Fisheries Division
Ministry of Agriculture, Forestry & Fisheries
Grenada

No.

PREPARATORY SURVEY REPORT

ON

THE PROJECT

FOR

IMPROVEMENT OF TRADITIONAL FISHING COMMUNITY INFRASTRUCTURE AT GOUYAVE

IN

GRENADA

July 2009

JAPAN INTERNATIONAL COOPERATION AGENCY

ECOH CORPORATION

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RURAL DEVELOPMENT DEPARTMENT,
JAPAN INTERNATIONAL COOPERATION AGENCY

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PREFACE

In response to a request from the Government of Grenada, the Government of Japan decided to conduct a preparatory survey on THE PROJECT FOR IMPROVEMENT OF TRADITIONAL FISHING COMMUNITY INFRASTRUCTURE AT GOUYAVE and entrusted the survey to the Japan International Cooperation Agency (JICA).

JICA sent to Grenada a survey team from August 15th, 2008 to September 22nd, 2008 and from March 16th, 2009 to April 7th, 2009.

The team held discussions with the officials concerned of the Government of Grenada, and conducted a field study at the survey area. After the team returned to Japan, further studies were made. Then, a mission was sent to Grenada in order to discuss a draft basic design, and as this result, the present report was finalized.

I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Government of Grenada for their close cooperation extended to the team.

July, 2009

Mr. Ariyuki Matsumoto
Vice-President
Japan International Cooperation Agency

July, 2009

Letter of Transmittal

We are pleased to submit to you the preparatory survey report on THE PROJECT FOR IMPROVEMENT OF TRADITIONAL FISHING COMMUNITY INFRASTRUCTURE AT GOUYAVE.

This survey was conducted by ECOH Corporation, under a contract to JICA, during the period from August, 2009 to July, 2009. In conducting the survey, we have examined the feasibility and rationale of the project with due consideration to the present situation of Grenada and formulated the most appropriate basic design for the project under Japan's Grant Aid scheme.

Finally, we hope that this report will contribute to further promotion of the project.

Very truly yours,

Eiichi Matsuura
Project Manager
Preparatory Survey Team on
THE PROJECT FOR IMPROVEMENT OF
TRADITIONAL FISHING COMMUNITY
INFRASTRUCTURE AT GOUYAVE
ECOH CORPORATION

Summary

SUMMARY

1. Outline of Country

Grenada is a volcanic islands country consisted of three major islands which are Grenada Island, Carriacou Island and Petite Martinique Island belonging to the Windward islands located in south of Lesser Antilles in the east Caribbean Sea. The land area is about 334 km^2 (about half of Japanese Sado Island) with the population of 106 thousand as of 2004. National income per capita is US$ 4,325 as of 2005 and it has attained independent as Commonwealth of Nations in 1974.

Grenada, after independent, has developed tourism and fisheries industries in addition to the production of Nutmeg, Banana, Cacao and etc. which are traditional agricultural products as the basic industry to support the independence of the own economy and recently, Transportation, Construction, Communication, Offshore Banking and etc. are expanded. However, since the domestic consumer's products are depended mostly on the import and the population and land area are limited, the industry size is small, tourism is seen sluggish growth and the economic base is not strong. And, the agriculture, tourism, public facilities, infrastructures and so forth were heavily damaged by hurricane "IVAN" and the total casualty loss was about double of GDP of Grenada (about US$ 90 million) and still making an effort for the reconstruction as of now.

The comparison ratio of GDP (EC$ 800.3 million) by industries are 13.4% by Transportation, 11.9% by Communication, 11.4% by Construction, 10.8% by Finance and Insurance, 9.1% by Wholesale and Retail, 6.2% by Manufacturing, 5.9% by Electricity and Water works and 5.8% by Hotel and Restaurants and the total primary industry has 5.9% (EC$ 47.18 million) and the Fisheries industry being out of it has 1.6% (EC$ 12.42 million). And, the deficit of 2006 is EC$ 1,494 million in total which is EC$ 196 million as domestic debt and EC$ 1,297 million as external debt and the trade balance in 2006 shows –EC$ 825 million that the heavy deficit is continued. Main domestic products for export are EC$ 11,021 thousand of Flour, EC$ 9,914 thousand of Fisheries, EC$ 7,156 of Nutmeg and share 60% of total export amount that is EC$ 11,021 thousand. However, the import amount of fisheries is EC$ 9,312 thousand out of the total import amount of food is EC$ 82,228 thousand and the fisheries export and import amount is almost the same amount.

2. Back Ground, path and outline of requested project

With the above the industrial structure and import and export balance, the Government of Grenada has focused attention on the development of plenty fisheries resources. From the latter part of 1980's to now, the Government of Grenada has established Fisheries Management and Development Plan: 2002 having purposes of the contribution to economic development by the sustainable and effective utilization, nutrition improvement and food supply to peoples (fulfilling of domestic demand by food import and substitute for importing food), acquisition of foreign currency by export promotion, creation of employment opportunity and increase of income of artisanal fishermen and has operated them by the support like Japanese grant aids. Gouyave district in St. John county where is the project site has continued fisheries more than 300 years and is the main fish landing place as well as the biggest traditional fishing village in Grenada. However, this district has the following problems.

1. Landing from small boat depending on marine conditions is difficult.
2. Ice is supplied from Melville Street where is about 20 km away due to the poor ice facility.
3. The access of buyers, retailers and etc. is inconvenient since the location of existing fisheries center is not good.
4. The existing facilities have been damaged by hurricane "IVAN".

