Appendices

[Appendices]

Appendix-1 Member List of Study Team

(1) Field Survey

Name	Assignment	Organization
Official Member		
Mr. Akihiko YAMADA	Leader / Project Coordinator	Fourth Project Management Division, Grant Aid Management Department, JICA
Mr. Sunao NAKAO	Technical Adviser	Office of the Overseas Fisheries Cooperation, Fisheries Agency
Consultant Member		
Mr. Kozo MATSUMURA	Project Manager / Fisheries Distribution Planning	ECOH CORPORATION
Mr. Toshimitsu TAKAHASHI	Architecture Planning	KYOKUYO CO., LTD.
Mr. Takahisa AOYAMA	Civil Engineering planning / Natural Condition Survey	ECOH CORPORATION
Mr. Shigeto NOMURA	Fisheries Equipment Planning	KYOKUYO CO., LTD.
Mr. Kenji KUROKI	Construction Planning / Cost Estimation	ECOH CORPORATION
Mr. Masamichi HOTTA	Fisheries Distribution Planning Survey	ECOH CORPORATION

(2) Explanation of Draft Basic Design

Name	Assignment	Organization
Official Member		
Mr. Norihiro IKEDA	Leader	Deputy Director Fourth Project Management Division, Grant Aid Management Department, JICA
Mr. Toshiyuki KUBODERA	Technical Adviser	Assistant Director Office of the Overseas Fisheries Cooperation, Fisheries Agency
Mr. Shinobu YOSHIZAWA	Project Coordinator	Fourth Project Management Division, Grant Aid Management Department, JICA
Consultant Member		
Mr. Kozo MATSUMURA	Project Manager / Fisheries Distribution Planning	ECOH CORPORATION
Mr. Toshimitsu TAKAHASHI	Architecture Planning	KYOKUYO CO., LTD.
Mr. Takahisa AOYAMA	Civil Engineering planning / Natural Condition Survey	ECOH CORPORATION
Mr. Shigeto NOMURA	Fisheries Equipment Planning	KYOKUYO CO., LTD.

Appendix-2 Survey Schedule

(1) Field Survey

No.	Date		Day	Itinerary	Accommodation	Activities
1	Jul	29	Sun	Tokyo - New York NH010 (1100-1030)	New York	Official Member Mr. Yamada & Mr. Nakao
2		30	Mon	New York – Port of Spain AA1819 (12:40-20:37)	Port of Spain	Official Member Mr. Yamada & Mr. Nakao
				Tokyo - New York JL006 (1200-1130)	New York	Consultant Member All Consultant Member (Exc. Mr. Hotta)
3	Jun	1	Tue		Port of Spain	Official Member (Mr. Yamada, Mr. Nakao) Courtesy Call to the Embassy of Japan
				New York – St. John's JM094 (0710-1335)	St. John's	All Consultant Member (Exc. Mr. Hotta)
4		2	Wed	Port of Spain - St. John's LI308(0700-0925)	St. John's	Official Member (Mr. Yamada, Mr. Nakao) All Study Members: Courtesy Call for Ministry of Planning and Trade and the others, Discussion in Antigua and Barbuda
5		3	Thu		St. John's	Mission Members: Discussion with Relevant Authorities
6		4	Fri	St. John's - Codrington LI(Local buying)	Codrington	Official Member and Consultant Member(Mr. Matsumura, Mr. Nomura) :Field Survey in Codrington
					St. John's	Other Consultant Members Preparing Field Study
7		5	Sat	Codrington – St. John's LI(Local Buying)	St. John's	Official Member and Consultant Member(Mr. Matsumura, Mr. Nomura) :Field Survey in Codrington
						Other Consultant Members Preparing Field Study
8		6	Sun		St. John's	Meeting within the Team
				Tokyo - New York JL006 (1200-1130)	New York	Consultant Member(Mr. Hotta)
9		7	Mon		St. John's	Official Member and Consultant Member(Mr. Matsumura, Mr. Takahashi) : Discussion and Signature on the Minutes of Meetings
						Other Consultant Members Preparing Field Study
				New York – St. John's JM094 (0710-1335)		Consultant Member(Mr. Hotta)
10		8	Tue	St. John's – San Juan AA5181(0850-1023)	New York	Official Members: Leave Antigua
				San Juan – New York AA1416(1215-1601)		
				St. John's – Codrington LI(Local Buying)	Codrington	Consultant Members: Field Study
11		9	Wed	New York – NH009(1215-)		Official Members (Mr. Yamada, Mr. Nakao) : Leave New York
					Codrington	Consultant Members: Field Study & Data Collection
12		10	Thu	- Narita NH009(-1450)	New York	Official Members (Mr. Yamada, Mr. Nakao) : Arrive Narita

					Codrington	Consultant Members: Field Study & Data Collection
13		11	Fri		Codrington	Consultant Members: Field Study & Data Collection
14		12	Sat		Codrington	Consultant Members (Mr. Matsumura, Mr. Nomura, Mr. Hotta): Field Study & Data Collection
				Codrington - St. John's	St. John's	Other Members: Field Study & Data Collection
15		13	Sun		Codrington	Consultant Members: Field Study & Data Collection
					St. John's	*Other Members: Field Study & Team Meeting*
16		14	Mon		Codrington	Consultant Members: Field Study & Data Collection
					St. John's	Other Members: Field Study & Data Collection
17		15	Tue		Codrington	Consultant Members: Field Study & Data Collection
					St. John's	Other Members: Field Study & Data Collection
18		16	Wed	Codrington - St. John's	St. John's	Mr. Matsumura, Mr. Nomura, Mr. Hotta come back St. John's Consultant Members: Field Study & Data Collection
19		17	Thu		St. John's	Consultant Members: Field Study & Data Collection
20		18	Fri		St. John's	Consultant Members: Field Study & Data Collection
21		19	Sat		St. John's	Consultant Members: Field Study & Team Meeting
22		20	Sun		St. John's	Consultant Members: Field Study & Team Meeting
23		21	Mon		St. John's	Consultant Members: Field Study & Data Collection
24		22	Tue		St. John's	Consultant Members: Field Study & Data Collection
25		23	Wed		St. John's	Consultant Members: Field Study & Data Collection
26		24	Thu		St. John's	Consultant Members: Field Study & Data Collection
27		25	Fri		St. John's	Consultant Members: Field Study & Data Collection
28		26	Sat		St. John's	Consultant Members: Field Study & Team Meeting
29		27	Sun		St. John's	Consultant Members: Field Study & Team Meeting
30		28	Mon		St. John's	Consultant Members: Field Study & Data Collection
31		29	Tue		St. John's	Consultant Members: Field Study & Data Collection
32		30	Wed		St. John's	Consultant Members: Field Study & Data Collection
				LI(Local Buying)	Codrington	Mr. Aoyama & Mr. Kuroki to Codrington for Survey
33		31	Thu		St. John's	Consultant Members: Field Study & Data Collection
					Codrington	Two Members: Field Study & Data Collection
34	Aug	1	Fri		St. John's	Consultant Members: Field Study & Data Collection
					Codrington	Two Members: Field Study & Data Collection
35		2	Sat		St. John's	Consultant Members: Field Study & Team Meeting
				Codrington - St. John's		Two Members come back from Codrington
36		3	Sun	St. John's - New York CO871(1500-1929)	New York	Two Members (Mr. Nomura, Mr. Hotta)
					St. John's	Consultant Members(Mr. Matsumura, Mr. Aoyama, Mr. Takahashi, Mr. Kuroki): Team Meeting
37		4	Mon	New York - JL005(1330-)		Two Members: Leave New York
					St. John's	Consultant Members: Discussion With Relevant Authority
38		5	Tue	JL005(-1620) Narita		Two Members: Arrive Narita
					St. John's	Consultant Members: Team Meeting
				St. John's - Port of Spain LI309(1645-1910)	Port of Spain	Consultant Chief: Leave St. John's
39		6	Wed	Port of Spain New York BW426(1600-2235)	New York	Consultant Chief: Report to the Japanese Embassy
				St. John's - New York CO871(1500-1929)		Other members: Leave St. Jchn's

40		7	Thu	New York - JL005(1330-)		Consultant Members: Leave New York
41		8	Fri	JA005(-1620)Narita		Consultant Members: Arrive Narita

(2) Explanation of Basic Design

No	Date		Day	Itinerary	Accommodation	Activities
1	Dce	13	Sat	Tokyo - New York JL006 (1200-1020)	New York	Official Member Mr. Ikeda , Mr. Kubodera & Yoshizawa Consultant Mr. Matsumura, Mr. Takahashi, Mr. Aoyama & Mr. Nomura
2		14	Sun	*New York – St John's* BW429 (14:15-19:15)	*St John's*	*Official Member* Mr. Ikeda , Mr. Kubodera & Yoshizawa Consultant Mr. Matsumura, Mr. Takahashi, Mr. Aoyama & Mr. Nomura
3		15	Mon		St John's	Courtesy Call for Ministry of Planning, Implementation and Public Service Affairs and others, Discussion with Planning and Fisheries Division
4		16	Tue		St. John's	Discussion with Fisheries Division and AFL
5		17	Wed		*St. John's*	*Discussion within the Team* Discussion with Planning and AFL
6		18	Thu		St. John's	Courtesy call for Minister of Agriculture Visit to Parham and Urlings Fishing Port and Jolly Harbour Explanation Project briefing to Point Wharf fishermen
7		19	Fri		St. John's	Signing of Minutes of Discussions
8		20	Sat		St. John's	Discussion within the Team
9		21	Sun	St. Jon's–Port of Spain BW415 (1645–1900) St. John's–New York CO871 (1555-1935)	Port of Spain New York	Official Member Mr. Ikeda , Mr. Kubodera & Yoshizawa Consultant Mr. Matsumura Consultant Mr. Takahashi, Mr. Aoyama, Mr. Nomura
10		22	Mon	Port of Spain – New York Bird attacks Flight(JL005)	New York New York	Report to the Embassy and Movement Official Member Mr. Ikeda , Mr. Kubodera & Yoshizawa Consultant Mr. Matsumura Consultant Mr. Takahashi, Mr. Aoyama, Mr. Nomura
11		23	Tue	New York – JL005(0700-) New York – JL005(1215-)		Consultant Mr. Takahashi, Mr. Aoyama, Mr. Nomura Official Member Mr. Ikeda , Mr. Kubodera & Yoshizawa Consultant Mr. Matsumura
12		24		Narita (1000) Narita (1625)		Consultant Mr. Takahashi, Mr. Aoyama, Mr. Nomura Official Member Official Member Mr. Ikeda , Mr. Kubodera & Yoshizawa *Consultant Mr. Matsumura*

