore an additional 12 boats have to be introduced to achieve the required fish catch.

APPX. 2.2.3

Evaluation of Working Space, and Cold Storage for Ice and Fish

The quantity of fish to be shipped from Arno to Majuro is 772 kg/day. As described in APPX. 2.2.2, 16 fishing boats are necessary to achieve this amount of fish catch. Based on the proportion of the male adult population in both islands 9 boats will be distributed to Arno and 7 to Ine. By operating these fishing boats, it is estimated that the average daily fish catch will be 434 kg in Arno and 338 kg in Ine.

The required capacity of cold storage for fresh fish and ice is estimated on the frequency in which transport vessels between Majuro and Arno are operated, and on the average storage period of fresh fish from Ine and Arno. The following conditions have been decided in order to calculate the capacity of cold storage.

- Transport vessel will operate once in two days between Majuro and Arno, and will be allowed one day to suspend operations in the event of rough weather, emergency repair, etc.

- The storage period of fresh fish at Arno will be for 3 days and will be 2 days in Ine.

Based on the above conditions, optimum cold storage capacity for Arno and Ine is obtained by the following calculation.

(1) Optimum cold storage capacity for fresh fish

Arno = Arno's daily catch x 3 days + Fresh fish volume/trip from Ine
= 434 kg/day x 3 days + 338 kg/day x 2 days
= 1,978 kg
i.e. approximately 2,000 kg

Ine = Ine's daily catch x 2-3 days
= 338 kg/day x 2-3 days
= 676 - 1,014 kg
i.e. approximately 1,000 kg

Accordingly, required cold storage capacity for fresh fish is set at 2 tons for Majuro and 1 ton for Ine, respectively. Required ice volume is to be the same as the required daily fish catch at each site. The storage capacity of each cold storage is shown in the table below.

Fishing Base	Storage Capacity	
	Fish Storage	Ice Storage
Arno	2 tons	2 tons
Ine	1 ton	1 ton

(2) Determining the required area specification for facilities in the multipurpose work building at the Arno fishing base

Required areas for both cold storage and the working space are determined as follows.

1) Fish cold storage

$$S = \frac{V \times a}{P \times h}$$

Where, S : Required area (m^2)
V : Capacity (2 tons)
P : Storage capacity per unit volume (0.3 ton/m^3)
a : Allowance ratio (1.5)
h : Effective height (1.6 m)

$$S = \frac{2 \times 1.5}{0.3 \times 1.6}$$

$$S = 6.25 \text{ m}^2$$

Based on this figure, the approximate specification of the external dimension is determined at 7.29 m^2 (2.7 m x 2.7 m)

2) Ice storage

$$S = \frac{V \times a}{P \times h}$$

Where, S : Required area (m^2)
V : Capacity (2 tons)
P : Storage capacity per unit volume (0.6 ton/m^3)
a : Allowance ratio (1.5)
h : Effective height (1.6 m)

$$S = \frac{2 \times 1.5}{0.6 \times 1.6}$$

$$S = 3.12 \ m^2$$

Based on this figure, the approximate specification of the external dimension is determined at 4.86 m^2 (2.7 m x 1.8 m)

3) Working space area

$$S = \frac{N}{R \times \alpha \times P}$$

Where, S : Required area (m^2)
N : Planned daily handling quantity (434 kg/day)
R : Operation rate (once/day)
P : Handling quantity per unit area (50 kg/m^2)
α : Occupancy ratio (0.2)

$$S = \frac{434}{1 \times 0.2 \times 50}$$

$$S = 43.4 \ m^2$$

This working space is mainly used for sorting and carrying the fish catch in and out of the building. This building has other functions such as fish/ice cold storages, machine room, office with warehouse, toilet, etc. When these required areas are taken into consideration, the pillar span of the building will be optimum at 4 m from an architectural viewpoint. In this case, an area of 52.5 m^2 can be shared for the working space area. Although it has about 9 m^2 more than the calculated area requirement, this 52.5 m^2 is to be adopted for the designed space because it will be used for other purposes such as repair work, meetings, etc.

(3) Determining the required specifications for facilities in the multipurpose work building at the Ine fishing base

Required areas for both cold storage and the working space are determined as follows.

1) Fish cold storage

$$S = \frac{V \times a}{P \times h}$$

Where, S : Required area (m^2)
V : Capacity (1 ton)
P : Storage capacity per unit volume (0.3 ton/m^3)
a : Allowance ratio (2.0)
h : Effective height (1.6 m)

$$S = \frac{1 \times 2.0}{0.3 \times 1.6}$$

$$S = 4.17 \ m^2$$

Based on this figure, the approximate specification of the external dimension is determined at 4.86 m^2 (2.7 m x 1.8 m).

2) Ice storage

$$S = \frac{V \times a}{P \times h}$$

Where, S : Required area (m^2)
V : Capacity (1 ton)
P : Storage capacity per unit volume (0.6 ton/m^3)
a : Allowance ratio (2.0)
h : Effective height (1.6 m)

$$S = \frac{1 \times 2.0}{0.6 \times 1.6}$$

$$S = 2.08 \text{ m}^2$$

Based on this figure, the approximate specification of the external dimension is determined at 3.24 m^2 (1.8 m x 1.8 m).

3) Working space area

$$S = \frac{N}{R \times \alpha \times P}$$

Where, S : Required area (m^2)
N : Planned daily handling quantity (332 kg/day)
R : Operation rate (once/day)
P : Handling quantity per unit area (50 kg/m^2)
α : Occupancy ratio (0.2)

$$S = \frac{332}{1 \times 0.2 \times 50}$$

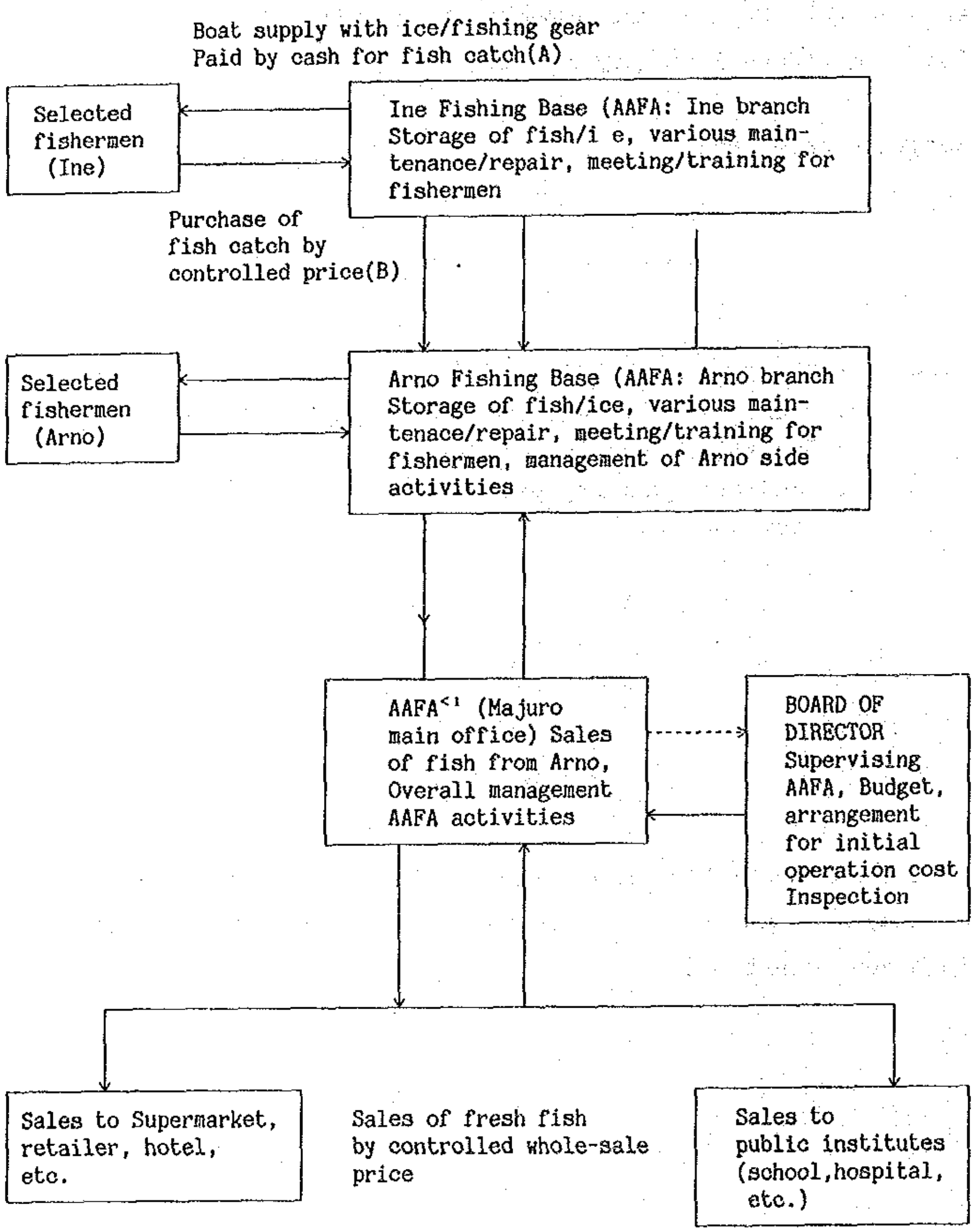
$$S = 33.2 \text{ m}^2$$

As in the Arno fishing base, the working space with an optimum pillar span is calculated at 35 m^2. Space required for repair work etc. was taken into consideration.

APPX. 2.2.4

Arno Fishery Commercialization System

After the Project has been completed, a trial will be undertaken to commercialize Arno fishery with the assistance of the OFCF. In order for Arno fisheries to become successfully commercialized and competitive with the fisheries activities in Majuro, operation under the management of a semi-public organization is required. With this organization functioning as a nucleus, the commercialization system is shown below.



AAFA = Arno Atoll Fishery Association (Semi-public organization)

APPX..2.2.5

Evaluation of Cost/Income Balance of Commercialization of Arno Fisheries

Income from commercialization of Arno fisheries and required operation and maintenance costs (O/M Cost) were estimated on several assumptions. The following are the results.

1. Estimation of O/M cost

(1) Man power

For implementation of Arno fisheries commercialization, a new semi-public market management organization named "Arno Atoll Fisheries Association: AAFA) will be organized . The following nine (9) staff members are required.

<u>Majuro side</u>

1) General manager/Majuro office manager
US$4.50/hour x 7 hours x 22 days = US$693/month

2) Marketing staff (2 members)
US$1.75/hour x 7 hours x 22 days = US$538/month

3) Accountant
US$3.50/hour x 7 hours x 22 days = US$539/month

<u>Arno side</u>

4) Arno manager
US$3.00/hour x 7 hours x 22 days = US$462/month

5) Mechanic
US$2.50/hour x 7 hours x 22 days = US$385/month

6) Ine operator/driver
US$2.00/hour x 7 hours x 22 days = US$308/month

<u>Transport Vessel</u>

7) Captain
US$2.75/hour x 7 hours x 22 days = US$423.50/month

8) Crew
US$2.00/hour x 7 hours x 22 days = US$308/month

Total	US$3,656.50/month

Accordingly the estimated manpower is US$3,656.50/month or US$43,378/year.