3. Summary of survey result and Project content

Under the situation, the improvement of production and distribution of this district was necessary in the study of the development of fisheries industry of Grenada. "Infrastructure improvement plan in Gouyave traditional fisheries district" was established in December, 2006 with the purpose of the improvement of fisheries facilities in Gouyave and has requested Grant Aid to Japan including ① construction of breakwater and improvement of jetty, ② Construction of fish market, ③Improvement of the existing fisheries center. However, as this project has included the construction of marine civil structures like breakwater to lead an anxiety of impact to the natural environment in addition that the detail of project site, implementation system of Grenada and its capability were not clear, preliminary survey team has been dispatched in January, 2008 and confirmed its relevancy and necessity. For the above, the Government of Japan has decided to conduct the Preparatory survey Study and the team was dispatched with the following schedule.

Preparatory survey : August 15, 2008～September 22, 2008
Additional Preparatory survey : March 16, 2009～April 7, 2009
Explanation of Draft Report : June 27, 2009～July 6, 2009

The following existing circumstances and the issues are found through the site survey.

① The sustainable and maximum effective utilization, of the coastal fisheries resources, are executed as ensuring job security for local artisanal fishermen and food security for the area people and, of the offshore fisheries resources as the resources for the consumers mainly in urban area , tourism industry and export market in the recent development guideline of fisheries sector. The fisheries base facilities in Goyave are still stayed ways they were responding to the coastal fisheries in spite of the change of fisheries pattern that the dependence degree is more than 95 % on offshore pelagic fish (migrant) from the coastal fisheries.

② Although the fish landing function of existing jetty is only just maintained by repeated disasters like hurricanes and repairs, a secured and safe berthing of artisanal fishing boat is in difficult condition due to the aging of steps for landing, no installation of fenders and etc. Steel pipe piles which support the jetty are corroded with the damages of coating for anti-corrosion and etc. exceeding the assumed corrosion speed.

③ Fisheries distribution function has been a scheme to support with the existing fisheries center and fish market that were constructed by Japanese Grant Aid for Fishery Sector in 1989/1990 however the existing fisheries center is not functioned due to the damage by hurricane "IVAN" and the functions like ice making machine have been deteriorated (actually 1.1 tons/day). The cold storage capability has also been seriously deteriorated with the corrosion of freezer and aging of wall, floor and door of refrigerator.

④ The situation to put off fishing has been happened stopping the fish landing and shipping at high season due to the lack of fisheries distribution facilities. And, according to the growing in fish size, frozen storage has been required but there is no capability of frozen storage therefore 9.8% of landed fish becomes post harvest loss (fish is thrown out).

⑤ These influence is appeared on the annual landing volume and the landing volume in Gouyave district shows downward trend (the landing volume in 2007 was 0.81 times of its 2002) while the landing volume of total Grenada shows no apparent change. (the landing volume in 2007 is 1.01 times of its 2002)

⑥ Fishing boats in Gouyave operating offshore of west coast of Grenada are inevitable to load safety tools (wireless application and etc.) while, the existing tower which works for observation of fishing boats activities, transmittal of signal at the time of emergency is existed at north east of

Grenada Island but the radio wave is not reached up to the west coast due to the terrain condition. Therefore, fishermen's safety such as observation of fishing boats activities which operate offshore or transmittal of emergency signal is not secured.

4. Implementation schedule of the Project and cost estimation

With the above, in this project, centering the existing fisheries center where is in Gouyave District, St. John County, Grenada, New Fisheries Center to put together all functions of the existing fisheries center and as the cooperation project, the components are ① Basic facilities of fishing port (Jetty, Revetment, Access road), ②Base facilities of fisheries production and distribution (Landed fish treatment, Storage, Processing facility and Sales booth, Facilities for management and welfare, Transmission facilities for fisheries), ③ Other facilities (Sewage treatment, Car parking, Fish net mending shed). The summary of the New Fisheries Center constructed by this project are as described in the following table and the detailed design needs 5.5 months and 17 months for the construction work.

Project cost can be estimated as 1,169 million Japanese yen by Japan side and 12 million Japanese yen by Grenada side (excluding the cost for land and relocation of resident).