Appendix-3 List of Parties Concerned in Recipient Country

Ministry of Planning, Implementation and Public Service Affairs

Hon. Gaston Browne	Minister
Mr. Daven Joseph	Technical Director
Mr. M.D. Vincent Benjamin	Permanent Secretary
Mr. Sean Cenac	Sector Planner
Mr. Austin Smith	Liaison Officer

Ministry of Agriculture, Fishery and Land

Mr. Vere. C. Bird Jr.	Minister

Fisheries Division Ministry Agriculture, Lands and Fisheries

Ms. Cheryl Appleton	Chief Fisheries Officer
Mr. Philmore James	Senior Fisheries Officer
Mr. George Loby	Senior Officer
Mr. Ian Horsford	Fisheries Officer
Mr. Shuji HAYASHI	JICA Expert (Fisheries Development)

Ministry of Public Works

Mr. Elneade Brooks	Deputy Director

Antigua Fisheries Ltd. (AFL)

Mr. Francis Henry	Chairman of Board of Director
Ms. Mavis George	Manager

Antigua Power and Utility Authority (APUA)

Mr. Reuben James	Senator
Mr. Jason Peters	Customer Service Engineer (Electrical Engineer)
Mr. Hastin Barnes	Superintendent Water
Mr. Michel Wyntec	Supervisor (Electric)
Mr. Earl Pioche	Planning Engineer (Telephone Engineer)

Barbuda Council

Mr. Hartford John	Chairman Agriculture & Fisheries Marine, Development at Barbuda

Mr. W. Nicholas	Deputy Chairman of Council
Mr. Randolph S. (TC) Beazer	Chairman Tourist, Sports, Culture and Youth Affairs
Mr. Lynton Thomas	Senator
Mr. T. H. Frank	M. P.
Mr. Chad Knight Alexander	Designer
Mr. John Mussington	Consultant
Mr. John Wayber	Counter Pert

White Fish Market.

Mr. Sylvester White	Owner／Manager

Antigua Port Authority

Capt. Edwardson Greene	Chief Pilot

V.C. Bird Meteorological Office

Mr. Patrick Jelemiah	Director of Meteorological Service
Mr. Kethley Meade	Climatologist

Development Control Authority

Mr. Aldin Crump	Town and Country Planner

St. John's Development Corporation

Mr. Saiiel Green	Executive Director

Parham Fishing Port.

Ms. Verlyn George	Manager

Urlings Fishing Port.

Mr. George Hunte	Manager

Appendix-4 Minutes of Discussions

(1) Field Survey

MINUTES OF DISCUSSIONS
ON
THE BASIC DESIGN STUDY
ON THE PROJECT FOR
CONSTRUCTION OF FISHERIES DEVELOPMENT CENTER
IN
ANTIGUA AND BARBUDA

Based on the results of the preliminary survey, the Government of Japan decided to conduct a Basic Design Study on the Project for Construction of Fisheries Development Center (hereinafter referred to as "the Project") and entrusted the study to the Japan International Cooperation Agency (hereinafter referred to as "JICA").

JICA sent to the Antigua and Barbuda the Basic Design Study Team (hereinafter referred to as "the Team"), which is headed by Mr. Akihiko YAMADA, Deputy Director, Forth Project Management Division, Grant Aid Management Department, JICA, and is scheduled to stay in the country from July 2 to 8, 2003.

The Team held discussions with the officials concerned of the Government of Antigua and Barbuda (hereinafter referred to as "the Antigua and Barbuda side") conducted a field survey at the study area.

In the course of discussions and field survey, both parties confirmed the main items described on the attached sheets. The Team will proceed to further works and prepare the Basic Design Study Report.

Antigua, July 7, 2003

Mr. Akihiko YAMADA
Leader
Basic Design Study Team
Japan International Cooperation Agency

Hon. Gaston BROWNE
Minister
Ministry of Planning, Trade, Industry,
Commerce and Public Service Affairs
Government of Antigua and Barbuda

ATTACHMENT

1. Objective of the Project

The objective of the Project is to develop the artisanal fisheries through the improvement of supporting facilities and fish distribution in Point Wharf and Codrington.

2. Project sites

The sites of the Project are located in Point Wharf and Codrington, as shown in Annex-1.

3. Responsible and Implementing Agency

3-1 The Ministry of Planning, Trade, Industry, Commerce and Public Service Affairs, and the Ministry of Agriculture, Lands and Fisheries are responsible and implementing organization of the Project during construction and procurement.

3-2 The Ministry of Agriculture, Lands and Fisheries and Antigua Fisheries Limited will be the responsible organizations for administration of the Project at Point Wharf site after facilities and equipments are provided.

3-3 The Ministry of Agriculture and Fisheries and the Barbuda Council will be the responsible organizations for administration of the Project at Codrington site after facilities and equipments are provided.

4. Items requested by the Government of Antigua and Barbuda

After discussion with the Team, the items described in Annex-2 were finally requested by the Antigua and Barbuda side. JICA will assess the appropriateness of the request and will recommend to the Government of Japan for approval.

5. Japan's Grant Aid Scheme

The Antigua and Barbuda side understood the Japan's Grant Aid Scheme and the necessary measures to be taken by the Antigua and Barbuda side as explained by the Team and described in Annex-3 and Annex-4 of the Minutes of Discussions of the Preliminary Survey signed by both parties on February 7, 2003.

6. Schedule of the Study

6-1. Consultants will proceed to further studies in Antigua and Barbuda until August 6, 2003.

6-2. JICA will prepare the draft report in English and dispatch a mission in order to explain its contents around October 2003.

6-3. In case that the contents of the report is accepted in principle by the Antigua and Barbuda side, JICA will complete the final report and send it to Antigua and Barbuda side by January 2004.

7. Other relevant issues

7-1. The Antigua and Barbuda side strongly requested a construction of an Administration Office in Point Wharf to be included in component of the Project. The Team explained that it should be prepared by the Antigua and Barbuda side, but agreed to deliver the request to the Government of Japan for further consideration.

7-2. Both sides agreed that necessity and detail of each component should be analyzed considering the function and capacity of facilities in other sites such as St. John's Fish Market, fishing port facilities of Parham and Urlings in order to avoid over supply of facilities.

7-3. The Antigua and Barbuda side agreed to allocate the enough budgets and personnel staff for the operation and maintenance of the facilities and equipments provided by the Project.

7-4. The Antigua and Barbuda side promised to present the plan for the administration and operation of the facilities and equipments to the consultants during their stay as in Antigua and Barbuda by August 6, 2003.

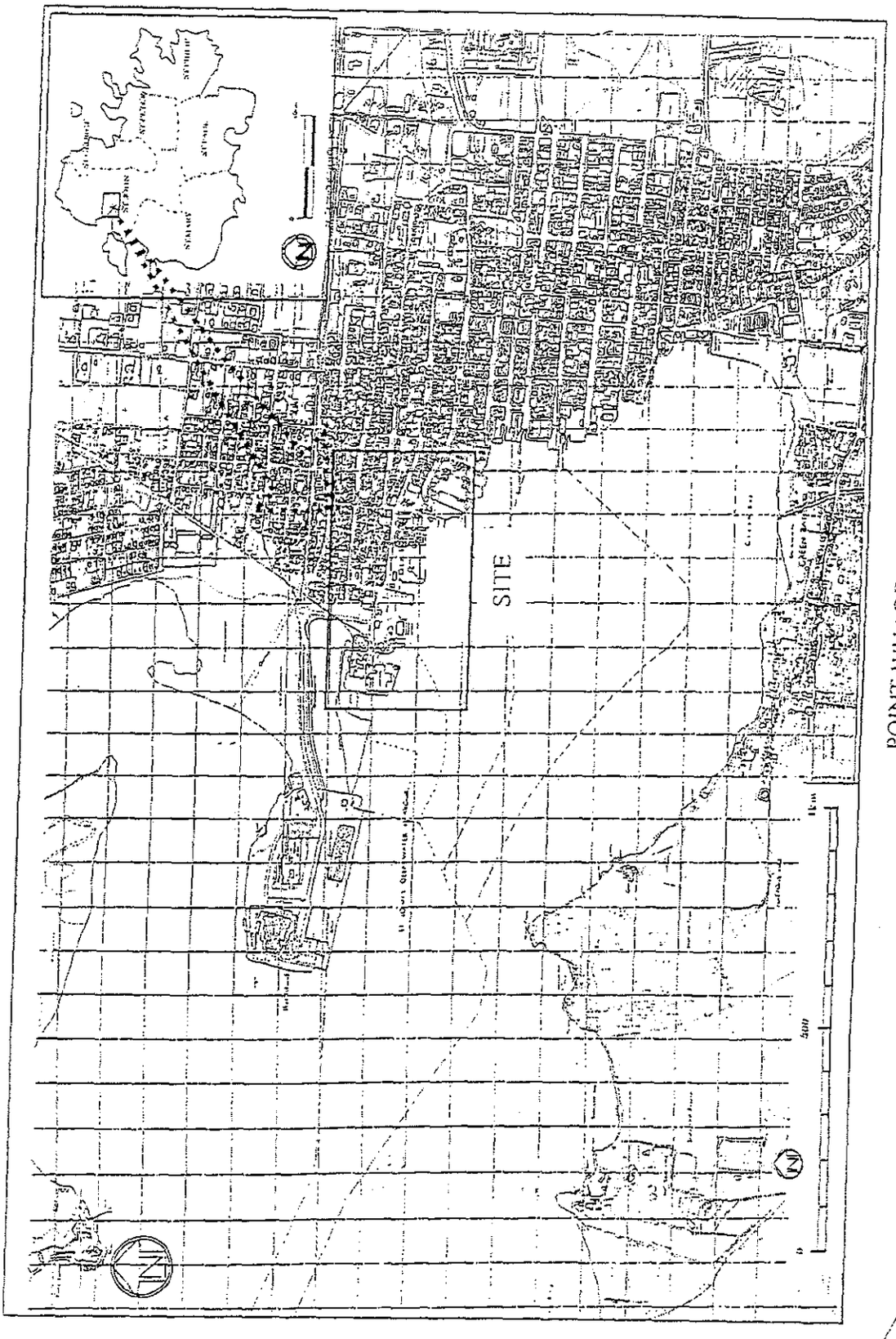
7-5. The Antigua and Barbuda side will implement and finish the Environmental Impact Assessment before the construction if it is required by the regulation of the Antigua and Barbuda side.

7-6 The Antigua and Barbuda side agreed to secure the land and remove unnecessary facilities and materials from the Project sites.