(2) Fuel cost of fishing boats

Assumptions

- As explained in APPX. 2.2.1, required daily fish catch is 727 kg/day
- As explained in APPX. 2.2.2, required daily fish catch per boat is 70 kg/day/boat
- Fishing boat applied to this Project is 22 feet FRP boat with 25 HP engine
- Eleven (11) fishing boats are required to achieve daily catch of 727 kg/day. However, in the event that frequency of fishing operations is 70%, total required number of fishing boats is sixteen (16).
- Daily fuel cost per boat is estimated as follows:

  Actual fuel consumption per boat operation in comparison to the fishing boat of the same scale in Majuro Atoll.

  Trolling : 57 liters (15 gallons)
  Bottom line : 30 liters (8 gallons)

Accordingly fuel cost per boat operation is estimated to be 43.5 liters (11.5 gallons) which is the average of the above.

Calculation

The gasoline price is US$0.43/liter (41.60/gallon) in Majuro at present. Accordingly per boat operation fuel cost is estimated:

43.5 x 0.43 = 18.71 US$18.70/boat/operation

Since eleven (11) boats will go fishing daily, the required annual fuel cost for operation is estimated at:

18.70 x 11 x 365 = 75,081, US$75,081/year

(3) Fishing gear replacement cost

Since fishing gear is consumable, replacement costs are estimated at the rate of 10 cents per kg of fish catch. This amount will be deducted and saved. Accordingly, required cost is estimated:

772 x 0.1 x 365 = 28,105, US$28,105/year

(4) Ice purchasing cost

Arno fishermen shall use ice during fishing operations to maintain fish quality. The ice is delivered to Arno fishing base from Majuro and stocked in cold storage. For cooling fish, the required ice weight will equal the weight of the fish catch. In order to compensate for weight loss during transportation and handling, the required daily ice weight is estimated at 1.3 times the weight of the daily fish catch. As the price of ice in Majuro is 4 cents/kg, the required annual ice cost is estimated as follows:

Daily ice required : 772 x 1.3 = 1004 kg
Daily ice cost : 1004 x 0.04 = US$40.20
Annual ice cost : 40.20 x 365 = 14,673, US$14,673/year

(5) Fuel cost of transport vessel

The transportation vessel is scheduled to operate three times a week between Arno and Majuro (annually 144 times). Its fuel consumption is about 57 liters (15 gallons) per each navigation. As the diesel price in Majuro is US$0.28/liter (US$1.05/gallon), the annual required cost of vessel navigation is estimated at :

57 x 0.28 x 144 = 2,298 US$2,298/year

(6) Fuel cost of transportation vehicle

Two vehicles will be used both for transporting fish between Arno-Ine, and for fish sales in Majuro. The fuel efficiency of the vehicles is assumed to be 5 km/liter. The fish catch from Ine is scheduled to be delivered to the Arno fishing base (to and fro 40 km and once in 2-3 days) Accordingly the annual fuel cost for transportation from Arno to Ine is estimated at:

(40 x 15 x 12)/5 x 0.43 = 619, US$619/year

Fish sales in Majuro will be carried out daily. The average daily average delivery distance is estimated at 50 km. Accordingly, annual fuel costs are estimated at:

(50 x 30 x 12)/5 0.43 = 1,548. US$1,548/year

Consequently, the total annual required fuel cost both in Arno and Majuro is US$2,167/year.

(7) Fuel cost of the generator

A generator is installed for the operation of each cold storage at each fishing base. Fuel consumption of these generators is 76.24 liter/day in Arno and 58.08 liter/day in Ine. Accordingly, the annual required fuel costs of the generators are:

Arno

76.24 x 30 x 12 x 0.28 = 7,685 US$7,685/year

Ine

52.08 x 30 x 12 x 0.28 = 5,250 US$5,250/year

Total US$12,935/year

The annual engine oil cost (US$3.85/liter) of the generator is 33.6 liters (US$129) in Arno and US$20.8 (US$80) in Ine. Consequently, the total fuel cost of the generators is estimated at:

12,935 + 209 = 13,144 US$13,144/year

(8) Maintenance cost

Annual maintenance cost of the facilities and the equipment used in the commercialization of Arno fisheries is as follows:

1) Outboard engine

5% of the cost of the engine is required annually for maintenance. US$72.50 is required annually for a 27 HP outboard engine. Therefore the total cost is estimated at US$1,160/year.

2) Transport vessel

5% of the cost of the vessel is required annually for maintenance and the estimated cost is US$1,538/year.

3) Vehicles

3% of the cost the vehicles is required annually for maintenance. US$462/year is required for one vehicle. Therefore, the total cost is estimated at US$924/year.

4) Generator

5% of the cost of the generator is required annually for maintenance and the estimated cost is US$20/year.

5) Pumps

5% of the cost of the pumps is required annually. The estimated cost is US$20/year.

6) Repainting of building

Repainting is to be done once in every three years. The necessary cost will be deposited annually. The total estimated cost is US$1,020/year.

Consequently, the total O/M cost is estimated at US$5,645/year.

(9) Renewal cost for facilities/equipment

All the facilities/equipment are to be replaced when they are no longer usable. The cost of facilities/equipment will be divided by their lifespan and this amount will be depoisted annually and saved to cover replacement costs. Details are as follows:

1) Fishing boats

Generally the lifespan of a FRP fishing boat is 15 years. However the lifespan of boats in this Project is expected to be 10 years because the frequency of bumping the boat on the coral reef bottom in the Project area is high. The necessary annual deposit for 16 fishing boats is estimated at US$6,917/year

2) Outboard engine

The lifespan is about four years with good maintenance. The necessary annual deposit for 16 engines is estimated at US$5,808/year.

3) Vehicles

The lifespan of vehicles in both Arno and Majuro is five years. The necessary annual deposit for them is estimated at US$3,692/year.

4) Transport vessel

The lifespan of the vessel is about 15 years. The necessary annual deposit is estimated at US$20,512/year.

5) Generator

The lifespan of the generator is about 10 years. The necessary annual deposit is estimated at US$1,077/year for the generator in Arno, and US$885/year for the generator in Ine. The total estimate is US$1,962/year.

6) Cooling units for cold storages

The lifespan of cooling units in this Project is assumed to be five years based on past experience in the Central/South Pacific oceans. The total of annual deposit for four units is estimated at US$2,380/year.

7) Pumps

The lifespan of a pump is about five years. Two pumps are installed in each fishing base. The total annual deposit is estimated at US$814/year.

8) Ice crusher

The lifespan of an ice crusher is about 10 years. The total annual deposit of two crushers is estimated at US$384/year.

Consequently, the total annual deposit is US$42,475/year.

The overall annual operation/maintenance cost described in the aforementioned (1) - (9) is US$227,466/year

2. Determining the sales price of fresh fish from Arno

One of the objectives of the Project is to utilize the abundant protein source of fishery products in the country, and to reduce the imported amount of canned fish. For this reason, the price of fresh fish from Arno will be set within a competitive viable range against the price of canned fish. As explained in APPX. 2.2.1, the price of mackerel/sardine cans is cheaper than fresh fish in Majuro. Accordingly, the price of Arno fish will be set at the CIF price of mackerel/sardine converted to that of fresh fish weight. The sales price of Arno fish using the conversion rate of 0.53 is calculated as follows.

- CIF price of mackerel/sardine can in Majuro (1988) is US$1.56/can (net 425 g/can)
  425/0.53 = 801.9 g (converted weight to fresh fish)
  US$1.56/801.9 = US$1.94/kg (can price converted to fresh fish price)

Accordingly, the price of Arno fish will be set at US$1.94/kg (US$0.88/lb) to compete with the price of mackerel/sardine cans. Accordingly, the wholesale price of Arno fish to the retailer is set at US$1.74/kg (US$0.79/lb) to secure a profit of 20 cents/kg for retailers. This wholesale price is much cheaper than the fish in Majuro.

As the expected annual fish catch is 281,780 kg, the total annual sale of fish in the Project is estimated at,

281,780 x 1.74 = 490,297, US$490,297/year

3. Purchase price from Arno fishermen

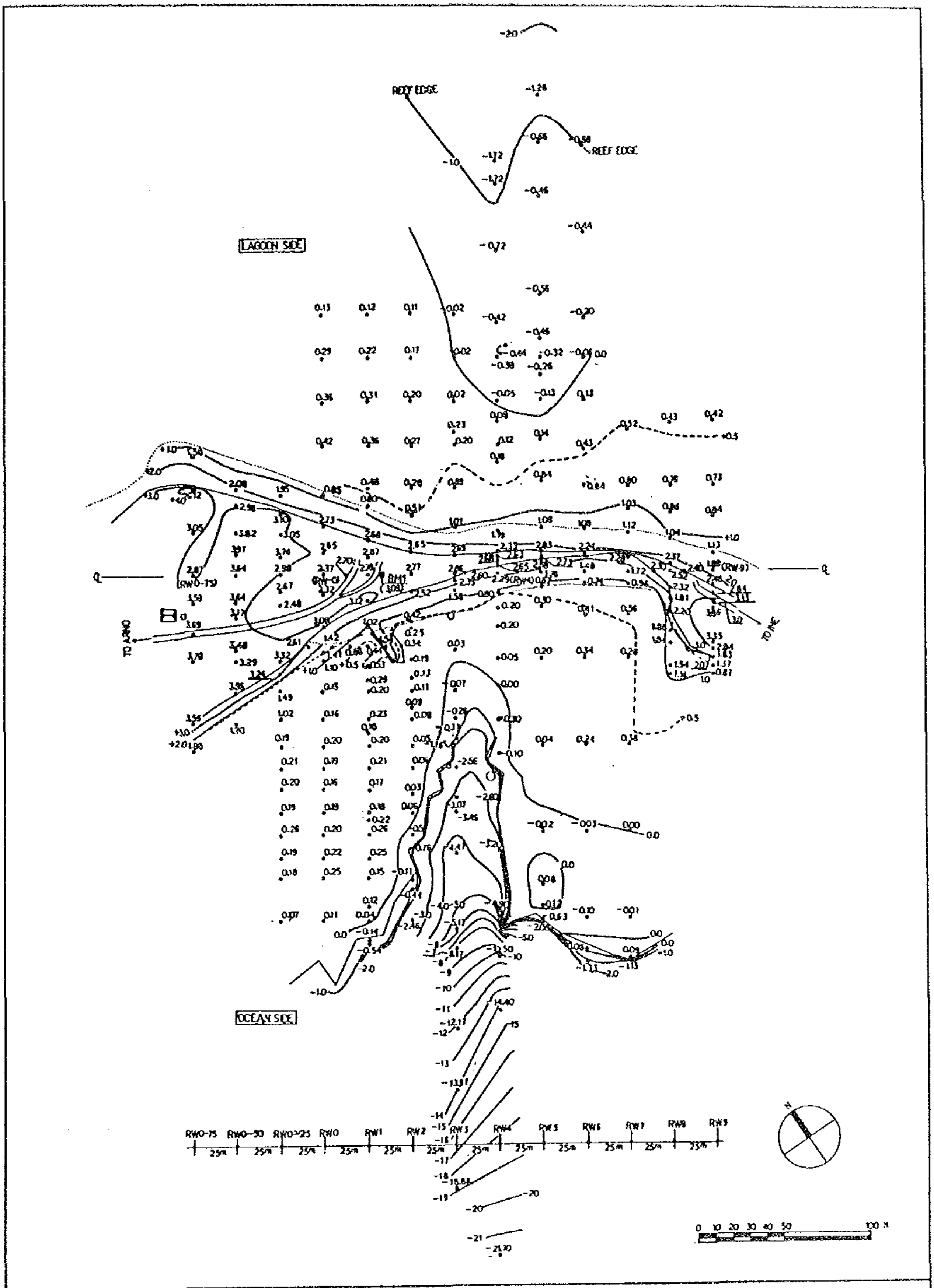
The estimated annual sale of fresh fish is US$490,297 and the annual cost is US$227,466 in the Project. The total amount to be returned to the Arno fishermen who participate in the Project is calculated at US$262,831/year which is the balance of the said sale and cost. At this cost and income balance, estimated cost per kg of fresh fish is US$0.81 (US$0.37/lb) and purchased fresh fish from Arno fishermen is US$0.93/kg (US$0.42/lb). The number of fishermen per boat is three (3), that is, a total of 48 fishermen in 16 boats. Accordingly, per capita income of US$5,476 (US$456/month) to Arno fishermen can be guaranteed. Since this income level is almost the same level as the salary of a Marine Research Specialist of MIMRA, it can be assumed that the planned purchase price of fish will be accepted by Arno fishermen.