Contents of Components

	Item	Usage	Spec/Quantity	Remarks
(1) Basic Facility for Fishing Port				
1	Breakwater	Improvement of wave condition around existing Jetty		
2	Partial improvement of existing jetty	Improvement of landing & preparation for fishing (for long-line fishing boat & trawler targeted large size offshore pelagic fish)	Jetty length: 83m(45m for berth section and 38m for access section)	・ Width of berth section: 9m, Width of access section: 4.88m ・ Included removal of existing jetty
3	Jetty lighting facility	Lighting facility for night work around jetty	4 sets	
4	Installation of gasoline & diesel supply pipe lines	To supply fuels to out& in board engines from the jetty	Installation of under ground duct	(Supply piping for oil and water is installed by Grenada)
5	Slipway facility			
	①Slipway	A slope for lifting boat to maintain and repair		
	②Lorry	For loading a boat on this		
	③Driving winch	For haul up a lorry		
	④Boat yard	Yard for maintain and repair boats lifted up		
	⑤Engine repair room	Room to maintain & repair for out & in board engines	Work shop (27.04m²)	
(2) Fisheries Production & Distribution Facilities 1. Landed fish treatment, storage and process facilities				
① Chest freezer		Storage mainly for domestic sales of large size pelagic fish and its processed products	Blast freezing room with 17 m³, ice storage room with 87 m³, slow freezing storage room with 117 m³ in -20℃ ~ -25℃	Blast freezing room: 250 kg/day, -25℃ ~ -30℃, Freezing storage room with 20 hours/one time: fish volume: 3.5 t at -20℃ for about 2 weeks. Slow freezing room: 4.3 t/day, -20℃ ~ -25℃ for about 3.5 days
②Cold storage room		2 to 4 days storage mainly for exporting tunas	38 m³	Ice storage: at -5℃ for 1.5 days storage, Ice storage: fish volume: 1.1 ton/day
③Bait room		Storage flying fishes etc. used for long-line fishing	58 m³	Fish storage volume: 540 kg/day at -20℃ for one month
④Ice machine & Ice storage room		Ice to be used for preparation of fishing, quick freezing of landed fish and its storage, domestic transportation and sales in fishing market of fresh fishes	Ice making capacity with 4 t /24 hours plate ice, Ice storage room (volume with 10 t)	
⑤Vending booth		Fresh fish sales for consumers in Gouyave district	10 booths (Vender's area: 133 m²)	Concrete made with Terrazo finishing
⑥Fish receiving & Cleaning room		Sorting, cleaning and weighing of landed fishes	Floor area of receiving & cleaning room: 80 m², weighing & recording room: 39 m2	Weighing tools and storage cases are born by the Government of Grenada
⑦Fish primary treatment room		Cleaning, gutting and removing scales of small size fishes to be sold in fish market	Floor area of vender's room: included in 133 m²	
⑧Fish cleaners sink		Cleaning, gutting and removing scales of small size fishes to be sold in fish market	10 sinks	
⑨Fish processing room		Process for fillet, round slice & etc. of large size pelagic fish for domestic caught in high season (processing products are stored as frozen and supply stably o meet with domestic market demand)	91 m²	Insulated storage box and processing equipment are born by the Government of Grenada
2. Facility management and Sanitary facilities				
① Manager's office		Business execution and receiving center guest	Fisheries Division: 1 room, Market management: 1 room	2F for Fisheries Division
② Administrative office		Management of the center	Fish Market Management Office x 1 room	
③ Training & conference room		Fisheries supervising and training to fishermen, PR activities, & fishermen's conference	1 room	2F
④ Warehouse for material		Storage for stationeries, documents, tools and etc.	1 room	1F Warehouse for management (storage for cleaning tools)
⑤ Staff toilet, & shower room		Sanitary & welfare facilities for staff	For men x 1, women x 1, with washing & shower (1 room)	
⑥ Staff changing room		For staff	1 room	
⑦Toilet & shower for fishermen & venders		Sanitary & welfare facilities for fishermen & venders	Toilet for market management x 2, shower x 2 (cum fishermen)	
⑧ Changing room for fishermen & venders		For fishermen & venders	Included in the above	
3. Revetment and outlaying facilities				
①Land reclamation and backfilling		Securing land for the New Fisheries Center	900 m²	
②Revetment & Parapet wall		Protection of the New Fisheries Center from waves	100m	
③Grating covers		Grating cover for rain water in site and making use of project site	Settlement bridge (Concrete made)	
④In port access road		Securing smooth and safe working environment in project site	L:95 m	
⑤Concrete pavement		Securing smooth and safe working environment in project site	850 m²	
⑥Exterior lighting, Illuminations		Securing night work in project site and its guard duty	4 sets	
⑦Sewage treatment plant		Treatment for sewage water generated in project site and domestic waste water and environment conservation	Septic tank, Removal of oil pollution from boat yard	
⑧Car parking		Securing convenience for visitors and fishermen	Concrete pavement	
4. Facilities concerning fisheries				
①Dry storage room		Mending of fish nets	3 m x 5 m 4 sets with temporary roof	
②Beacon light		For calling port by fishing boats	1 (beacon light with solar generation)	Distance: 5 n-miles
(3) Remote communication facility				
①Antenna		Expansion of communication coverage of VHF radio loaded on fishing boats (Presently fixed type with boat about 25 n-miles change and expand to potable type with about 50 to 90 n-miles)	Self standing communication antenna tower (L-type steel structure with the height of 180 ft)	
②Repeater installation shed		Installation of VHF repeater, storage (just beneath antenna or the side)	4 m x 4m (Office space) 4m x 2m (Generator and warehouse)	Necessary separation between repeater installation and office due to protection of radio disturbance
③Marine VHF Repeaters		Communication rely between VHF radio loaded on fishing boat and Gouyave land station(1 for primary reception and 1 for mutual communication)	Power (50 w x 2)	
(4) Equipments				
①Forklift		For landing, loading and transportation of landing fish and ice loading	1 vehicle (LPG specification)	Loading capacity: 1 ton
②Truck with crane		Fishing landing and transportation	1 truck (2 tons)	Lifting capacity: 1 ton

It is evaluated as relevant and significant as Grant Aid Cooperation since the following effects can be expected by the implementation of this project.

(DIRECT EFFECT)

① Improvement of fish landing volume

Annual handling volume in the existing fish market is 428,782 lbs however, the handling volume in the New Fisheries Center shall be increased with the construction of the new fisheries center and conduction of effective distribution in the market. And, it is estimated that the current post harvest loss of fisheries products is 9.8% (61,977 lbs/year) of annual handling volume of the existing fish market, as the effective distribution of fisheries products is executed with the provision of freezing rooms in the new fisheries center, these post harvest losses shall be resolved.

② Promotion of efficiency and safety of landing with construction of jetty

Fish landing is difficult in the existing jetty since the crown height is elevated against present fishing boats. And, since the gratings which were installed at lower part of jetty by Grenada are too narrow without installing fenders, there are troubles at landing works and problems of safety. Safe and effective landing works will become possible solving these problems by the construction of jetty.

③ Improvement of convenience and sanitary condition and increase of users by improving function of fish market

The existing fish market has no car parking space and the available sales booths are only 4 due to the narrowness. As the sales booths will be increased and about 16 vehicles can be used simultaneously in the consolidated new fisheries center, it will be more convenient. 10 sales booths for the venders which are 2.5 times of the present will be made. The area of sales table per booth will be wider and the booth will be possible to put fish on ice which leads to the sanitary sales with preserving freshness and the consumers can purchase fresh fisheries products. Consequently, the increase of the number of users to purchase fisheries products and the venders to utilize the market can be expected.

④ Increase of processing volume and variety in fish market

As expanding the function of freezing storage in the New Fisheries Center, the variety of handling fishes from fresh fish to frozen fishes shall be increased. As well as tuna processing for export can be possible, cutting process in rounds of frozen fish (Tuna, Atlantic sailfish and Common dolphin fish) for domestic market is promoted. And, the expanding process room makes handling of processed fish possible.