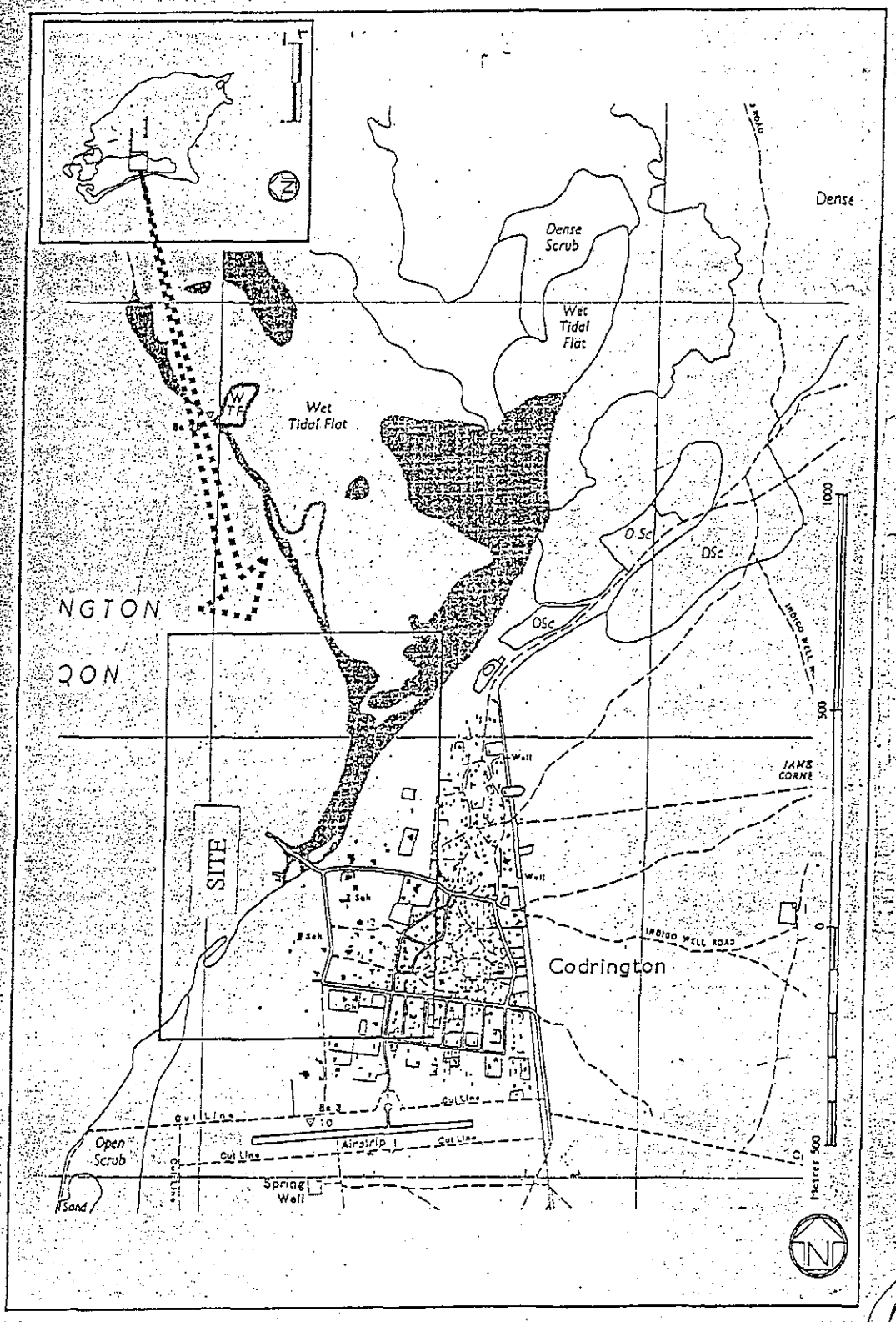
7-7 The Antigua and Barbuda side will take necessary measures to remove all vessels and vehicles.

from the project sites and prepare a temporary yard close to the Project sites.

7-8. The Antigua and Barbuda side will ensure that no activities affect the construction work during implementation of the Project.


SITE
POINT WHARF

Annex-1


Dense
Dense Scrub
Wet Tidal Flat
Wet Tidal Flat
W T E
NGTON
ON
SITE
Codrington
CODRINGTON
Open Scrub
Airstrip
Spring Well
Sand
Metres 500
0
500
1000

(2) Explanation of Draft Basic Design

MINUTES OF DISCUSSIONS ON THE BASIC DESIGN STUDY ON THE PROJECT FOR CONSTRUCTION OF FISHERIES DEVELOPMENT CENTER
IN
ANTIGUA AND BARBUDA
(EXPLANATION ON DRAFT REPORT)

In July 2003, the Japan International Cooperation Agency (hereinafter referred to as "JICA") dispatched the Basic Design Study Team on the Project for Construction of Fisheries Development Center (hereinafter referred to as "the Project"), and through discussion, field survey and technical examination of the results in Japan, JICA prepared draft report of the Study.

In order to explain and to consult the Government of Antigua and Barbuda on the components of the draft report, JICA sent to Antigua and Barbuda the Draft Report Explanation Team (hereinafter referred to as "the Team"), which is headed by Mr. Norihiro IKEDA, Deputy Director, Forth Project Management Division, Grant Aid Management Department, JICA, from 13 December to 24 December, 2003.

As a result of discussions, both parties confirmed the main items described on the attached sheets.

Antigua, 19 December, 2003

Mr.Norihiro IKEDA	Hon. Gaston BROWNE
Leader	Minister
Draft Explanation Study Team	Ministry of Planning Implementation and Public Service Affairs
Japan International Cooperation Agency	Government of Antigua and Barbuda

ATTACHMENT

1. Components of the Draft Report

1-1. The Team explained that it is better for the Project to focus on Point Wharf in order to effectively utilize available financial and human resources. The Antigua and Barbuda side agreed with this explanation.

1-2. The Government of Antigua and Barbuda agreed and accepted in principle the components of the draft report explained by the Team.

2. Japan' s Grant Aid Scheme

The Antigua and Barbuda side understands the Japan' s Grant Aid Scheme and the necessary measures to be taken by the Government of Antigua and Barbuda as explained by the Team and described in Annex-3 and Annex-4 of the Minutes of Discussions of the Preliminary Survey signed by both parties February 7, 2003.

3. Schedule of the Study

JICA will complete the final report in accordance with the confirmed item and send it to the Government of Antigua and Barbuda by March, 2004.

4. Other Relevant Issues

4-1. The Antigua and Barbuda side will secure the official appraisal and approval required for the implementation of the Project by the Government of Antigua and Barbuda before the start of the construction work.

4-2. The Government of Antigua and Barbuda understands that the project will be implemented in two phases and understands its process(especially the process that tender will be implemented at each phases in accordance with "the Guidelines of the Japanese Grant Aid for General Projects and for Fisheries").

4-3. The Antigua and Barbuda side is responsible for allocating the enough budget and personal staff (especially at hygienic laboratory and the

Processing Plant) for the operation and maintenance of the facilities and equipments provided by the Project.

4-4. The Antigua and Barbuda side will implement and finish the Environmental Impact Assessment before the construction if it is required by the regulations of Antigua and Barbuda.

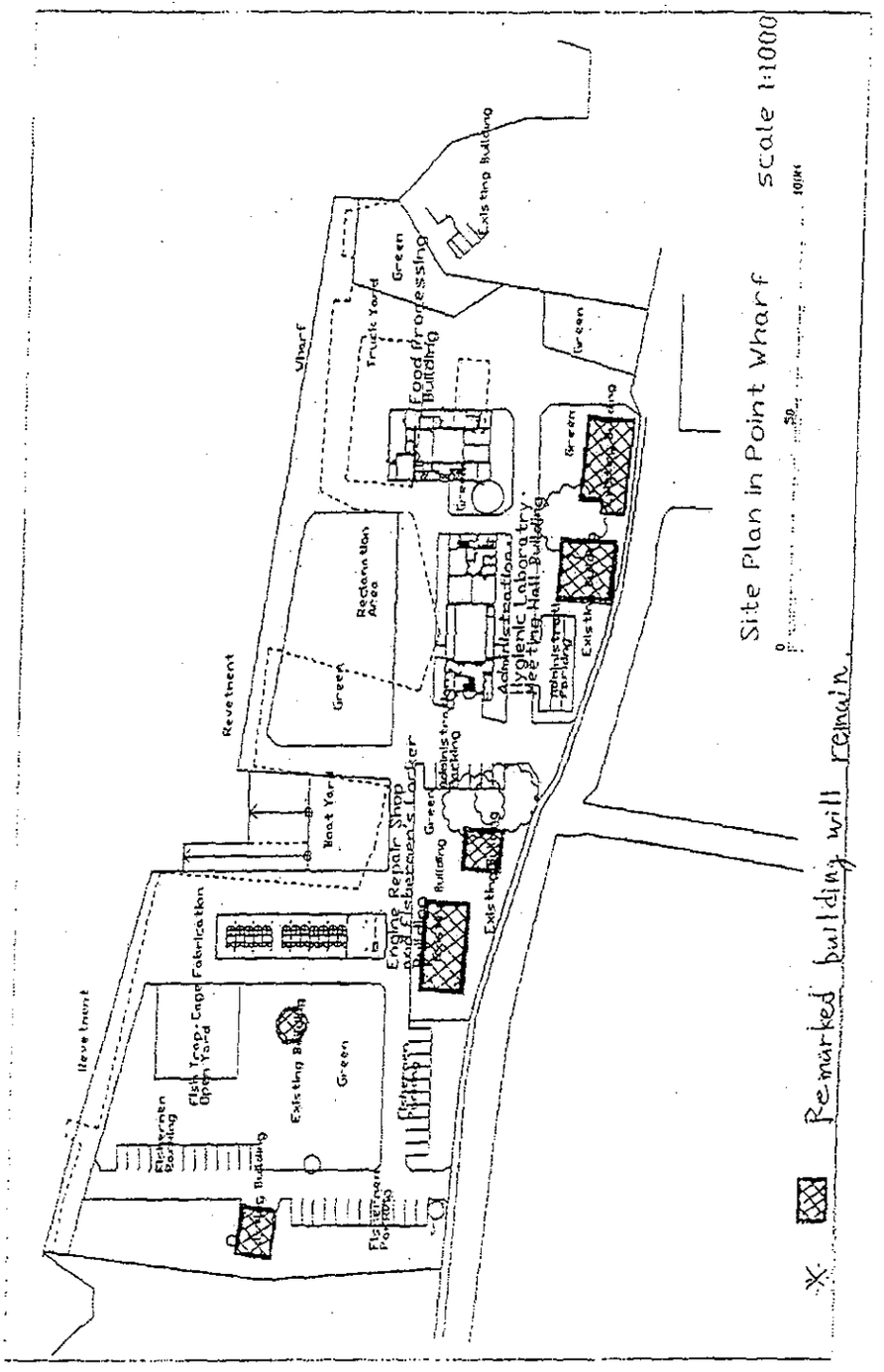
4-5. The Antigua and Barbuda side should take necessary measures to remove unnecessary facilities, materials, all vessels and vehicles from the Project site (except marked existing buildings in the attached drawing) and prepare a temporary yard(approximately 5,000m2) close to the Project sites (within 1km) before the start of the construction work.