4. Income and expenditure of commercialization of Arno fishery

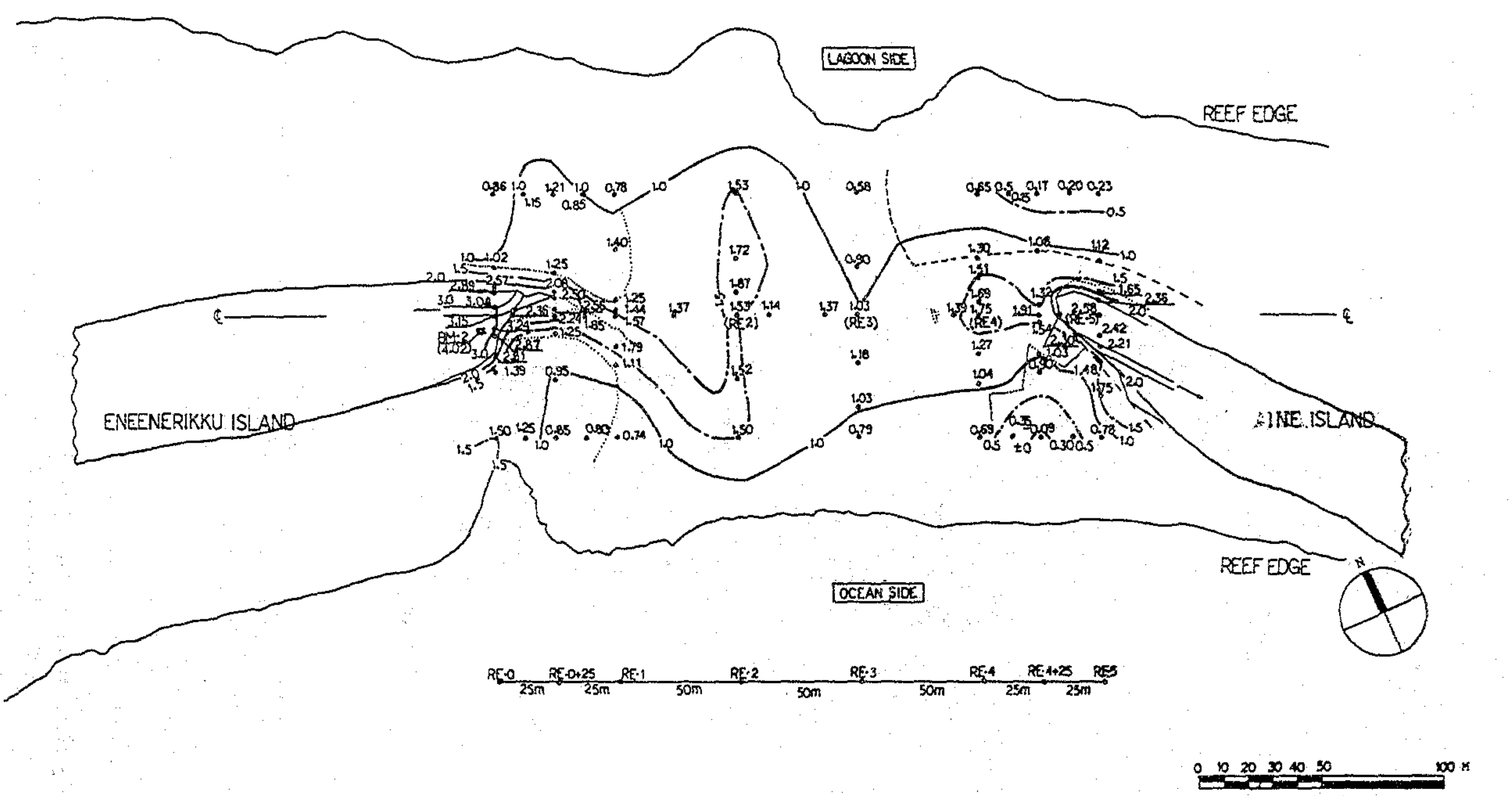
Based on the results of calculation described above in section 1.2.3, the expected income and expenditure of commercialization of Arno fishery is shown in the table below.

Income : Fresh fish sales (Approx. 281 tons/year			US$490,297
Expenditure :	1) Personnel		43,878
	2) Fuel cost (Fishing boat)		75,081
	3) Replacement cost (gears)		28,105
	4) Ice cost		16,673
	5) Fuel cost (Transport vessel)		2,298
	6) Fuel cost (Vehicle)		2,167
	7) Fuel (Generator)		13,144
	8) Maintenance cost		5,645
	Outboard engine	1,160	
	Transport vessel	1,538	
	Vehicle	924	
	Generator	980	
	Pump	21	
	Painting	1,022	
	9) Depreciation cost facilities/machinery		42,475
	Outboard engine (16)	6,917	
	Fishing boat (16)	5,808	
	Vehicles (2)	3,692	
	Transport vessel (1)	20,513	
	Generator (2)	1,962	
	Cooling unit (4)	2,385	
	Pump (4)	814	
	Ice crusher (2)	384	
Total			227,466
Arno fishermen's income			262,837

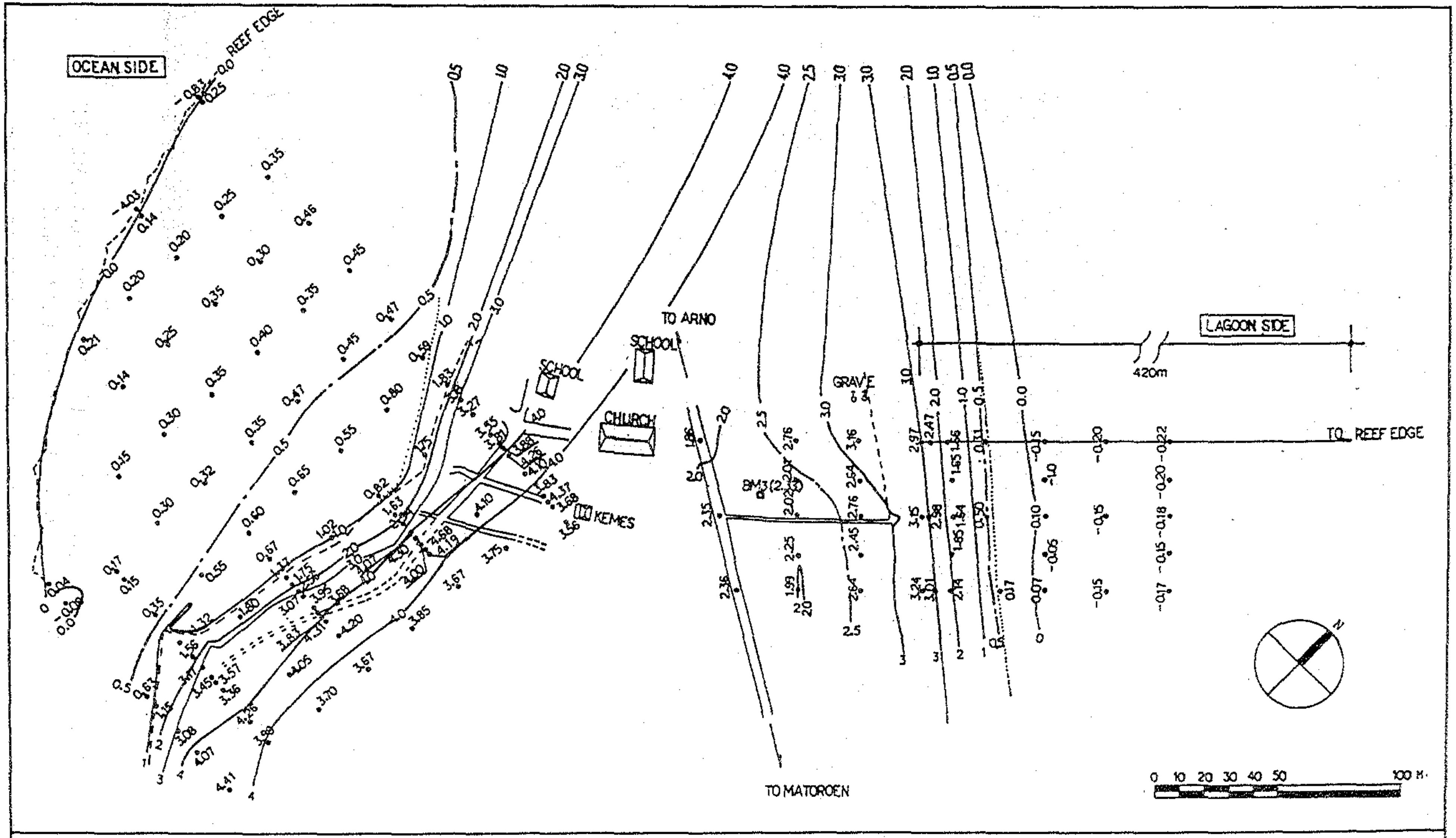
2-3 RESULTS OF NATURAL CONDITIONS SURVEY