⑤ Increase of ice sales volume and income

As the ice supplying capacity corresponding to the present ice demand in the New Fisheries Center shall be improved, the ice sales volume will be increased and its income of the Fisheries Center which is operating organization will be increased. As the ice making capacity will be 4 tons/day from the present 1.1 tons/day and the storage capacity will be 10 tons, the annual ice sales amount will be increased.

⑥ Decease of number of marine peril

Most of fishing boats in Gouyave have operated at the offshore of 40 to 70 sea miles. Although the antenna was installed at Kublal located north side of Grenada Island St. Catherine hampers the radio wave and it does not transmitted to open sea. About 30 marine perils at Gouyave district have occurred in the past 5 years. Half of these (16 perils) were caused by having trouble contacting in an emergency.

The antenna which will be constructed with this project is set 90 miles as longitudinal coverage and basically most of fishing boats can be operated within the range of the radio. Therefore, the improvement of receipt of rescue signal from fishing boats, finding of operation area, provision of information and etc. become easy and decrease the marine perils can be expected.

(INDIRECT EFFECT)

① Income increase of related business with fish market

Fresh fishes will be always possible to be supplied in the New Fisheries Center and the handling volume will be increased and the income increase of related business with fish market can be expected.

② Supply of protein sources to the people of Grenada and increase of employment opportunities

As fresh fisheries products are supplied throughout Grenada, 110 thousand of peoples national shall receive the effect such as getting supply of protein and the benefit the increase of employment opportunity by the development of fisheries industries through the export of fisheries products.

Fisheries division which is an implementation organization of the New Fisheries Center is proposed to make efficient use of the New fisheries Center and operate and maintain it after completion of construction of this project with well taking care of the following points.

(1) System to steadily execute daily management and periodical maintenance for building and facility

In order to maintain and keep the functions of buildings, facilities and equipment induced by this project, the daily management is important. It is important to follow the daily cleaning work also in the New Fisheries Center although the daily cleaning work is executed in the existing fisheries center and kept clean and it is necessary to organize the system to record daily operation and utilization status of buildings, facilities and equipment and its periodical maintenance.

(2) Establishment of monitoring system

It is necessary to understand the fish freshness and the user's need by executing weighing and record of landed fish, supply fuel to fishing boats and the record of supply volume, checking of berth occupancy time by fishing boats for fish landing, checking of fish freshness, periodical questionnaire survey to users and etc.

(3) Establishment of operation manual

Operation manual in sales booth, process room, ice making and cold storage facility for its facility cleaning, how to handle fish, processing method, freshness assessment method and etc. and distributes them to venders and staff of the New Fisheries Center and controls strictly.

(4) Break ground of market

It is also necessary to respond to fresh fish for export promotion and frozen fish for restaurant, hotel and hospital in addition to fresh fish for venders in the New Fisheries Center. In order that the New Fisheries Center shall develop in a sustainable way, the new business target is necessary as well as maintaining freshness monitoring their comments and requirement all the time from new buyers and try to promote its quality.

(5) Reserve fund for facility renewal

Ice making and cold storage facility in the New Fisheries Center shall need periodical maintenance fee, main parts replacement fee and renewal fee at the 13th year of the durable years. This renewal fee is necessary to be reserved properly.