4-6. The Antigua and Barbuda side promised to prepare a temporary unloading site and necessary facilities near the Project site for the fishing activities and set limits to use the Project site, not to disturb the implementation of the Project and the present fishery activities in Point Wharf before the start of the construction work.

4-7. The Antigua and Barbuda side agreed that the Managing Director of Antigua Fisheries Limited will make the implementation plan of the Processing Plant and submit to the Embassy of Japan in Trinidad and Tobago before the completion of the construction work.

4-8. The Antigua and Barbuda side agreed that the Director of Fisheries Division, Ministry of Agriculture will make the implementation plan of the fishing port of Point Wharf which includes the list of vessels and submit to the Embassy of Japan in Trinidad and Tobago before the completion of the construction work.

4-9. The Japanese side will consider to assist the operation and maintenance of the facilities and equipments provided by the Project through technical cooperation.


Site Plan in Point Wharf
scale 1:1000
Wharf
Revetment
Existing Building
Truck Yard
Green
Food processing Building
Reclamation Area
Administration
Hygienic Laboratory
Meeting Hall Building
Boat Yard
Engine Repair Shop
Fishermen's Lodge
Existing Building
Fish Trap Engg Fabrication
Open Yard
Fishermen Parking
Fishermen Parking
Remarked building will remain

Appendix-5 Design Wave and Meteorological Tidal Range Forecasting

1. Forecasting Method

Design wave and meteorological tidal range at St John's which is located north east of Antigua Island is forecasted under method.

Table-1.1 Forecasting Element

No.	Forecasting Items	Forecasting Model	Result of Forecasting
①	Ocean wave at hurricane	Spectral wave prediction system for a single point	Offshore wave height /period
②	Locally-generated waves within St John's Harbour	SMB Method	Wave height, period
③	Extra-high tide at hurricane	Nonlinear long period wave theory	Storm surge amplitude
④	Wave deformation at shallow water	Energy balance equation	Wave height, shoaling coefficient

Table-1.2 Condition of Offshore Wave Forecasting

Forecasting Point	Offshore Wave Forecasting Point		Object Hurricane
	North Latitude	South Longitude	
North-west sea from Antigua Island	17°29′12″	61°54′00″	LUIS (1995)

① Forecasting of Ocean Wave

Ocean wave forecasting model is given a spectral wave prediction system for a single point by Goto's group. Atmospheric pressure distribution model is given Hujita model formula shown under.

$$P = P_C - \Delta P \Big/ \sqrt{1+(r/r_0)^2}$$

where P: Pressure at distance r from center of hurricane
P_C: Pressure at center of hurricane
ΔP: Registered central atmospheric pressure of hurricane ($\Delta P = P' - P_C$)
P': Pressure at far apart
r_0: Distance from center of hurricane to maximum wind velocity point

② Forecasting of Development Wave in Harbor

Point Wharf is located head of the St John's Harbour have a possibilities to come under the influence of propagation wave from ocean, wind and development wave in a harbor. Forecasting of development wave in a harbor approaching of the hurricane gives SMB method. In addition, Wilson's formula (1955) gives forecasting wave.

$$\frac{gH_{1/3}}{U^2} = 0.30\left[1-\left\{1+0.004\left(gF/U^2\right)^{1/2}\right\}^{-2}\right], \qquad \frac{gT_{1/3}}{2\pi U} = 1.37\left[1-\left\{1+0.008\left(gF/U^2\right)^{1/3}\right\}^{-5}\right]$$

Where

$H_{1/3}$: Significant wave height(m)

$T_{1/3}$: Significant wave period (m)

U : Wind velocity (m/s) above 10m sea surface

F : Fetch (m)

g : Gravitational constant (m/s^2 : $9.8m/s^2$)

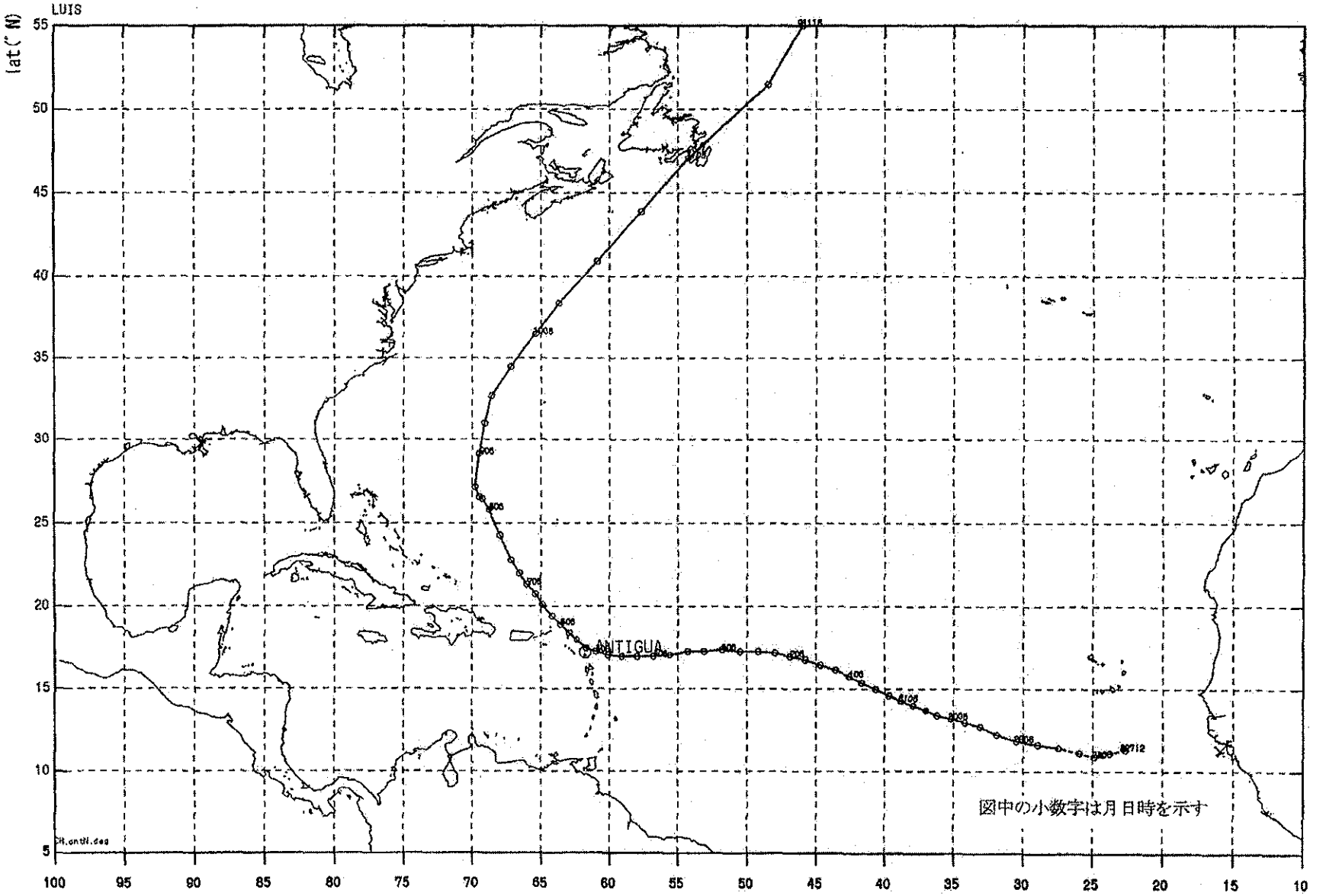


Figure-1.1 Route Map of Hurricane Luis (1995)

Wind (m/s) data is applied mean wind velocity observed at V.C. Bird Airport on September 5, 1995, when Hurricane Luis approached close the Antigua. Table-1.3 is shown description of wind data.

Table-1.3 Description of wind data that is applied forecasting of development wave in a St John's Harbour

Object Forecasting	Forecasting Point	Wind Data
Wave on Hurricane Luis approached Antigua	Mouth of St John's Harbour	18.5m/s (mean wind velocity on September 5, 1995)

③ Abnormal tide at the time of approach of hurricane

Abnormal tide at the time of approach of hurricane is forecasted wave setup to be occurred wind setup and pressure sit-down by Nonlinear Long Period Wave Theory. Marine wind which is element of forecasting for storm surge gives Myers formula based on pressure distribution approach of hurricane.

④ Wave deformation at shallow water

Ocean wave height is deformed by shoaling such as inflection and diffraction caused by depth. Wave height in front of structure such as revetment and breakwater etc. is calculated to determine height of those structures. Energy balance equation is used in this study.

In addition, Incident wave condition at offshore are each direction of wave height and period by a spectral wave prediction system for a single point.

Cases of calculate are 7 cases that 6 cases are shown in table-1.4 by each direction based on offshore wave and one case is maximum data of table-1.1 (wave direction is west).

Table-1.4 Results of Wave Forecasting at Ocean of St John's

Direction / Height/period	W	WNW	NW	NNW	N	NNE
Wave height Ho(m)	5.38	7.19	7.82	8.18	8.50	10.33
Period To(sec)	8.6	9.5	9.8	10.0	10.2	11.3

Spreading parameter (S_{max}) which is indicated maximum spreading of wave directions is S_{max}=10 on the assumption that wind waves.

Results of numerical calculate relation is shown Figure-1.2 Wave Forecasting Flow.