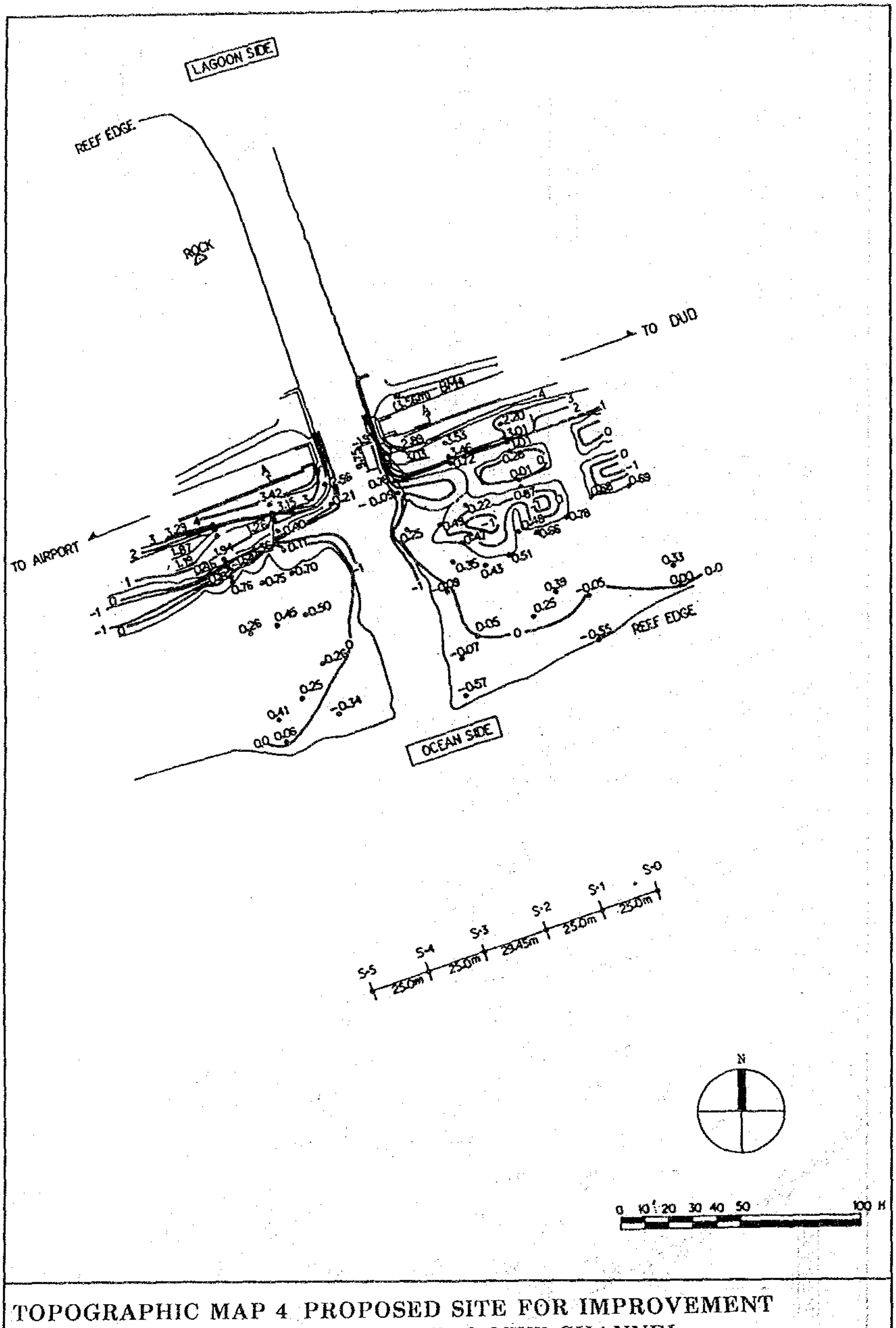
TOPOGRAPHIC MAP 1 PROPOSED SITES FOR ARNO FISHING BASE & CAUSEWAY BETWEEN ARNO AND INE (WEST SIDE)



TOPOGRAPHIC MAP 2 PROPOSED SITE FOR CAUSEWAY BETWEEN ARNO AND INE (EAST SIDE)



TOPOGRAPHIC MAP 3 PROPOSED SITE FOR INE FISHING BASE

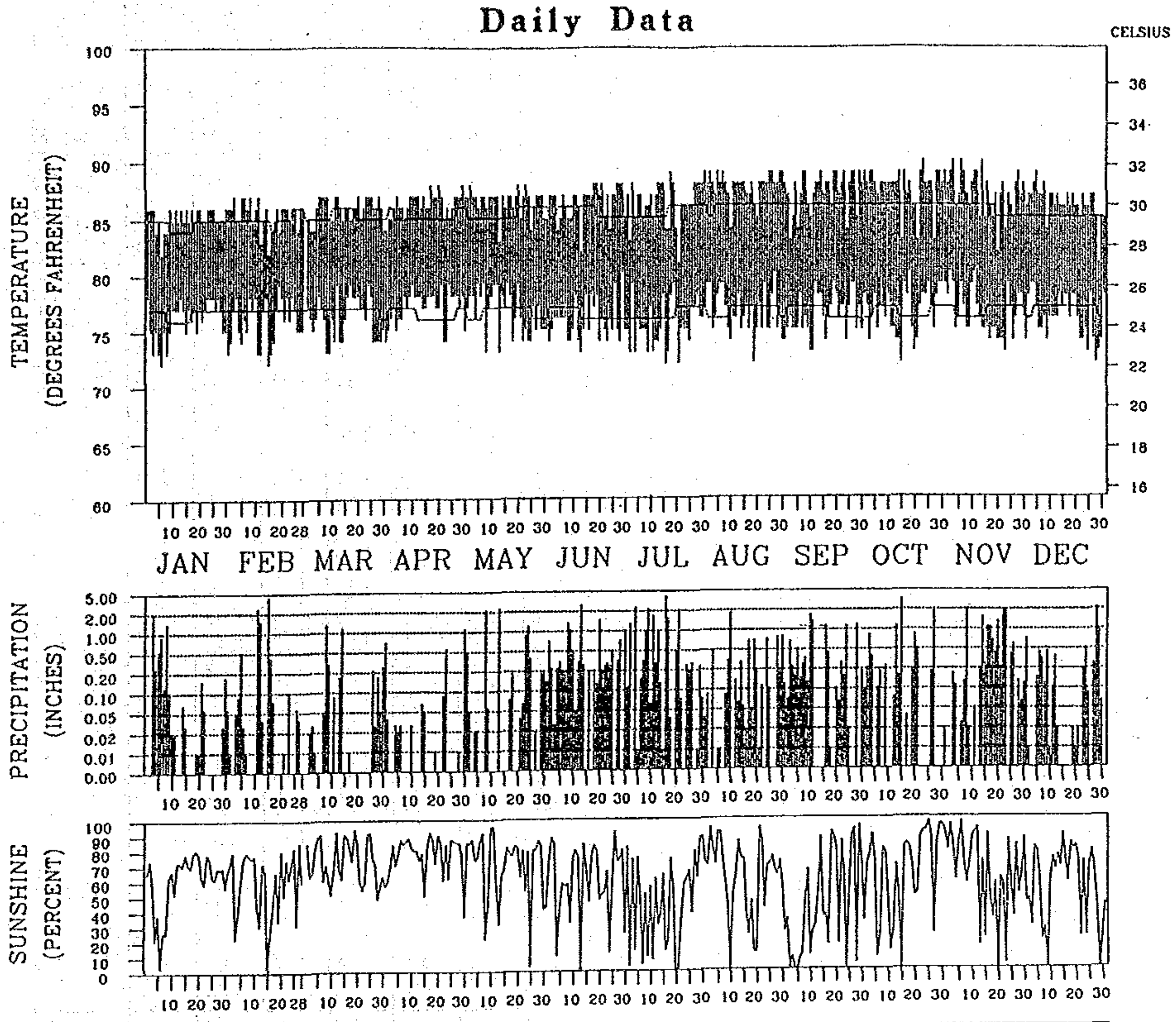


TOPOGRAPHIC MAP 4 PROPOSED SITE FOR IMPROVEMENT OF THE MAJURO NEW CHANNEL

ISSN 0198-4330

1987 LOCAL CLIMATOLOGICAL DATA
ANNUAL SUMMARY WITH COMPARATIVE DATA
MAJURO, MARSHALL ISLANDS,
PACIFIC

Daily Data



TEMPERATURE DEPICTS NORMAL MAXIMUM, NORMAL MINIMUM AND ACTUAL DAILY HIGH AND LOW VALUES (FAHRENHEIT)
PRECIPITATION IS MEASURED IN INCHES, SCALE IS NON-LINEAR
SUNSHINE IS PERCENT OF THE POSSIBLE SUNSHINE

I CERTIFY THAT THIS IS AN OFFICIAL PUBLICATION OF THE NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION, AND IS COMPILED FROM RECORDS ON FILE AT THE NATIONAL CLIMATIC DATA CENTER, ASHEVILLE, NORTH CAROLINA, 28801

Kenneth D Hadeen
DIRECTOR
NATIONAL CLIMATIC DATA CENTER

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METEOROLOGICAL DATA FOR 1987