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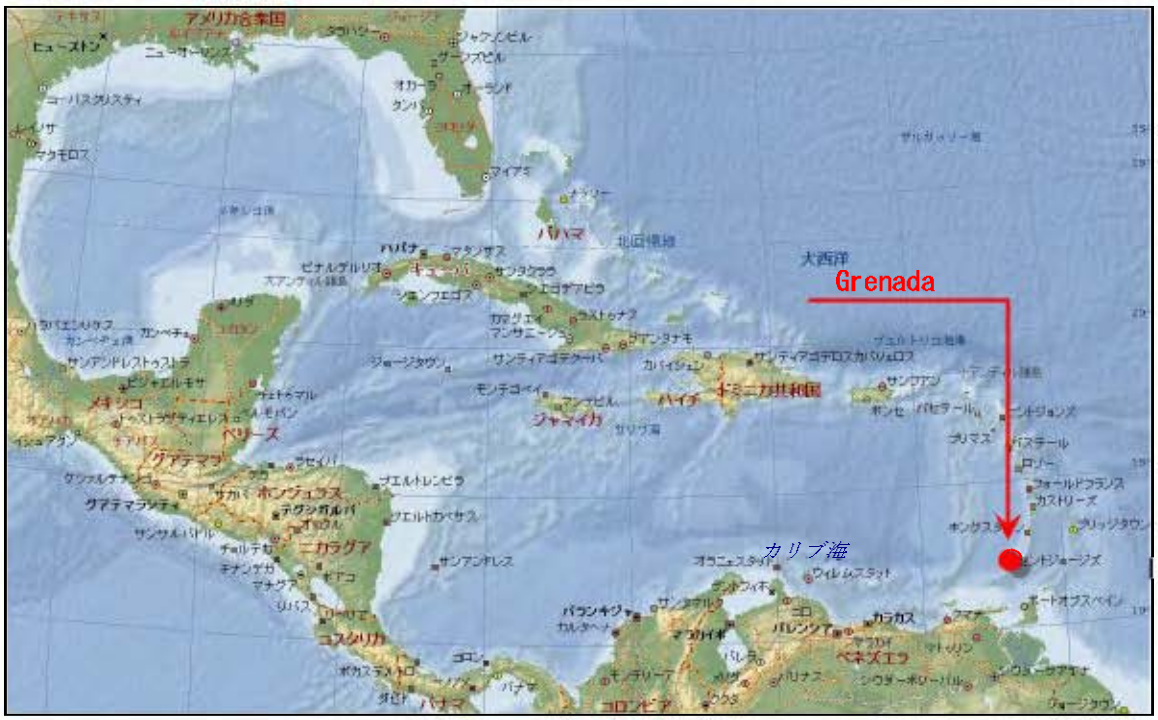
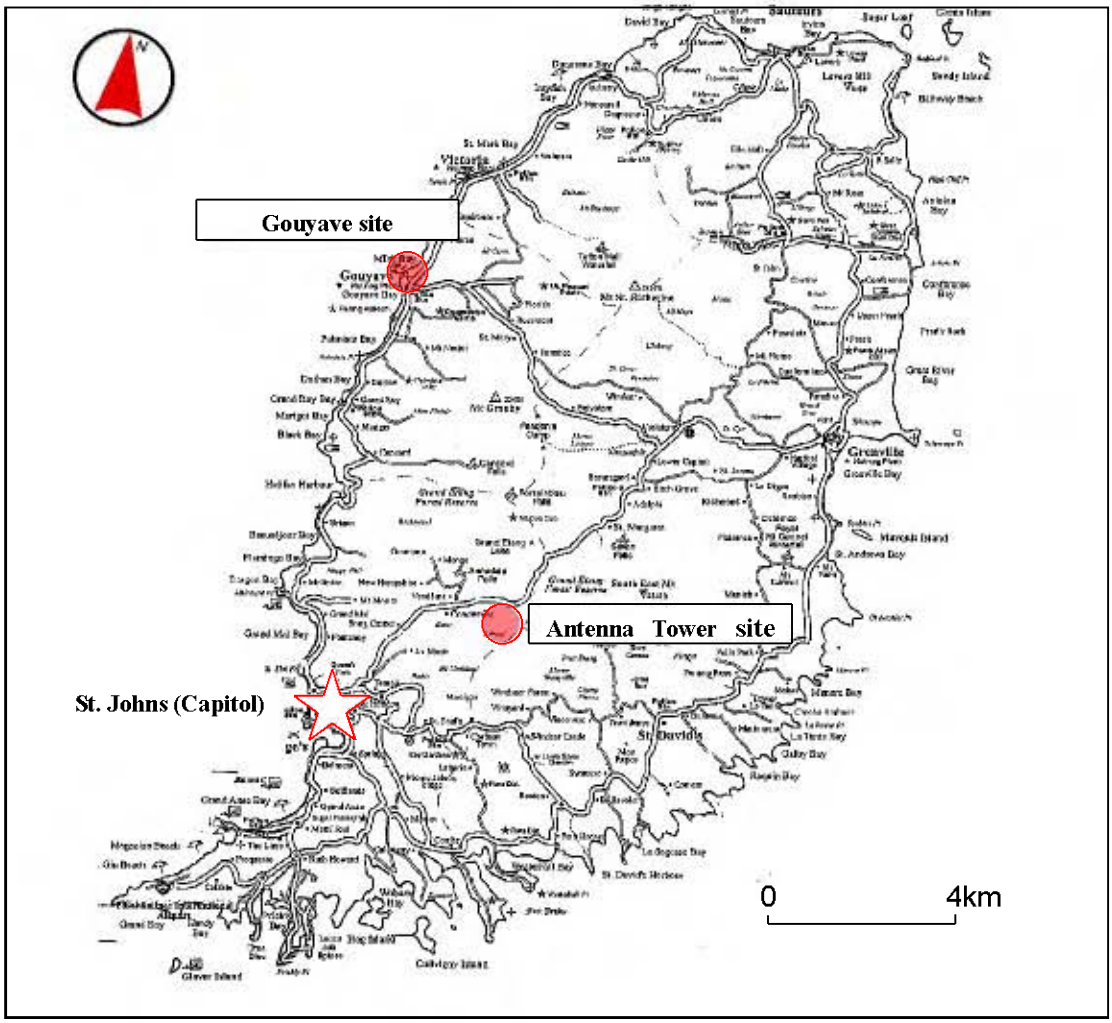
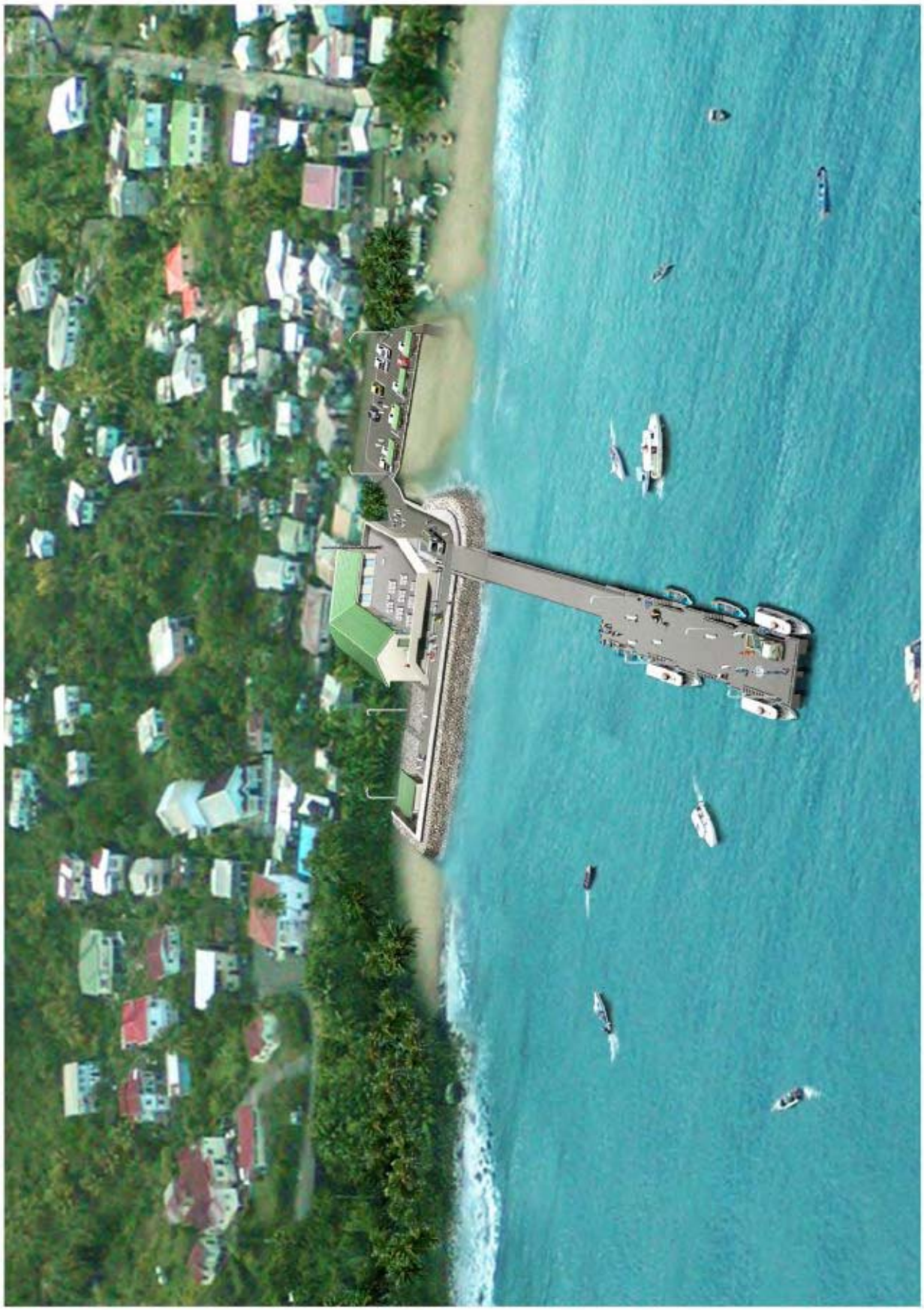
¦ Location Map of Grenada