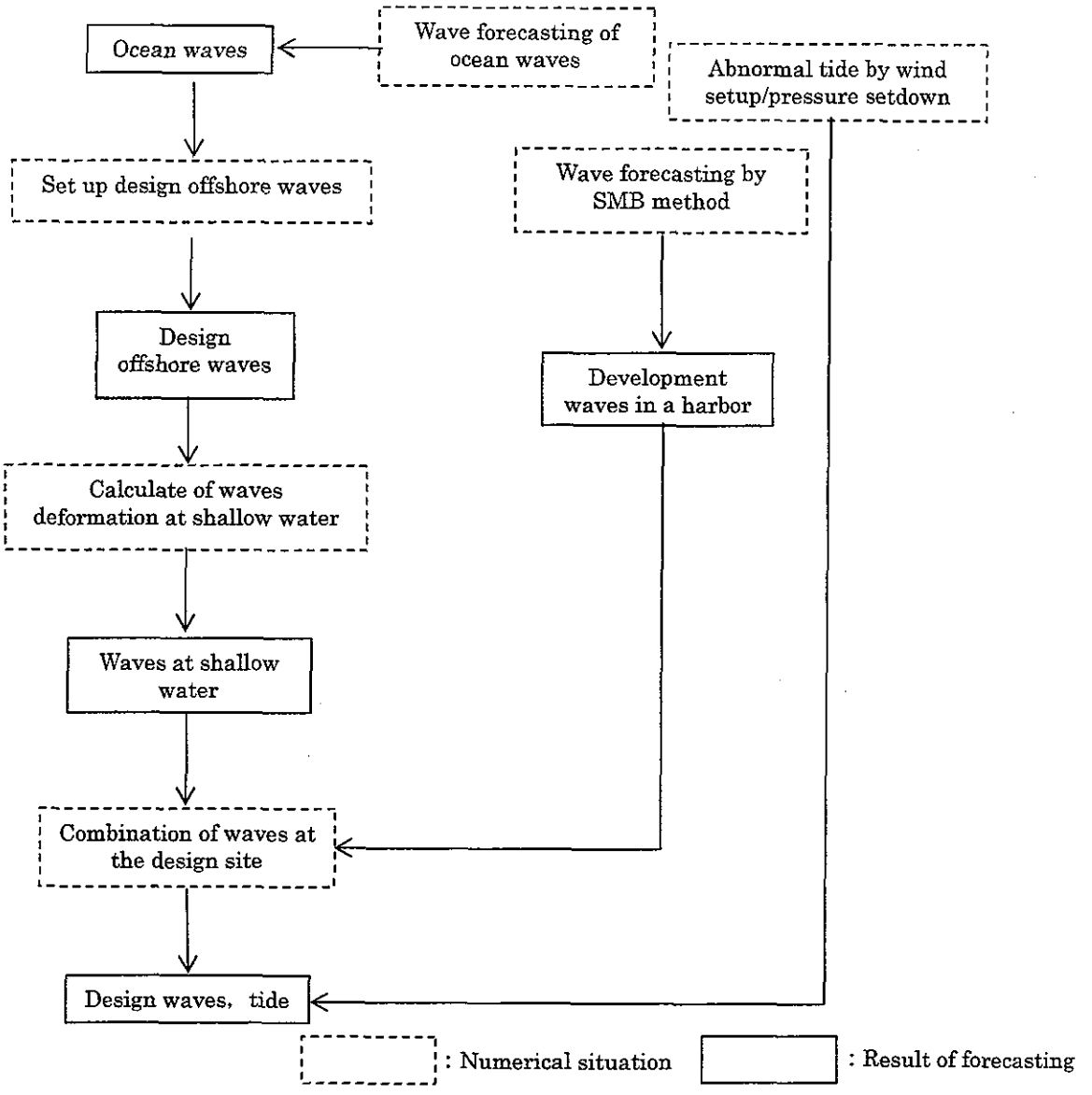


Figure-1.2 Wave Forecasting Flow

2. Calculate condition

① Characteristics of hurricane

Characteristics of hurricane are position, atmosphere pressure, storm radius, strong wind radius by time series. (Source by National Hurricane Center)

② Characteristics of tide

Characteristic of tide is given tide at St John's by Admiralty Tide Tables Vol.II,2003 (H.W.L.=D.L.+0.4m).

③ Water depth data

Water depth water is given by field survey and Admiralty Charts.

Table-2.1 To be used Chats

		Map No.	Scale	Publication Agency
Ocean	North Atlantic Ocean	4012	1:10,000,000	The United Kingdom Hydrographic Office
	North Atlantic Ocean	4013	1:10,000,000	〃
Shallow water	ANTIGUA	2064	1:60,000	〃
	Northern ANTIGUA	2065	1:25,000	〃

④ Effective fetch

Effective fetch is approximately 2,000m which is Point Wharf to mouth of St John's Harbour.

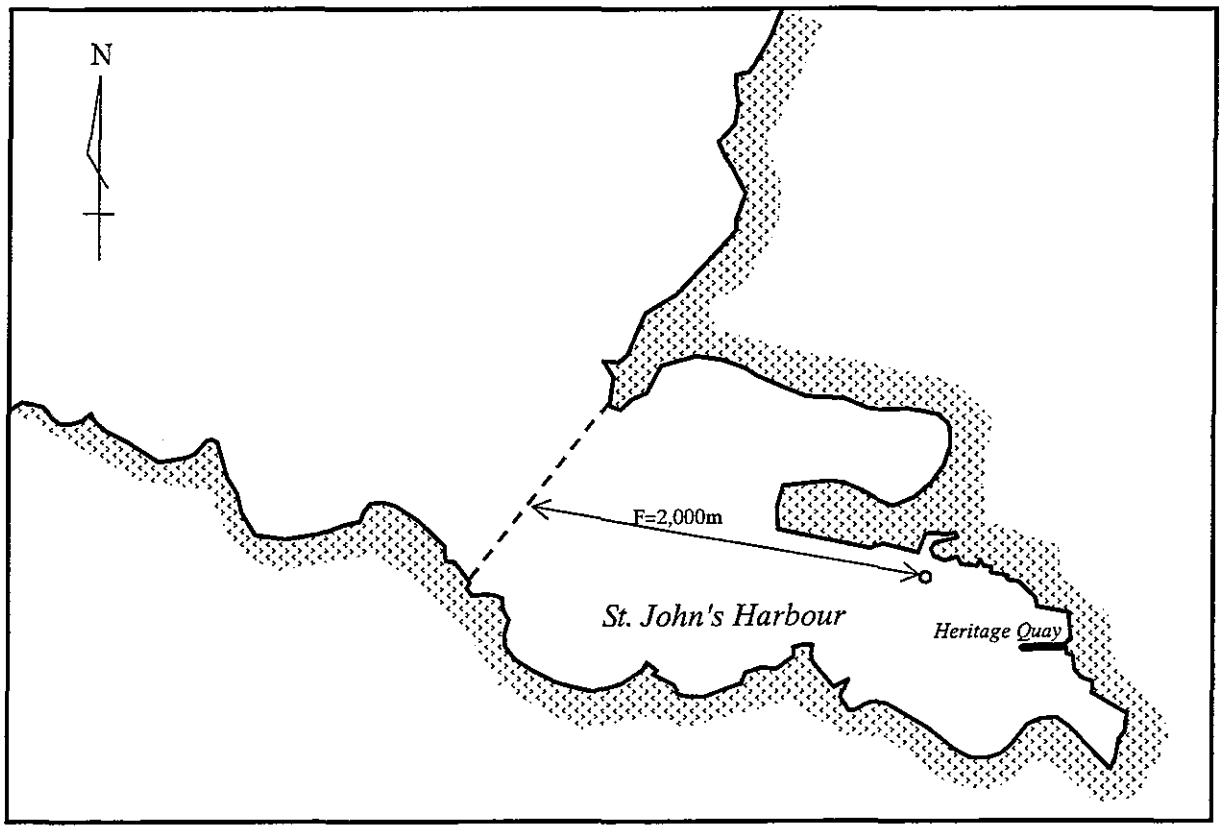


Figure-2.1 Effective fetch at St John's Harbour

Table-2.2 Hurricane Data 1995 LUIS

Date/Time (UTC)	Lat. (°N)	Lon. (°W)	Pressure (mb)	Wind Speed (kt)	50 Knot Radius (nm)	34 Knot Radius (nm)
8/29/00	11.6N	29.0W	1005	35		50
6	11.8N	30.5W	1000	40		50
12	12.2N	31.9W	1000	40		50
18	12.7N	33.1W	1003	40		40
8/30/00	13.0N	34.2W	1005	40		40
6	13.2N	35.2W	1005	45		40
12	13.4N	36.2W	1005	55		40
18	13.7N	37.0W	1002	65		40
8/31/00	14.0N	37.9W	998	70	30	75
6	14.3N	38.8W	992	80	50	100
12	14.6N	39.7W	979	85	50	100
18	15.0N	40.7W	971	95	50	100
9/01/00	15.4N	41.7W	965	100	75	125
6	15.8N	42.6W	958	105	75	125
12	16.2N	43.6W	950	115	75	125
18	16.5N	44.7W	948	115	75	125
9/02/00	16.8N	45.8W	948	115	75	125
6	17.0N	46.9W	948	115	75	125
12	17.2N	48.0W	948	115	75	150
18	17.3N	49.2W	948	115	75	150
9/03/00	17.3N	50.5W	948	115	75	150
6	17.4N	51.8W	948	120	75	150
12	17.3N	53.1W	948	120	75	150
18	17.3N	54.3W	945	120	75	125S/150N
9/04/00	17.1N	55.6W	942	120	100	140S/160N
6	17.0N	56.8W	940	120	100S/125N	140S/175N
12	17.0N	58.0W	945	120	100S/125N	140S/175N
18	17.0N	59.1W	943	120	100S/125N	140S/175N
9/05/00	17.1N	60.1W	940	120	100S/125N	140S/175N
6	17.3N	61.0W	939	120	100S/125N	140S/175N
12	17.5N	61.7W	945	115	90S/150N	140S/200N
18	18.0N	62.4W	944	115	90S/150N	150S/200N
9/06/00	18.4N	63.0W	942	115	90SW/125SE/150	150S/200N
6	18.9N	63.6W	939	115	90S/150N	150S/200N
12	19.4N	64.2W	943	115	90S/150N	150S/200N
18	20.1N	64.9W	940	115	100SW/120NW/150	150W/200E
9/07/00	20.7N	65.4W	938	115	100SW/120NW/150	150W/200E
6	21.3N	66.0W	936	115	100SW/120NW/150	150W/200E
12	22.0N	66.6W	941	110	150	175W/250E
18	22.8N	67.2W	938	110	150	175W/250E
9/08/00	24.3N	68.0W	935	110	MSG	MSG
6	25.8N	68.8W	939	110	150	175W/250E
12	26.4N	69.3W	941	105	150	175W/250E
18	26.5N	69.5W	944	100	120W/150E	175W/250E
9/09/00	27.1N	69.8W	945	95	120W/150E	175W/250E
6	29.1N	69.5W	949	90	120W/160E	175W/250E
12	31.0N	69.1W	952	85	120W/160E	175W/250E
18	32.7N	68.6W	955	85	110W/175E	175W/250E
9/10/00	34.5N	67.2W	959	85	110W/175E	175NW/250
6	36.5N	65.4W	963	85	100NW/175SE/150	175NW/275SE/225
12	38.4N	63.7W	961	80	100NW/180SE/150	175NW/225NE/275
18	40.9N	60.9W	966	80	50NW/180SE/150	175NW/275SE/250
9/11/00	43.9N	57.7W	965	80		
6	47.1N	54.2W	963	80	50NW/100NE/250	100NW/200NE/300
12	51.5N	48.5W	960	70	75N/150S	120N/275S

3. Result

① Result of offshore waves and development waves

Result of waves forecasting is shown table-2.3.