MAJURO, MARSHALL ISLANDS, PACIFIC

LATITUDE: 7°05' N LONGITUDE: 171°23'E ELEVATION: FT. GRND 10 BARO 8 TIME ZONE: 180E MER WBAN: 40710

	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEP	OCT	NOV	DEC	YEAR
TEMPERATURE °F:													
Averages													
-Daily Maximum	85.3	85.5	85.9	86.5	86.5	86.4	86.4	87.8	87.3	87.7	87.2	86.3	86.6
-Daily Minimum	75.9	75.9	76.0	77.1	76.5	75.7	75.3	76.3	76.2	76.6	76.3	76.0	76.2
-Monthly	80.6	80.7	81.0	81.8	81.5	81.1	80.9	82.1	81.8	82.2	81.8	81.2	81.4
-Monthly Dewpt.													
Extremes													
-Highest	86	87	87	88	88	88	89	89	89	90	90	89	90
-Date	31	11	28	29	23	29	31	30	29	23	14	5	NOV 14
-Lowest	72	72	73	74	73	73	72	72	73	72	73	72	72
-Date	6	15	9	23	13	13	21	19	11	15	23	28	DEC 28
DEGREE DAYS BASE 65 °F:													
Heating	0	0	0	0	0	0	0	0	0	0	0	0	0
Cooling	491	447	501	510	520	489	499	537	510	540	510	508	6062
% OF POSSIBLE SUNSHINE	61	58	72	77	69	60	46	60	43	64	62	54	61
AVG. SKY COVER (tenths)													
Sunrise - Sunset	9.2	9.2	8.7	8.0	9.0	9.0	9.1	8.3	8.8	8.9	9.0	9.5	8.9
Midnight - Midnight													
NUMBER OF DAYS:													
Sunrise to Sunset													
-Clear	0	0	0	0	0	0	0	0	0	1	0	0	1
-Partly Cloudy	3	3	6	11	6	6	4	8	8	5	5	2	67
-Cloudy	28	25	25	19	25	24	27	23	22	25	25	29	297
Precipitation .01 inches or more	18	16	16	12	18	26	27	24	22	18	23	21	241
Snow,Ice pellets 1.0 inches or more	0	0	0	0	0	0	0	0	0	0	0	0	0
Thunderstorms	0	0	2	0	0	0	0	1	0	0	3	0	6
Heavy Fog, visibility 1/4 mile or less	0	0	0	0	0	0	0	0	0	0	0	0	0
Temperature °F													
-Maximum													
90° and above	0	0	0	0	0	0	0	0	0	1	3	0	4
32° and below	0	0	0	0	0	0	0	0	0	0	0	0	0
-Minimum													
32° and below	0	0	0	0	0	0	0	0	0	0	0	0	0
0° and below	0	0	0	0	0	0	0	0	0	0	0	0	0
AVG. STATION PRESS. (mb)													
RELATIVE HUMIDITY (%)													
Hour 00	82	80	80	80	83	86	85	81	83	84	85	82	83
Hour 06 (Local Time)	82	80	80	82	83	86	86	84	84	85	85	82	76
Hour 12	75	73	71	72	77	80	78	75	78	78	79	77	79
Hour 18	79	75	76	76	79	82	80	77	81	80	82	78	83
PRECIPITATION (inches):													
Water Equivalent													
-Total	6.24	10.38	4.90	2.14	9.22	14.76	21.17	8.36	11.09	11.29	15.45	7.48	122.48
-Greatest (24 hrs)	2.09	4.59	1.69	1.17	2.61	3.23	5.86	1.98	1.77	3.70	2.30	2.59	5.86
-Date	3- 4	15-16	8- 9	30	13	13-14	16-17	9-10	10	15	21-22	28-29	JUL 16-17
Snow,Ice pellets													
-Total	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
-Greatest (24 hrs)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
-Date													
WIND:													
Resultant													
-Direction (!!!)													
-Speed (mph)													
Average Speed (mph)													
Fastest Mile													
-Direction (!!!)	E	E	E	E	E	E	E	SE	NW	SE	SE	NE	E
-Speed (mph)	30	26	26	25	21	24	23	27	27	22	23	25	30
-Date	21	16	30	3	25	7	14	22	4	13	4	27	JAN 21
Peak Gust													
-Direction (!!!)	E	E	E	E	SE	SE	SE	SE	NW	SE	E	E	E
-Speed (mph)	39	35	33	31	32	31	30	32	31	25	26	32	39
-Date	21	15	30	2	4	27	14	22	4	13	30	1	JAN 21

(!!!) See Reference Notes on Page 68

Page 2

NORMALS, MEANS, AND EXTREMES

MAJURO, MARSHALL ISLANDS, PACIFIC

LATITUDE: 7°05'N LONGITUDE: 171°23'E ELEVATION: FT. GRND 10 BARO 8 TIME ZONE: 180E MER WBAN: 40710

	(a)	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEP	OCT	NOV	DEC	YEAR
TEMPERATURE °F:														
Normals														
-Daily Maximum		84.7	85.1	85.3	85.2	85.4	85.5	85.5	85.9	86.0	86.0	85.6	85.0	85.4
-Daily Minimum		76.7	77.0	76.9	76.5	76.6	76.4	76.4	76.6	76.5	76.5	76.6	76.8	76.6
-Monthly		80.7	81.1	81.1	80.9	81.0	81.0	81.0	81.3	81.3	81.3	81.1	80.9	81.1
Extremes														
-Record Highest	32	89	88	89	89	90	89	90	91	90	91	90	90	91
-Year		1979	1986	1984	1983	1986	1986	1980	1969	1986	1958	1987	1979	AUG 1969
-Record Lowest	32	69	70	70	70	70	70	70	71	72	70	70	70	69
-Year		1958	1985	1982	1985	1985	1958	1985	1986	1986	1984	1984	1984	JAN 1958
NORMAL DEGREE DAYS:														
Heating (base 65°F)		0	0	0	0	0	0	0	0	0	0	0	0	0
Cooling (base 65°F)		487	451	499	477	496	480	496	505	489	505	483	493	5861
% OF POSSIBLE SUNSHINE	27	62	64	66	57	58	54	56	61	59	55	54	53	58
MEAN SKY COVER (tenths) Sunrise - Sunset	31	8.6	8.3	8.4	8.6	8.6	8.7	8.6	8.4	8.5	8.6	8.7	8.7	8.6
MEAN NUMBER OF DAYS:														
Sunrise to Sunset														
-Clear	31	0.9	1.0	1.3	0.7	0.7	0.4	0.6	0.6	0.9	0.9	0.5	0.6	9.1
-Partly Cloudy	31	6.4	7.6	6.9	6.6	6.9	6.4	6.2	8.1	6.3	6.7	6.4	6.0	80.5
-Cloudy	31	23.7	19.6	22.8	22.6	23.4	23.3	24.2	22.3	22.8	23.4	23.1	24.4	275.6
Precipitation .01 inches or more	33	17.0	15.6	18.2	21.1	23.4	24.3	24.4	23.4	22.5	23.6	23.1	22.0	258.5
Snow,Ice pellets 1.0 inches or more	33	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Thunderstorms	18	0.3	0.6	0.7	0.6	0.9	1.9	1.6	1.8	2.8	2.2	2.1	1.1	16.6
Heavy Fog Visibility 1/4 mile or less	19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Temperature °F														
-Maximum														
90° and above	33	0.0	0.0	0.0	0.0	0.*	0.0	0.*	0.3	0.3	0.5	0.1	0.*	1.3
32° and below	33	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
-Minimum														
32° and below	33	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0° and below	33	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AVG. STATION PRESS. (mb)	11	1008.9	1009.3	1009.6	1009.3	1009.6	1009.3	1009.1	1009.3	1009.3	1008.8	1008.2	1008.3	1009.1
RELATIVE HUMIDITY (%)														
Hour 00	31	80	79	81	83	84	84	83	82	82	82	82	82	82
Hour 06 (Local Time)	32	81	80	81	84	85	84	84	84	83	83	83	82	83
Hour 12	32	75	73	74	77	78	78	77	76	76	76	77	76	76
Hour 18	31	78	77	78	80	81	80	79	78	78	79	80	79	79
PRECIPITATION (inches):														
Water Equivalent														
-Normal		7.99	6.37	8.96	11.91	12.32	12.04	12.65	11.61	13.09	15.24	13.47	11.52	137.17
-Maximum Monthly	33	21.97	18.34	18.51	31.10	22.23	17.63	21.17	19.98	21.11	24.26	23.56	24.80	31.10
-Year		1961	1957	1955	1971	1956	1975	1987	1986	1964	1955	1978	1968	APR 1971
-Minimum Monthly	33	0.78	0.40	0.66	1.97	1.49	5.40	5.34	5.33	6.42	7.11	4.53	2.28	0.40
-Year		1973	1970	1983	1983	1983	1984	1961	1959	1984	1969	1972	1957	FEB 1970
-Maximum in 24 hrs	33	9.57	6.28	8.14	6.63	5.86	7.39	5.86	5.29	5.76	8.74	10.01	17.88	17.88
-Year		1961	1957	1972	1973	1962	1983	1987	1986	1982	1974	1957	1972	DEC 1972
Snow,Ice pellets														
-Maximum Monthly														
-Year														
-Maximum in 24 hrs	33													
-Year														
WIND:														
Mean Speed (mph)	24	12.8	13.7	13.2	12.1	11.1	10.0	8.5	7.3	7.1	7.5	8.9	12.5	10.4
Prevailing Direction through 1963		ENE	ENE	ENE	ENE	ENE	ENE	ENE	ENE	E	E	E	ENE	ENE
Fastest Mile														
-Direction (!!!)	29	E	E	NE	E	E	NE	E	NW	E	E	SW	E	SW
-Speed (MPH)	29	38	35	36	35	38	38	34	33	36	38	45	38	45
-Year		1986	1962	1959	1963	1962	1964	1973	1985	1973	1985	1982	1973	NOV 1982
Peak Gust														
-Direction (!!!)	4	E	E	E	E	E	E	SE	NW	E	E	SW	E	E
-Speed (mph)	4	40	39	40	35	36	40	39	38	39	47	39	39	47
-Date		1986	1984	1986	1986	1984	1984	1986	1986	1984	1985	1984	1984	OCT 1985

(!!!) See Reference Notes on Page 68.

PRECIPITATION (inches)