¦ Project Site Location



■ Perspective Plan



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ABBREVIATIONS

BOD	Biochemical Oxygen Demand
BHN	Basic Human Needs
CCA	Caribbean Conservation Association
CDL	Chart Datum Line
CIDA	Canadian International Development Agency
COD	Chemical Oxygen Demand
CUBiC	Caribbean Uniform Building Code
EEZ	Exclusive Economic Zone
EIA	Environment Impact Assessment
E/N	Exchange of Notes
FAO	Food and Agriculture Organization of the United Nations
GDP	Gross National Product
GL	Ground Level
GRENLEC	Grenada Electricity Services Ltd.
GSWMA	Grenada Solid Waste Management Authority
HDBK	Port and Harbor Design Criteria
HEM	n-Hexane Extractable Material
HWL	High Water Level
IEE	Initial Environmental Evaluation
MAFF	Ministry of Agriculture, Forestry and Fisheries
MALFFEP	Ministry of Agriculture, Lands, Forestry, Fisheries, Energy and Public Utilities
MHWS	Mean High Water Spring
MHWN	Mean High Water Neap
MLWN	Mean Low Water Neap
MLWS	Mean Low Water Spring
MSL	Mean Sea Level
NAWASA	National Water and Sewage Authority
NHHWL	Nearly Highest High Water Level
OECS	Organization of Eastern Caribbean States
PH	Potential of Hydrogen
PPU	Physical Development Unit
RC	Rein Forced Concrete
TSS	Total Suspended Solid
WL	Water Level

Chapter 1 Back ground of the Project

Chapter 1 Back ground of the Project

1-1 Back ground of request for Grant Aid Cooperation

Fisheries industry of Grenada is placed to be important out of the Primary Industry in the National Development Plan (2001 to 2005) and the targets of development are to encourage increase of cash income through modernized fishing industries, to achieve self-sufficiency in fish products, to generate foreign exchange by stimulating fishing activities, to generate and amplify employment opportunity and etc.

Gouyave district, St. John County is the largest traditional and long-established fishing community more than 300 years in Grenada in addition to main fish landing place. However, this district has the following problems.

① Ice supply is received from Melville Street Market where is 20 km away due to the lack of enough ice facility,

② It is inconvenient for other local users, venders or others to access due to the bad conditions of the existing fishing market,

③ The existing facilities were damaged by the hurricane " IVAN",

④ It is difficult to fish landing from small fishing boat depending on marine phenomenon.

Under this situation, the improvement of production and distribution system in this district is necessary upon studying the development of fisheries industry of Grenada and Grenada has made "Improvement Plan of the Traditional Fishing Community Infrastructure at Gouyave" aiming to improve fisheries facilities at Gouyave in December, 2006 and has requested the Grant Aid Cooperation to the Government of Japan including Construction of revetment and Improvement of Jetty, Construction of Fish Market, Improvement of the Existing Fisheries Center.

However, as the details of project site and implementing system and capability of the government were uncertain and the construction of marine structures like revetment has been planned, the influence on natural environment was anticipated. Therefore, the preliminary Study Team was sent in January, 2008 and got the following results.

① This project site, Gouyave where the infrastructures were constructed at "Coastal Fisheries Development Plan" by Grant Aid Cooperation, thereafter, the catching object was changed to the large size offshore pelagic fish centering yellow fin tuna from the coastal resources with the good result of technical transfer through dispatch of long stay experts from Japan. And, now it supports Grenada fishing industry as tuna landing base.

② Facilities constructed in the "Coastal Fisheries Development Plan" are no longer able to respond to the needs which fishermen suffer now such as growing in size of fishing boat.

As these facilities were damaged by hurricane "IVAN" in 2004, the facilities could not be recovered enough and disturbed to fishery production activities.

③ Special caution and careful examination are necessary on by acquisition of project site, management of the new Fisheries Center and Fish Market, understanding of proper ice making volume, the environmental impact assessment (sand sedimentation and scouring) and etc. associated with the construction of marine structures (improvement of tranquility)

④ As for the rest, a stakeholders meeting was held sponsored by implementing agency and got the opinions from market users and fishermen, the support for this project was confirmed.