Table-2.3 Result of Waves Forecasting (1995 LUIS)

No.	Waves Direction	Ocean Waves		
		Wave Height (m)	Period (s)	Year/Month/Day/Time
1	NNE	10.33	11.32	95/09/06/06
2	NE	0.00	0.00	---------
3	ENE	0.00	0.00	---------
4	E	0.02	0.00	95/08/29/01
5	ESE	0.00	0.00	---------
6	SE	0.00	0.00	---------
7	SSE	0.00	0.00	---------
8	S	0.00	0.00	---------
9	SSW	0.00	0.00	---------
10	SW	0.00	0.00	---------
11	WSW	0.00	0.00	---------
12	W	5.38	8.61	95/09/07/09
13	WNW	7.19	9.53	95/09/07/23
14	NW	7.82	9.81	95/09/07/18
15	NNW	8.18	10.03	95/09/07/12
16	N	8.50	10.23	95/09/06/06

Development waves in harbor is calculated under formula.

$$\frac{gH_{1/3}}{U^2} = 0.30\left[1-\left\{1+0.004\left(gF/U^2\right)^{1/2}\right\}^{-2}\right], \qquad \frac{gT_{1/3}}{2\pi U} = 1.37\left[1-\left\{1+0.008\left(gF/U^2\right)^{1/3}\right\}^{-5}\right]$$

[Characteristic]

Fetch : 2,000m

Wind velocity : 18.5m/s (mean value of field survey at September 5, 1995.)

[Result]

Waves Height H=0.6m

Period T=2.3sec

② Result of waves deformation

Result of waves deformation is shown by figure-2.2(1)～(7).

Table-2.4 Characteristic of waves deformation (ocean waves)

Height/period \ Wind Direction		W	WNW	NW	NNW	N	NNE	W (Max.)
Wave Height	Ho(m)	5.38	7.19	7.82	8.18	8.50	10.33	10.33
Period	To(sec)	8.6	9.5	9.8	10.0	10.2	11.3	11.3

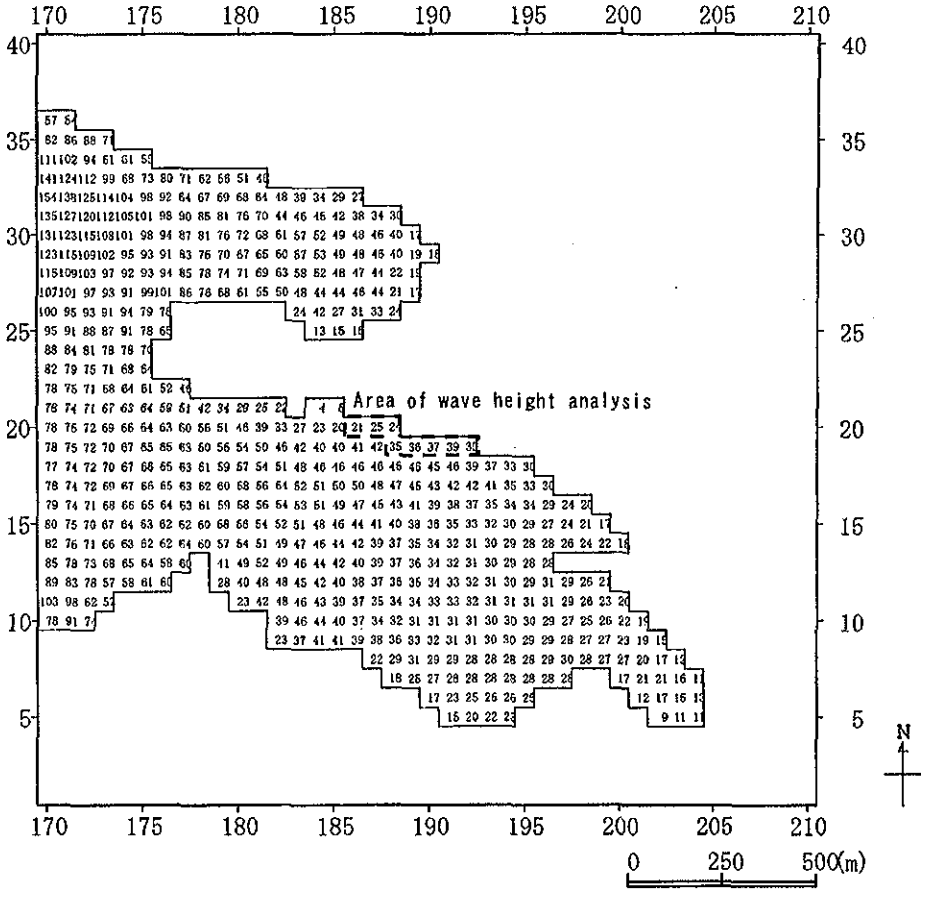


Figure-2.2(1) Result of deformation waves
(Waves Direction : W, $H_{1/3}$=5.38m, $T_{1/3}$=8.6s)

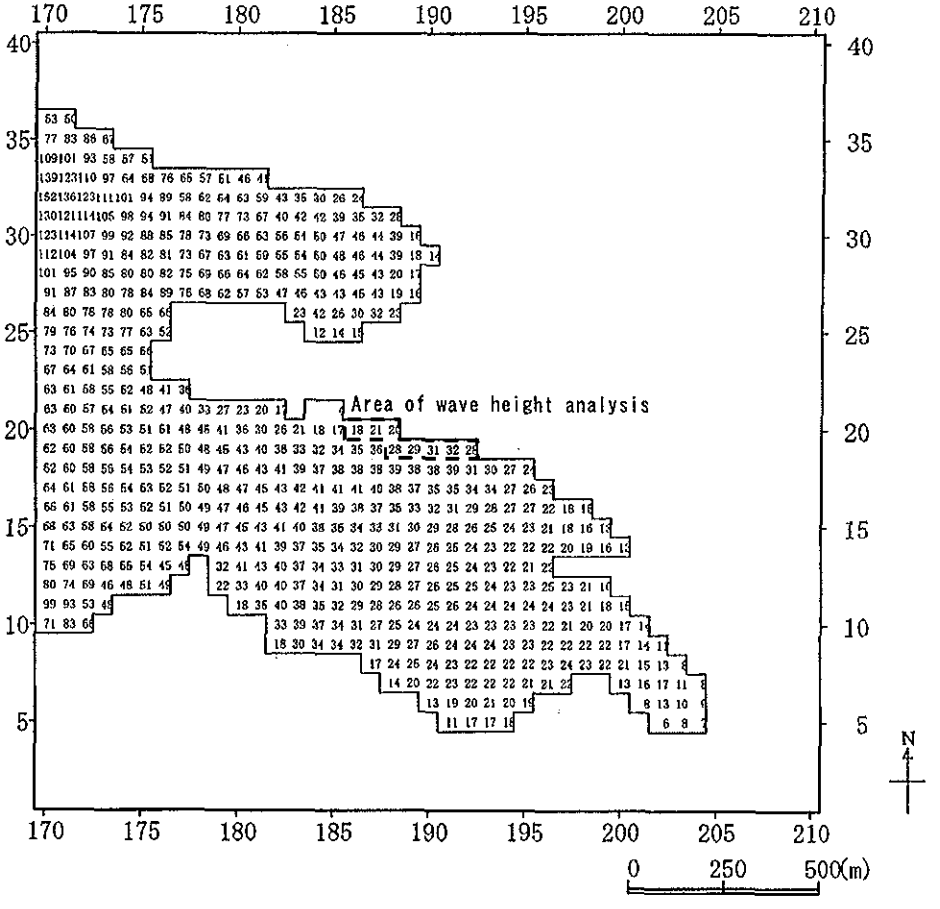


Figure-2.2(2) Result of deformation waves
(Waves Direction : WNW, $H_{1/3}$=7.19m, $T_{1/3}$=9.5s)

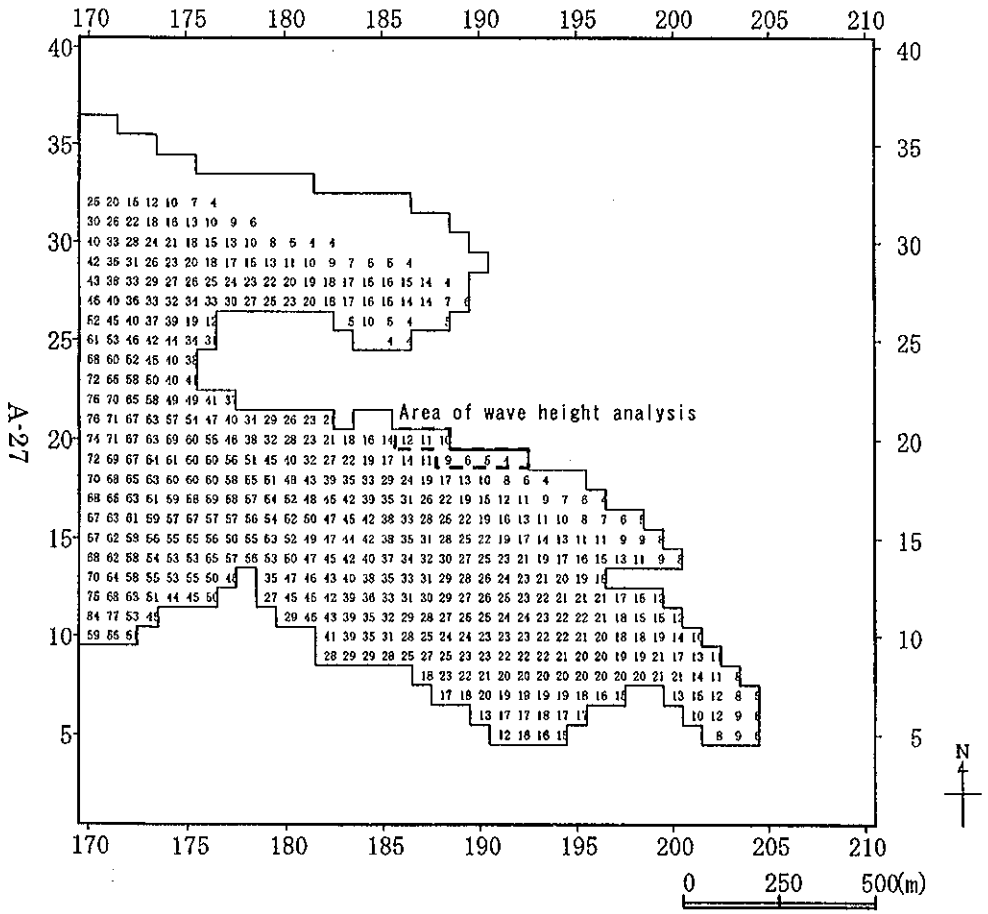


Figure-2.2(3) Result of deformation waves
(Waves Direction : NW, $H_{1/3}$=7.82m, $T_{1/3}$=9.8s)