MAJURO, MARSHALL ISLANDS, PACIFIC

YEAR	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEP	OCT	NOV	DEC	ANNUAL
1958	9.78	0.96	7.77	8.03	8.53	14.30	14.55	9.05	6.88	18.71	13.53	8.45	120.54
1959	1.07	9.47	8.72	12.69	6.35	14.17	11.00	5.33	16.36	11.49	19.92	14.00	130.57
1960	9.17	3.60	11.17	23.41	14.27	13.22	14.10	14.59	16.93	9.71	16.32	6.54	153.03
1961	21.97	6.50	4.24	8.50	8.34	13.90	5.34	11.31	11.14	11.50	12.04	16.91	131.69
1962	17.55	5.15	11.48	5.95	12.01	7.54	11.02	8.91	21.03	16.36	22.69	11.71	151.40
1963	17.46	9.57	12.43	6.21	11.31	11.96	11.69	10.76	6.83	13.13	11.60	8.57	131.52
1964	1.40	6.99	7.23	11.46	22.02	11.16	18.69	15.58	21.11	22.79	16.85	7.42	162.70
1965	9.85	5.32	1.98	4.69	7.93	11.45	14.85	6.92	15.46	14.71	12.12	9.55	114.83
1966	3.79	4.42	5.80	16.03	8.64	9.40	14.94	6.52	13.95	13.53	12.24	19.44	128.70
1967	11.88	9.72	12.46	7.64	4.93	10.98	13.87	7.99	13.78	15.16	11.16	6.48	126.05
1968	5.38	3.49	11.12	8.86	9.33	16.07	11.39	11.50	9.77	12.06	11.97	24.80	135.74
1969	8.22	2.35	16.17	17.21	8.78	13.01	16.65	10.24	15.65	7.11	11.68	7.21	134.28
1970	5.62	0.40	1.73	2.87	9.23	10.66	7.73	11.24	11.75	12.64	6.68	8.40	88.95
1971	8.21	5.74	9.80	31.10	19.86	13.42	15.49	14.92	7.93	18.06	9.46	8.40	162.39
1972	9.58	7.11	15.45	9.17	14.96	14.88	14.76	10.84	18.96	14.06	4.53	23.36	157.66
1973	0.78	1.84	11.05	14.59	14.33	12.23	7.29	13.86	12.78	13.79	14.21	7.24	123.99
1974	11.09	8.07	7.18	15.67	12.84	13.66	12.48	13.69	10.44	19.90	9.29	14.49	148.80
1975	5.20	3.21	7.77	12.76	10.58	17.63	14.23	16.35	16.51	18.29	15.28	13.95	151.76
1976	8.57	9.42	15.68	19.41	15.28	9.43	16.78	8.36	17.66	8.95	12.70	2.77	145.01
1977	2.39	0.77	2.60	10.62	17.21	8.37	10.88	11.15	9.72	17.59	11.85	18.88	122.03
1978	3.60	5.25	3.39	12.65	13.90	10.70	16.25	8.86	9.73	20.56	23.56	14.35	142.80
1979	6.78	2.77	7.14	11.75	7.91	13.23	6.67	13.03	6.54	15.04	11.33	7.10	109.29
1980	8.11	9.70	5.05	7.03	11.34	6.73	8.48	13.89	12.85	9.25	5.35	10.56	108.34
1981	0.90	4.34	17.40	10.20	9.04	5.43	16.53	12.24	6.71	7.28	14.61	14.47	119.15
1982	12.63	9.72	13.29	4.68	11.46	16.98	14.66	11.72	18.94	8.17	19.08	3.17	144.50
1983	0.83	0.98	0.66	1.97	1.49	14.45	12.58	6.05	11.25	13.47	9.84	12.74	86.31
1984	16.12	16.83	1.29	3.87	4.18	5.40	9.35	9.20	6.42	14.77	13.31	14.95	115.69
1985	8.70	16.56	4.59	15.38	9.67	14.67	13.18	16.77	8.03	18.06	12.81	11.30	149.72
1986	10.51	3.91	14.75	12.23	14.94	15.89	12.09	19.98	10.52	7.32	9.37	17.10	148.61
1987	6.24	10.38	4.90	2.14	9.22	14.76	21.17	8.36	11.09	11.29	15.45	7.48	122.48
Record Mean	7.99	6.92	8.79	10.92	11.35	12.20	12.88	11.61	12.52	14.36	13.36	11.29	134.18

See Reference Notes on Page 6B.

Page 4A

AVERAGE TEMPERATURE (deg. F)

MAJURO, MARSHALL ISLANDS, PACIFIC

YEAR	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEP	OCT	NOV	DEC	ANNUAL
1958	80.3	81.8	81.1	81.0	80.5	80.6	81.0	81.7	81.7	81.6	81.7	81.3	81.2
1959	81.2	80.9	81.5	80.5	82.0	81.1	81.3	82.2	81.4	81.4	81.1	80.6	81.3
1960	81.0	81.6	81.5	80.2	80.6	80.6	81.1	81.2	81.7	82.3	81.8	81.7	81.3
1961	81.3	81.8	82.6	81.7	81.5	81.2	81.5	81.3	81.1	81.9	81.4	80.9	81.5
1962	80.9	81.6	80.7	81.7	82.2	81.3	81.2	81.8	81.0	81.5	80.7	81.5	81.3
1963	80.5	80.5	80.7	82.1	82.3	81.8	81.7	82.2	82.8	81.7	81.8	81.3	81.6
1964	81.8	81.6	81.3	81.4	81.1	80.7	80.8	80.8	80.5	80.7	80.7	80.8	81.0
1965	80.2	80.5	81.5	81.3	81.0	81.2	80.7	82.1	81.3	81.4	81.0	80.8	81.1
1966	81.0	81.3	81.3	80.7	81.7	81.7	81.9	82.5	81.8	81.9	81.2	80.9	81.5
1967	81.0	80.8	80.2	81.2	82.0	81.3	81.4	82.2	82.0	81.4	81.2	81.5	81.4
1968	81.1	81.4	80.3	80.6	80.8	81.1	80.9	81.4	81.8	81.1	81.1	80.6	81.0
1969	80.1	81.1	81.0	80.7	81.5	81.2	80.5	81.6	81.5	82.4	82.0	81.3	81.2
1970	81.2	82.0	82.0	82.1	81.5	80.7	81.1	80.8	81.1	80.6	81.2	80.6	81.3
1971	80.6	80.9	80.9	79.5	80.0	80.2	80.5	80.1	80.8	80.5	81.1	80.5	80.5
1972	80.2	80.9	80.8	80.8	81.2	81.5	80.9	81.2	81.3	80.9	81.7	80.8	81.0
1973	80.9	81.8	81.6	81.3	80.6	80.8	80.9	80.8	80.2	80.5	80.7	81.1	80.9
1974	79.9	80.8	80.8	80.5	80.8	80.6	80.7	81.0	80.9	81.0	80.9	80.3	80.7
1975	80.4	81.0	80.7	80.2	80.5	79.7	79.7	79.9	80.0	78.8	79.4	79.5	80.0
1976	79.4	79.4	79.6	79.5	80.0	80.0	80.0	80.7	80.4	81.4	80.2	80.1	80.1
1977	80.3	81.3	81.5	80.5	80.1	81.2	80.9	81.2	82.4	81.1	81.2	81.1	81.1
1978	81.2	81.1	81.5	80.9	80.5	80.9	80.4	81.5	81.6	81.2	80.6	80.3	81.0
1979	81.2	81.0	81.6	79.7	80.9	81.5	81.5	80.9	82.0	82.1	81.8	81.7	81.3
1980	81.4	81.3	81.3	81.6	81.5	81.9	81.5	81.5	81.7	82.2	81.9	81.0	81.6
1981	81.4	81.5	81.0	80.9	81.4	82.0	80.8	81.4	82.0	82.0	81.0	80.6	81.3
1982	80.5	80.7	80.5	81.8	81.3	81.3	81.1	81.3	81.4	82.0	81.4	80.2	81.1
1983	80.1	80.5	81.4	82.2	83.0	81.4	81.3	82.2	81.8	80.9	81.0	80.3	81.3
1984	80.6	80.6	82.0	81.9	81.5	80.3	80.6	81.1	81.2	80.8	80.6	80.9	81.0
1985	80.8	80.3	80.7	79.8	81.1	80.4	80.7	80.4	81.5	81.4	81.5	80.9	80.8
1986	81.1	81.9	80.3	81.1	81.7	81.1	81.7	81.8	81.8	82.1	81.9	80.5	81.4
1987	80.6	80.7	81.0	81.8	81.5	81.1	80.9	82.1	81.8	82.2	81.8	81.2	81.4
Record Mean	80.7	81.0	81.1	81.0	81.2	81.0	80.9	81.3	81.3	81.3	81.2	80.8	81.1
Max	84.8	85.2	85.5	85.4	85.7	85.6	85.6	86.1	86.2	86.2	85.8	85.2	85.6
Min	76.6	76.8	76.7	76.5	76.6	76.3	76.2	76.4	76.5	76.4	76.5	76.5	76.5

See Reference Notes on Page 6B.

Page 4B

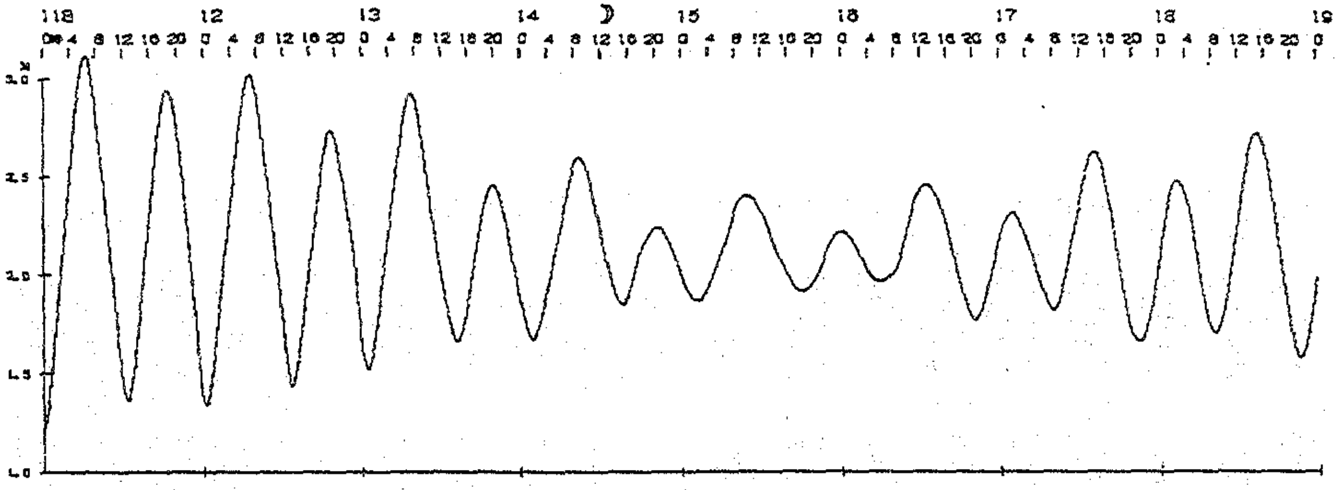
***** HOURLY TIDAL OBSERVATIONS *****

AREA : Marshall Islands
STATION : Arno Atoll
TIME ZONE : − 12.00
LATITUDE : 7 3 0 N
LONGITUDE : 171 27 0 E
EPOCH : 1989 3 11 0
UNIT : CENTIMETER

HOUR																									
11	121	142	180	215	251	286	310	308	280	250	216	180	147	136	161	197	230	264	289	293	275	245	209	171	5356
12	137	140	171	204	234	265	291	302	289	263	234	203	171	144	153	180	207	233	259	273	267	247	226	200	5293
13	162	152	168	196	222	248	271	290	289	270	244	219	198	179	167	170	187	207	227	241	246	238	222	204	5217
14	186	172	167	177	192	208	224	240	256	260	252	237	220	204	192	185	189	202	213	220	224	223	217	209	5069
15	198	191	187	188	194	203	211	221	233	239	240	238	232	224	215	207	200	194	192	193	197	204	213	220	5034
16	222	220	215	208	201	197	197	199	202	211	225	237	244	246	242	235	224	209	195	184	177	181	192	205	5068
17	221	229	232	225	217	206	195	186	182	190	206	222	239	255	263	259	243	223	200	180	168	166	174	189	5070
18	210	232	246	247	240	224	200	180	171	173	187	207	230	252	268	273	264	243	216	191	170	158	163	180	5125
19	203	227	247	261	260	241	217	192	168	158	167	188	215	245	273	285	278	257	232	200	172	151	153	172	5162
20	198	224	246	262	263	253	233	201	174	155	152	165	194	229	263	284	289	275	249	213	173	144	136	150	5125
21	178	210	241	271	289	282	248	210	175	145	134	145	176	218	263	291	293	276	246	213	180	147	129	136	5096
22	169	205	238	267	288	285	255	219	191	153	140	143	170	204	238	272	297	306	287	246	201	162	139	142	5217
23	165	198	230	260	282	282	254	223	193	165	144	137	153	188	224	260	290	302	286	250	211	170	139	126	5132
24	136	171	211	247	274	283	270	244	218	187	156	134	131	160	200	243	274	285	276	255	224	190	160	132	5061
25	139	174	205	237	270	297	300	276	244	212	178	145	133	153	185	221	253	283	292	277	250	213	180	147	5264
SUM	2645	2887	3184	3465	3677	3760	3676	3491	3265	3031	2875	2800	2853	3037	3307	3562	3718	3759	3659	3429	3135	2839	2652	2583	77289