Accordingly, the Preparatory Survey to verify the necessity, appropriateness and urgency of requested project is conducted as Grant Aid Cooperation and establishment of project plan and estimation of project cost are to be conducted. And as this project is categorized as "B" on "Guide Line for Environmental and Social Consideration published by JICA", it is required to realize countermeasures considering enough to the environmental society such as the impact on natural environment, waste water mitigation, explanation to fishery related people and the vicinity, waste treatment

1-2 Components requested as Grant Aid Cooperation

Table 1-2(1) shows the requested components from Grenada side, priority evaluation and remarks of each component at the time of preliminary study. Figure 1-2(1) shows the summary of "Improvement Plan of the Traditional Fishing Community Infrastructure at Gouyave" by the Government of Grenada.

Table 1-2(1) Requested Components of the Government of Grenada and priority evaluation of each component at Preliminary Study

Item	Usage	Requested	Priority (Preliminary Study)	Remarks
(1) Basic Facility for Fishing Port				
1 Breakwater	Improvement of wave condition around existing Jetty	170m Rubble mound (with wave absorbing function)	A	
2 Partial improvement of existing jetty	Improvement of landing & preparation for fishing (for long-line fishing boat & trawler targeted large size offshore pelagic fish)		A	・Width of berth section: 9m, Width of access section: 4.88m ・Included removal of existing jetty
3 Jetty lighting facility	Lighting facility for night work around jetty	2 sets	A	
4 Installation of gasoline & diesel supply pipe lines	To supply fuels to out& in board engines from the jetty	2 sets	D	(Supply piping for oil and water is installed by Grenada)
5 Slipway facility				
① Slipway	A slope for lifting boat to maintain and repair	60 m^2	A	
② Lorry	For loading a boat on this	Corresponding to 28 ft to 45 ft	A	
③ Driving winch	For haul up a lorry	Power driven (12 t)	B	
④ Boat yard	Yard for maintain and repair boats lifted up	160m^2	B	
⑤ Engine repair room	Room to maintain & repair for out & in board engines	25 m^2	D	
(2) Fisheries Production & Distribution Facilities				
1. Landed fish treatment, storage and process facilities				
① Chest freezer	Storage mainly for domestic sales of large size pelagic fish and its processed products	120 m^2 x 2 rooms	A	Quick freezing room: 250 kg/day, -25℃- -30℃, Freezing storage room with 20 hours/one time: fish volume: 3.5 t at -20℃ for about 2 weeks. Slow freezing room: 4.3 t/day, -20℃- -25℃ for about 3.5 days
② Cold storage room	2 to 4 days storage mainly for exporting tunas	20 m^2 x 2 rooms	A	Ice storage: at -5℃ for 1.5 days storage, Ice storage fish volume: 1.1 ton/day
③ Bait room	Storage flying fishes etc. used for long-line fishing	20 m^2 x 2 rooms	A	Fish storage volume: 540 kg/day at -20℃ for one month
④ Ice machine & Ice storage room	Ice to be used for preparation of fishing, quick freezing of landed fish and its storage, domestic transportation and sales in fishing market of fresh fishes	Ice making capacity with 4 t /24 hours flake ice, Ice storage room (volume with 40 m^2 x 1 room)	A	
⑤ Vending booth	Fresh fish sales for consumers in Gouyave district	10 booths	A	Concrete made with Terrazzo Finishing
⑥ Fish receiving & Cleaning room	Sorting, cleaning and weighing of landed fishes	Floor area with 80 m^2 x 1 room	A	Weighing tools and storage cases are born by the Government of Grenada
⑦ Fish primary treatment room	Cleaning, gutting and removing scales of small size fishes to be sold in fish market	Floor area with 20 m^2 x 1 room	A	
⑧ Fish cleaners sink	Cleaning, gutting and removing scales of small size fishes to be sold in fish market	10 sinks	A	
⑨ Fish processing room	Process for fillet, round slice & etc. of large size pelagic fish for domestic caught in high season (processing products are stored as frozen and supply stably o meet with domestic market demand)	Floor area with 100 m^2 x 1 room	A	Insulated storage box and processing equipment are born by the Government of Grenada
2. Facility management and Sanitary facilities				
① Manager's office	Business execution and receiving center guest	1 room	A	2F for Fisheries Division
② Administrative office	Management of the center	1 room (Fisheries Development Office cum Data Processing Room)	A	
③ Training & conference room	Fisheries supervising and training to fishermen, PR activities, & fishermen's conference	1 room	A	2F
④ Warehouse for material	Storage for stationeries, documents, tools and etc.	1 room	A	1F Warehouse for management (storage for cleaning tools)
⑤ Staff toilet, & shower room	Sanitary & welfare facilities for staff	For men x 1, women x 1, with washing & shower (1 room)	A	
⑥ Staff changing room	For staff	1 room	A	
⑦ Toilet & shower for fishermen & venders	Sanitary & welfare facilities for fishermen & venders	Toilet fro fishermen x 2, shower x 3 (cum venders)	A	
⑧ Changing room for fishermen & venders	For fishermen & venders	1 room	A	
3. Revetment and other facilities				
① Land reclamation and backfilling	Securing land for the New Fisheries Center	800 m^2	A	
② Revetment & Parapet wall	Protection of the New Fisheries Center from waves	100 m.	A	
		Parapet 25m	A	
③ Grating covers	Grating cover for rain water in site and making use of project site	80 m^2	A	
④ In port access road	Securing smooth and safe working environment in project site		A	
⑤ Concrete pavement	Securing smooth and safe working environment in project site		A	
⑥ Exterior lighting, Illuminations	Securing night work in project site and its guard duty		A	
⑦ Sewage treatment plant	Treatment for sewage water generated in project site and domestic waste water and environment conservation		A	
(3) Communication facility				
① Antenna	Expansion of communication coverage of VHF radio loaded on fishing boats (Presently fixed type with boat about 25 n-miles change and expand to potable type with about 50 to 90 n-miles)	Self standing communication antenna tower (Steel structure with the height of 180 ft)	A	
② Repeater installation shed	Installation of VHF repeater, storage (just beneath antenna or the side)	3 m x 3m	A	Necessary separation between repeater installation and office due to protection of radio disturbance
③ Marine VHF Repeaters	Communication rely between VHF radio loaded on fishing boat and Gouyave land station(1 for primary reception and 1 for mutual communication)	Power (50 w x 2)	A	