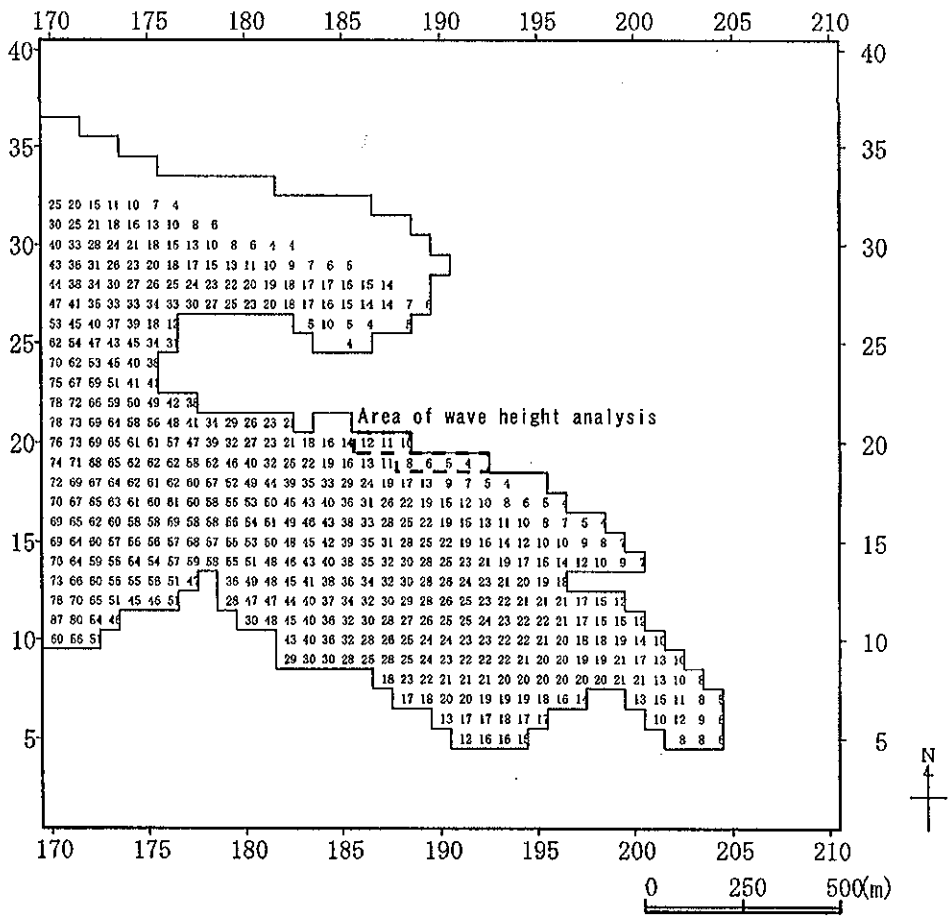


Figure-2.2(1) Result of deformation waves
(Waves Direction : WNW, $H_{1/3}$=8.18m, $T_{1/3}$=10.0s)

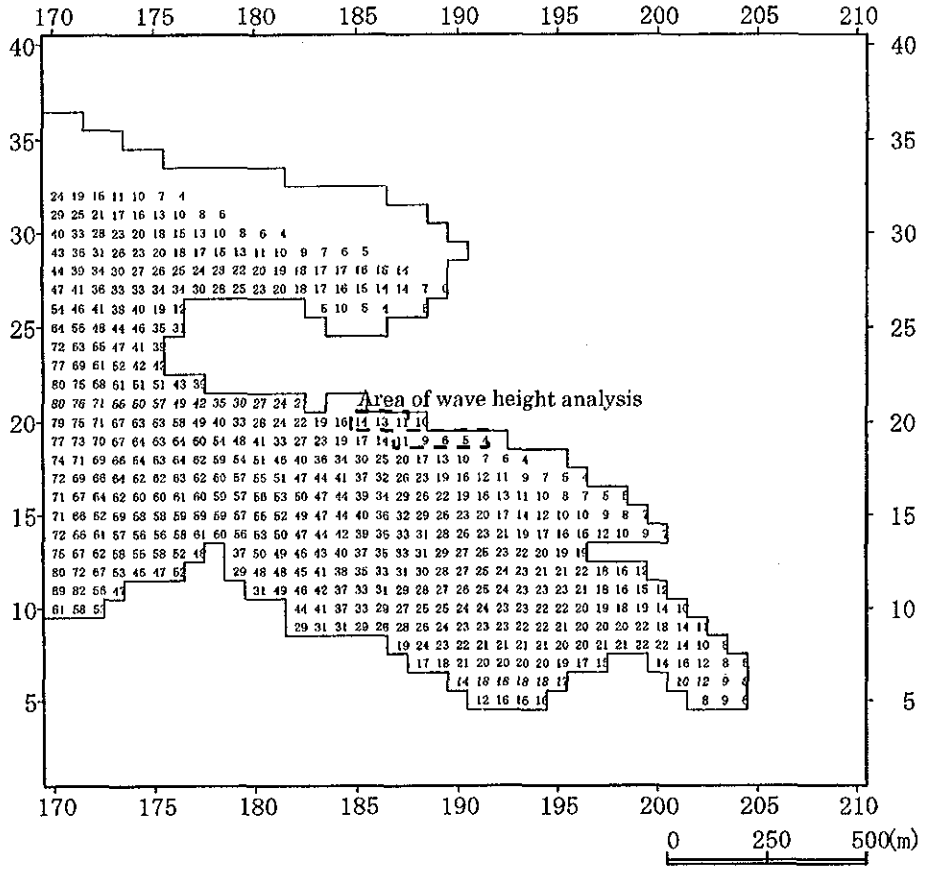


Figure-2.2(5) Result of deformation waves
(Wave Direction : N, $H_{1/3}$=8.50m, $T_{1/3}$=10.2s)

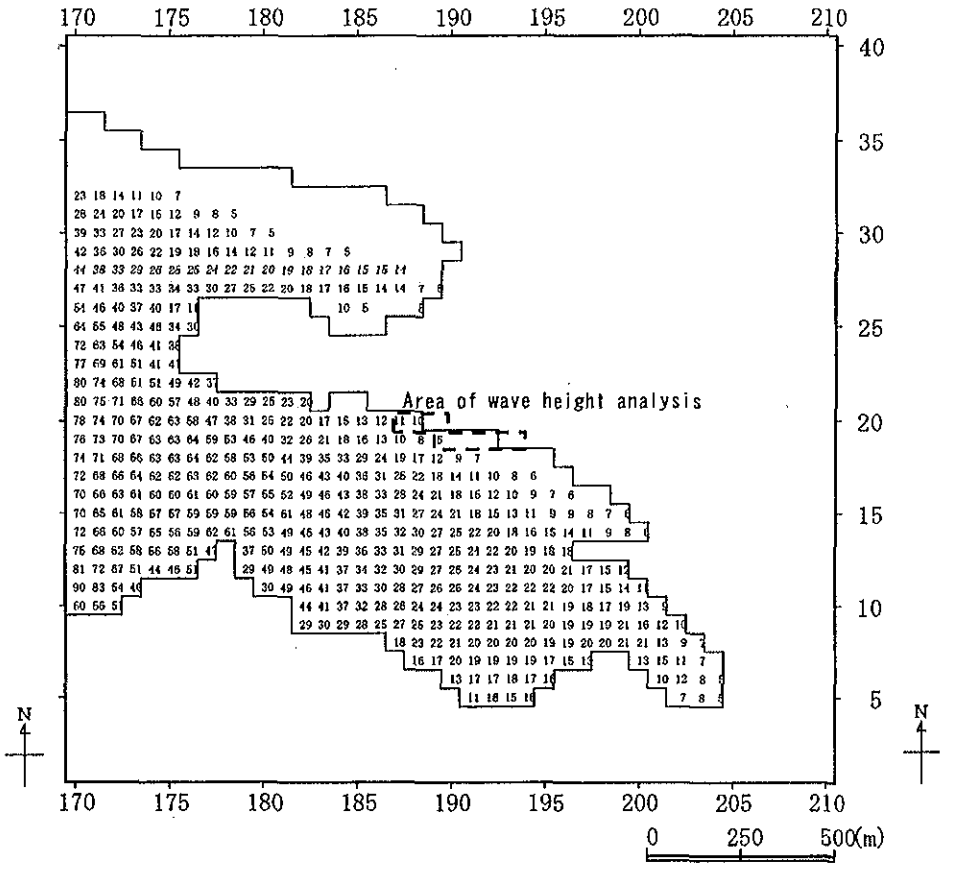


Figure-2.2(6) Result of deformation waves
(Wave Direction : NNE, $H_{1/3}$=10.33m, $T_{1/3}$=11.3s)