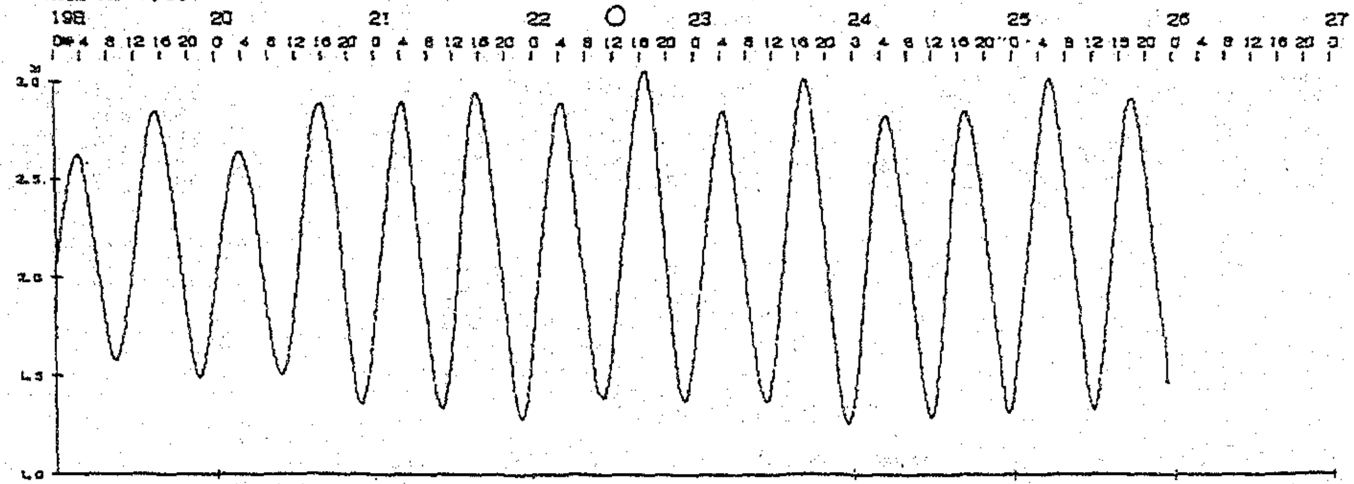
Area : Marshall Islands Station : Arno

March 1989



Tidal range

March 1989



Tidal range

Tidal curve

***** THE ANALYSIS OF TIDAL HARMONIC CONSTANTS *****

AREA	:	Marshall Islands
STATION	:	Arno Atoll
TIME ZONE	:	−12.00
LATITUDE	:	7 3 0 N
LONGITUDE	:	171 27 0 E
EPOCH	:	1989 3 11 0
UNIT	:	METER
THEORY	:	T.I. METHOD FOR 15 DAYS

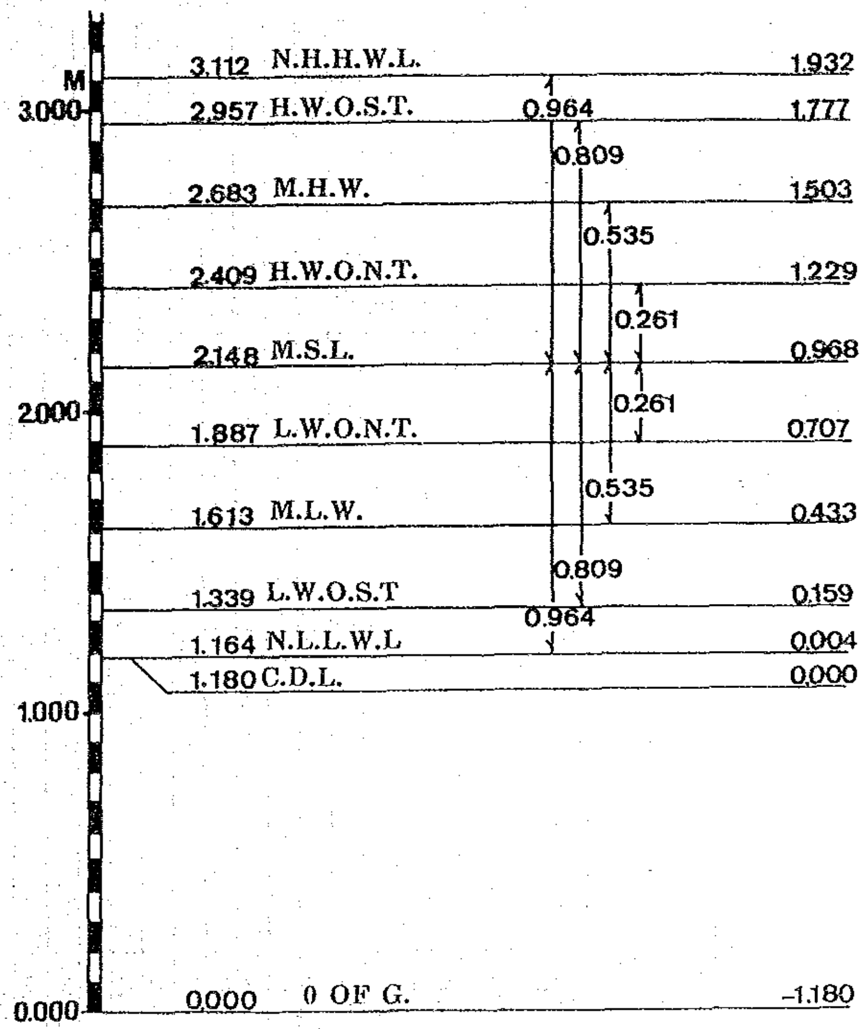
SYMBOL	H	K	G	NAME OF COMPONENT TIDE
M2	0.535	112.3	117.2	PRINCIPAL LUNAR
S2	0.274	129.2	146.3	PRINCIPAL SOLAR
K2	0.075	129.2	147.2	LUNISOLAR SEMIDIURNAL
N2	0.121	114.3	112.6	LARGER LUNAR ELLIPTIC
K1	0.073	242.4	251.5	LUNISOLAR DIURNAL
O1	0.082	210.4	206.3	PRINCIPAL LUNAR DIURNAL
P1	0.024	242.4	250.5	PRINCIPAL SOLAR DIURNAL
Q1	0.035	244.4	233.7	LARGER LUNAR ELLIPTIC
M4	0.009	24.5	34.3	LUNAR QUARTER DIURNAL
MS4	0.009	79.3	101.3	M2 + S2
AO	2.148			MEAN WATER LEVEL

Calculation of Standard Reference Level

In the Marshall Islands the lowest low water level (L.L.W.L) is usually adopted as the standard level, and in Kwajalein Atoll where the US base is located -0.15 m (-0.5 ft.) from the mean spring low water level (M.S.L) is being used in the projection of tide table. The standard levels obtained by the US method is -0.96 from the M.S.L, while in the observation results of this survey the total of major 4 component tide is -0.97 m (ZO). The difference between both figures is only 1 cm. Consequently, it is justifiable to adopt ZO = 0.97 for designing from safety point of view. The results are shown below.

Comparison of Harmonic Constants with Unharmonic Constants
(Referred to Admiralty Tide Tables, Vol.3)

Symbol	6776 Kwajalein Island		6768 Majuro Island Dajirat		Results in this survey Arno Island		6767 Arno Island Dodo	
	H(m)	G(°)	H(m)	G(°)	H(m)	G(°)	H(m)	G(°)
M2	0.47	115	0.53	117	0.536	117.2	0.59	115
S2	0.27	149	0.29	154	0.274	146.3	0.26	153
K1	0.10	247	0.08	252	0.073	251.5	0.07	258
O1	0.07	207	0.05	214	0.082	206.3	0.05	213
ZO	0.96		0.98		0.97		0.97	
M2+S2	0.74		0.82		0.809		0.85	
K1+O1	0.17		0.13		0.155		0.12	
$\frac{K1+O1}{M2+S2}$	0.23		0.16		0.19		0.14	
M2+S2+K1+O1	0.91		0.95		0.946		0.97	
M2−S2	0.20		0.24		0.261		0.33	
$\frac{M2-S2}{M2+S2}$	0.27		0.29		0.32		0.39	
$K_S - K_M$	34°		37°		29.1°		38°	
K1−KO	40°		28°		43.9°		45°	


M
3.000
2.000
1.000
0.000
3.112 N.H.H.W.L. 1.932
2.957 H.W.O.S.T. 1.777
2.683 M.H.W. 1.503
2.409 H.W.O.N.T. 1.229
2.148 M.S.L. 0.968
1.887 L.W.O.N.T. 0.707
1.613 M.L.W. 0.433
1.339 L.W.O.S.T 0.159
1.164 N.L.L.W.L 0.004
1.180 C.D.L. 0.000
0.000 0 OF G. -1.180
0.964
0.809
0.535
0.261
0.261
0.535
0.809
0.964

DATA SHEET OF CURRENT METER

Area Marshall Islands | Date 1989. 3.22 | Set,Layer | Lat

St,No Velocity | Velocity m/sec. | Propeller,No 470675-B | Long,

Time	Velocity	Direction	Time	Velocity	Direction	Time	Velocity	Direction	Time	Velocity	Direction
0:00			6:00			12:00			18:00	0.13	
:10			:10			:10			:10	0.39	
:20			:20			:20			:20	0.32	
:30			:30			:30			:30	0.46	
:40			:40			:40			:40	0.60	
:50			:50			:50			:50	0.78	
1:00			7:00			13:00			19:00	0.81	
:10			:10			:10			:10	0.75	
:20			:20			:20			:20	0.54	
:30			:30			:30			:30	0.23	
:40			:40			:40			:40	0.43	
:50			:50			:50			:50	0.38	
2:00			8:00			14:00			20:00	0.61	
:10			:10			:10			:10	0.69	
:20			:20			:20			:20	0.67	
:30			:30			:30			:30	0.54	
:40			:40			:40			:40	0.52	
:50			:50			:50			:50	0.67	
3:00			9:00			15:00			21:00	0.60	
:10			:10			:10			:10	0.23	
:20			:20			:20			:20	0.35	
:30			:30			:30			:30	0.40	
:40			:40			:40			:40	0.43	
:50			:50			:50			:50	0.29	
4:00			10:00			16:00			22:00	0.42	
:10			:10			:10			:10	0.58	
:20			:20			:20			:20	0.64	
:30			:30			:30		H	:30	0.39	
:40			:40			:40			:40	0.12	L
:50			:50			:50			:50	0.09	
5:00			11:00			17:00			23:00	0.40	
:10			:10			:10			:10	0.46	
:20			:20			:20			:20	0.40	
:30			:30			:30			:30	0.34	
:40			:40			:40			:40	0.21	
:50			:50			:50	0.09		:50	0.31	
						A=		B=		C=	

DATA SHEET OF CURRENT METER

Area Marshall Islands   Date 1989. 3.23   Set,Layer -2.0m   Lat

St,No Velocity   Velocity m/sec.   Propeller,No 470675-B   Long,

Time	Velocity	Direction	Time	Velocity	Direction	Time	Velocity	Direction	Time	Velocity	Direction
0:00	0.54		6:00			12:00			18:00	0.23	
:10	0.67		:10			:10			:10	0.12	
:20	0.72		:20			:20			:20	0.07	
:30	0.67		:30			:30			:30	0.29	
:40	0.58		:40			:40			:40	0.27	
:50	0.61		:50			:50			:50	0.29	
1:00	0.69		7:00			13:00			19:00	0.25	
:10	0.72		:10			:10			:10	0.35	
:20	0.75		:20			:20			:20	0.32	
:30	0.81		:30			:30			:30	0.20	
:40	0.87		:40			:40			:40	0.26	
:50	0.90		:50			:50			:50	0.24	
2:00	0.78		8:00			14:00			20:00	0.33	
:10	0.81		:10			:10			:10	0.19	
:20	0.78		:20	(a)		:20			:20	0.16	
:30	0.75		:30			:30			:30	0.38	
:40	0.64		:40			:40			:40	0.48	
:50	0.69		:50			:50			:50	0.40	
3:00	0.58		9:00			15:00			21:00	0.31	
:10	0.67		:10			:10	(a)		:10	0.40	
:20	0.55		:20			:20			:20	0.43	
:30	0.27		:30			:30			:30	0.29	
:40	0.31		:40			:40			:40	0.38	
:50	0.43		:50			:50			:50	0.23	
4:00	0.27		10:00			16:00			22:00	0.06	
:10	0.35		:10			:10			:10	0.26	
:20	0.29		:20			:20			:20	0.09	
:30			:30			:30			:30	0.06	
:40		H	:40			:40			:40	0.17	
:50	(a)		:50		L	:50		H	:50	0.26	
5:00			11:00			17:00			23:00	0.09	L
:10			:10			:10			:10	0.20	
:20			:20			:20	0.23		:20	0.12	
:30			:30			:30	0.17		:30	0.06	
:40			:40			:40	0.22		:40	0.14	
:50			:50			:50	0.29		:50	0.21	

Note : (a) denotes lack of data

A= B= C=

DATA SHEET OF CURRENT METER

Area Marshall Islands　　Date 1989. 3.24　　Set,Layer －2.0m　　Lat

St,No Velocity　　Velocity m/sec.　　Propeller,No 470675-B　　Long,

Time	Velocity	Direction	Time	Velocity	Direction	Time	Velocity	Direction	Time	Velocity	Direction
0:00	0.29		6:00	0.26		12:00			18:00		
:10	0.58		:10	0.32		:10			:10		
:20	0.72		:20	0.17		:20			:20		
:30	0.93		:30	0.36		:30			:30		
:50			:50			:50	0.29		:50	0.21	
:50	0.78		:50	0.58		:50			:50		
1:00	0.66		7:00	0.32		13:00			19:00		
:10	0.75		:10	0.38		:10			:10		
:20	0.78		:20	0.43		:20			:20		
:30	0.81		:30	0.39		:30			:30		
:40	0.78		:40	0.29		:40			:40		
:50	0.72		:50	0.09		:50			:50		
2:00	0.75		8:00	0.02		14:00			20:00		
:10	0.75		:10	0.17		:10			:10		
:20	0.72		:20	0.29		:20			:20		
:30	0.81		:30	0.26		:30			:30		
:40	0.81		:40	0.17		:40			:40		
:50	0.75		:50	0.17		:50			:50		
3:00	0.75		9:00	0.35		15:00			21:00		
:10	0.72		:10	0.20		:10			:10		
:20	0.75		:20	0.21		:20			:20		
:30	0.69		:30	0.06		:30			:30		
:40	0.46		:40	0.13		:40			:40		
:50	0.38		:50	0.21		:50			:50		
4:00	0.40		10:00	0.12		16:00			22:00		
:10	0.40		:10	0.21		:10			:10		
:20	0.58		:20	0.20		:20			:20		
:30	0.61		:30			:30			:30		
:40	0.50		:40			:40			:40		
:50	0.36		:50			:50			:50		
5:00	0.23	H	11:00			17:00			23:00		
:10	0.14		:10		L	:10			:10		
:20	0.19		:20			:20		H	:20		
:30	0.12		:30			:30			:30		
:40	0.07		:40			:40			:40		
:50	0.12		:50			:50			:50		
						A=		B=		C=	

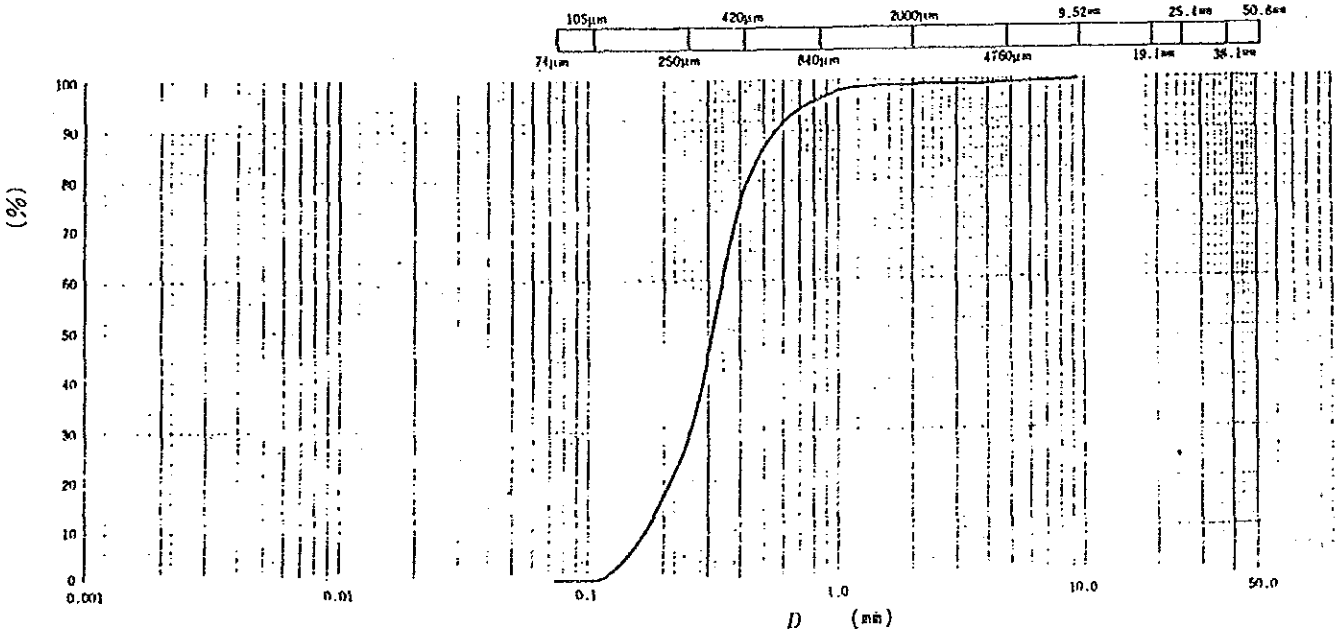
JIS A 1204	PARTICLE SIZE ANALYSIS	

AREA. SITE. MARSHALL, CORAL SAND

DATE

Sample No. Depth				
	Grain size (mm)	Wt. %	Grain size (mm)	Wt. %
Sieve	50.8		50.8	
	38.1		38.1	
	25.4		25.4	
	19.1		19.1	
	9.52	100.0	9.52	
	4.76	99.5	4.76	
	2.00	99.2	2.00	
	0.84	96.6	0.84	
	0.42	78.7	0.42	
	0.25	28.9	0.255	
	0.105	0.6	0.104	
	0.074	0.5	0.07	
Hydrometer		%		
	# 4	0.5		
	8	0.7		
	16	1.0		
	30	8.0		
	50	44.0		
	100	96.0		
		150.2÷	100 =1.5	

Sample No. Depth	No. 0 (0.00m ~ m)		No. 0 (0.00m ~ m)	
Particle more than 4.76 mm %	1			
Granule (4.76 ~2mm) %	0	1		
Coarse sand (2 ~0.42mm) %	20			
Fine sand (0.42 ~0.074mm) %	78	98		
Silt (0.074 ~0.005mm) %	1			
Clay* (<0.005 mm) %	*			
Colloid (<0.001mm) %	*			
2000μm sieve wt. %	99			
420μm sieve wt. %	79			
74μm sieve wt. %	1			
Maximum size	9.52			
60 % main size	0.3416			
30 % main size	0.2546			
10 % main size	0.1682			
Uniformity coefficient	2.03			
Curvature coefficient	1.13			
Specific gravity of particle size	2.825			
Dispersing agent D20 mm	0.2110			
Dispersing agent D50 mm	0.3137			



Colloid	Clay	Silt	Fine sand	Coarse sand	Granule		Rocky
0.001	0.005	0.074	0.42	2.0	4.76	75	

Note

*:Include colloid

JIS A 1202	SPECIFIC GRAVITY ANALYSIS OF SOIL PARTICLE	

AREA. SITE. MARSHALL, CORAL SAND DATE

Sample No. (Depth)	No. 0	(0.00m - m)	
Analysis No.	1	2	3
Pynometer No.	32	33	34
Weight of [oven dried (or wet) clay + distilled water + pynometer] m_b g	88.831	87.074	91.902
Temperature of contents measured mb at T°C	16	16	16
Weight of oven dried clay in pynometer m_s g / No. of pynometer / Wt. of dried clay + pynometer (g) / Wt of pynometer / m_s g	8.343	8.370	8.374
Reduced weight of (distilled water + pynometer at T°C m_a	83.441	81.664	86.495
$m_s+(m_a-m_b)$ g	2.953	2.960	2.967
Specific gravity of clay particle at T°C $G_s(T℃/T℃)=\frac{m_s}{m_s+(m_a-m_b)}$	2.825	2.828	2.822
Correction cofficient K	0.9998	0.9998	0.9998
Specific gravity of clay particle at 15°C $G_s(T℃/15℃)=K\cdot G_s(T℃/T℃)$	2.825	2.827	2.822
Average value		= 2.825	
Specific gravity of water at T°C $G_s(T℃/4℃)=G_T\cdot G_s(T℃/T℃)$			
Average value	Specific gravity (T℃/4℃) =		

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