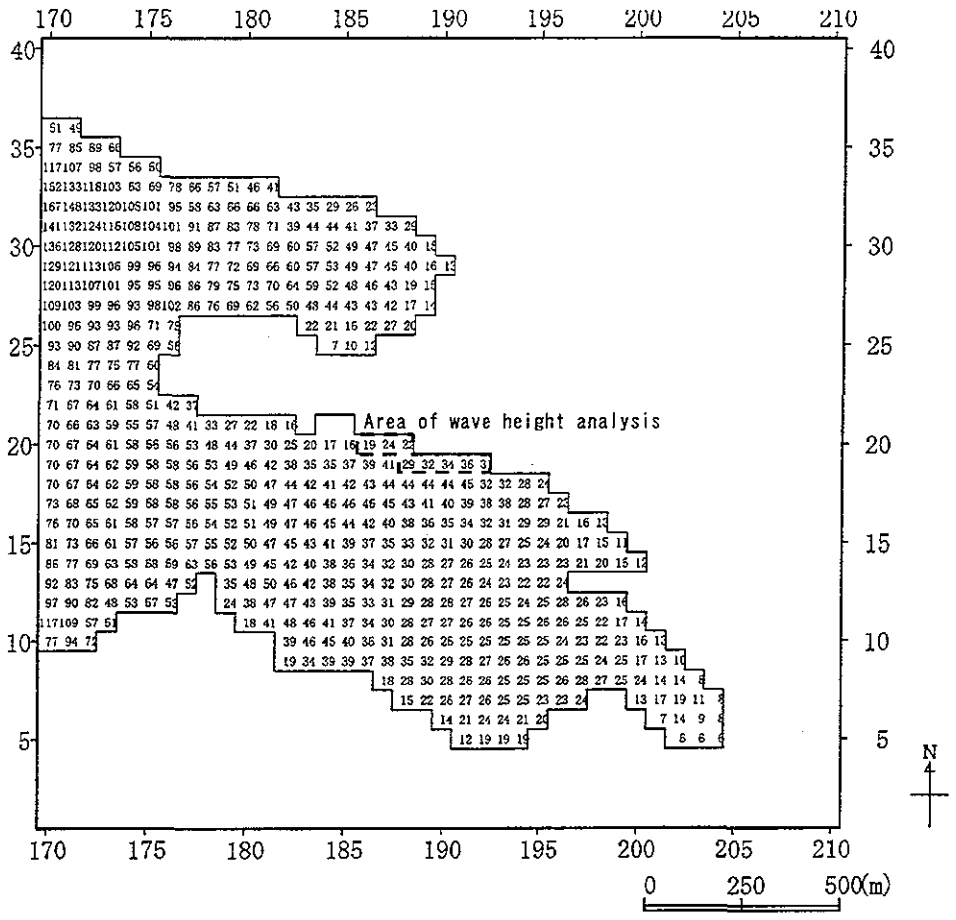


Figure-2.2(5) Result of deformation waves
(Wave Direction : W/max., $H_{1/3}$=10.33m, $T_{1/3}$=11.3s)

Maximum wave height distribution is waves at design site based on analysis. Maximum waves at Point Wharf is shown in Table-2.5.

Table-2.5 Result of wave Deformation (shallow water)

Waves Direction / Waves height	W	WNW	NW	NNW	N	NNE	W (Max.)
Maximum waves Height (m)	0.39	0.32	0.12	0.12	0.13	0.12	0.36
Period (s)	8.6	9.5	9.8	10.0	10.2	11.3	11.3

Maximum waves : H=0.4m, T=8.6sec (Wave Direction : W)

③ Result of abnormal Tide (storm surge)

Result of abnormal tide is shown in figure-2.3. Maximum abnormal tide is 0.99m.

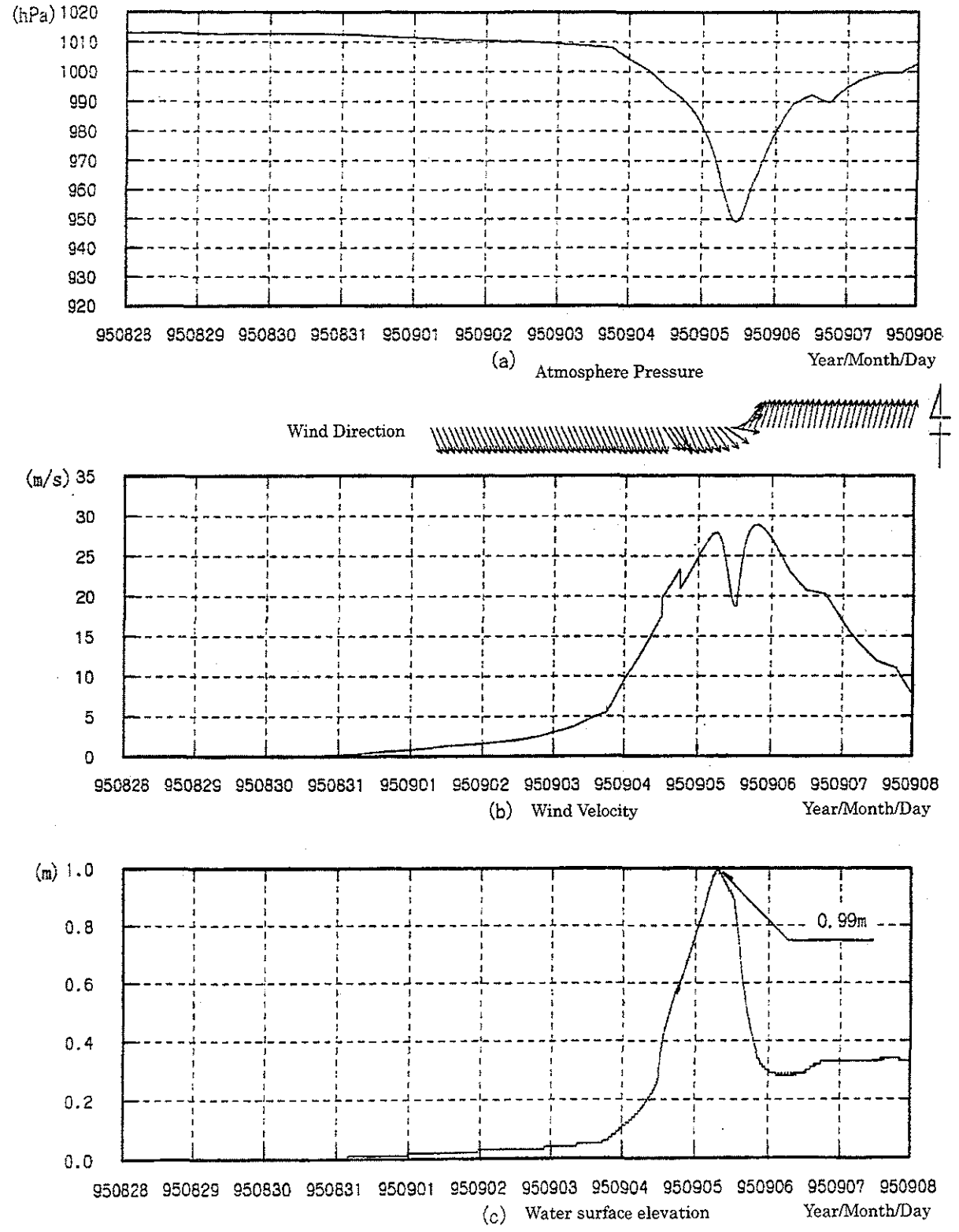


Figure-2.3 Result of abnormal tide (storm surge) (1995:LUIS)

Appendix-6 Earthquakes

Table - 6.1 Records of Earthquakes occurred near Antigua and Barbuda (Over M=5.0)

Year	N.Lat.	W. Long.	Magnitude
8th Oct,1974	17.30	62.00	7.5
14th Jan, 1997	17.37	61.62	5.4
28th Aug,1999	17.12	61.36	5.4
20th Dec, 1999	17.31	61.71	5.6

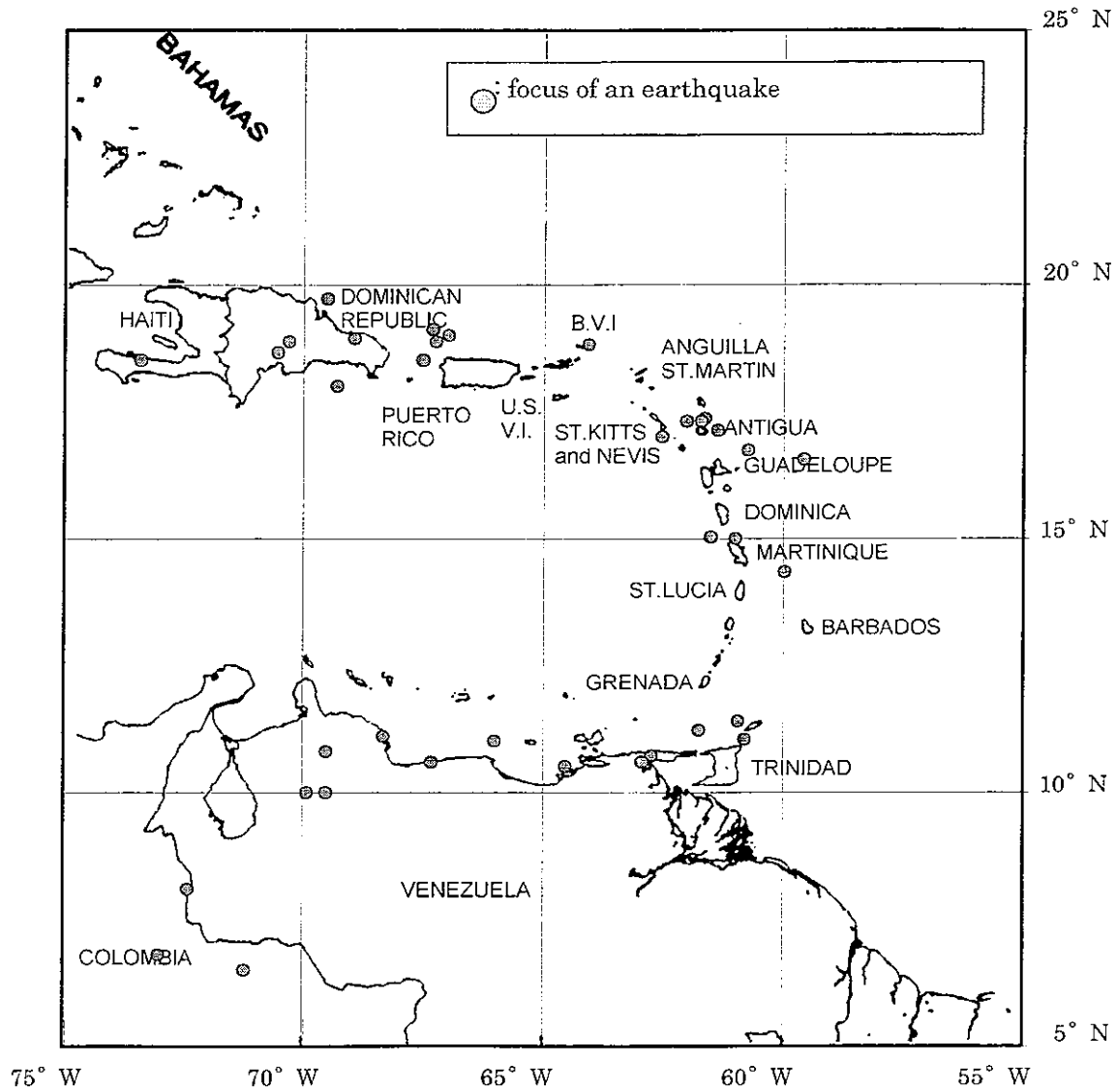


Figure - 6.1 Record Map of Earthquakes in Carribean Sea (1990～1999 Over M=5.0)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