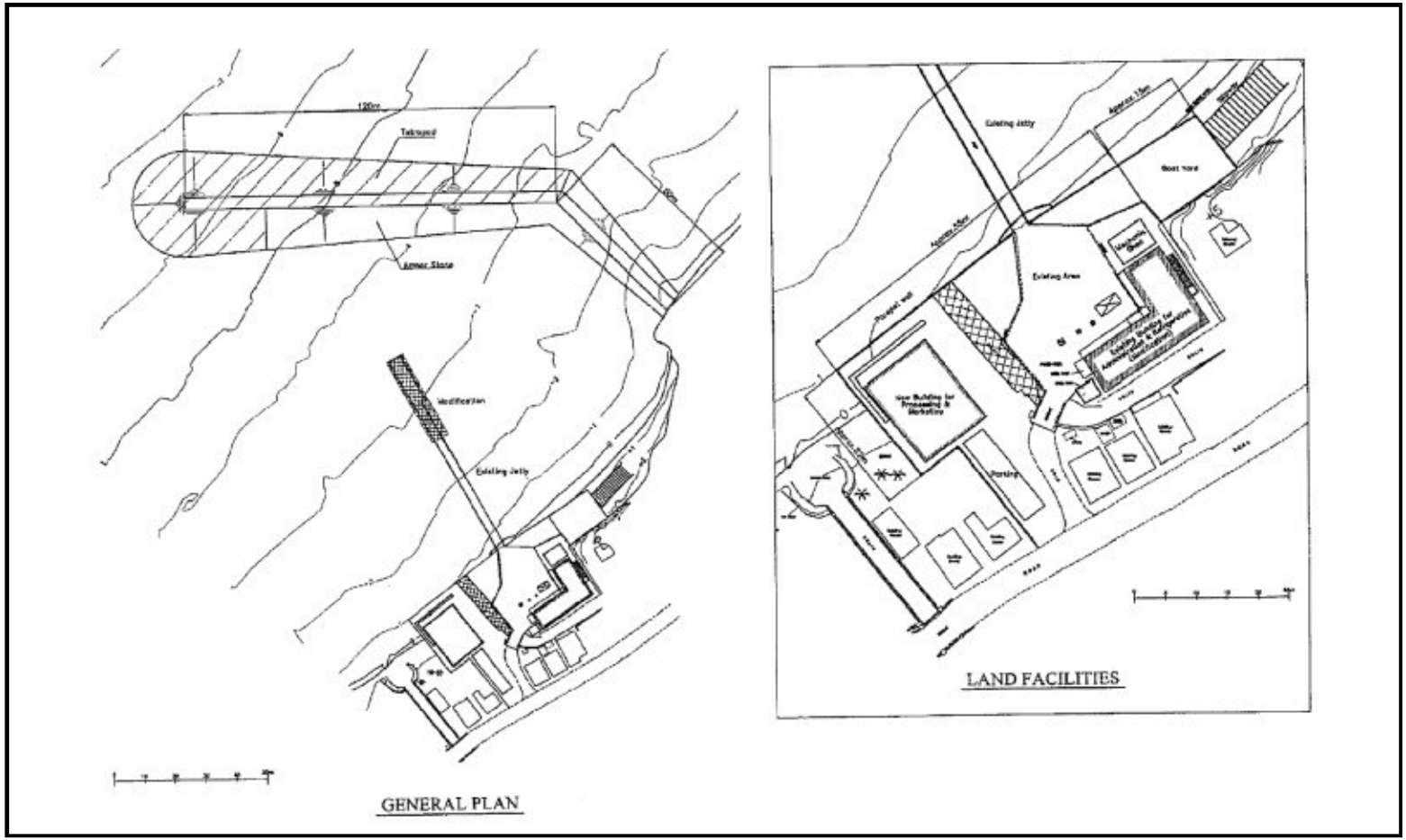


Figure 1-2(1) The project for improvement of the traditional fishing community infrastructure at Gouyave by the Government of Grenada (Request Letter)

1-3 Natural Conditions

(1) Geographical Features

Grenada is an islands country located at Lesser Antilles in the Caribbean Sea (at latitude 12 degree north and longitude about 61 degree west). The land area is 334 km^2 and has small islands like Carriacou Island and Petite Martinique Island in addition to Grenada Main Island. Main Island having capitol, St. Georges is the volcanic origin island with the area of about 20 km from east to west and about 30 km from north to south. There is mountainous land in the center reaching a height of about 900 m above sea level and less flat land in the coastal area. There are many buildings for government offices, enterprises, housings and etc. built on a slope.

Gouyave city where is the project site is the county capitol of St. Georges County located at northwest of main island facing to Caribbean Sea. It keeps away about 15 km as the linear distance from St. Georges. The urban district is located at river mouths of Gouyave and Little river and private houses are densely built at small area of flat land and on a slope back side.

(2) Topography

Grenada Island is the volcanic origin island however presently the volcanic activity is resting. The surface is covered by clay-rich soil (refer to Figure 1-3(1) topographical distribution chart) and many vegetations make their habitant there. And, according to the result of site survey, there seen sand beaches with involvement of iron sand in the seashore of northwest of Grenada Island. The iron sand exists more at backside of beach than water's edge and also as it is confirmed many in river bed of Little river and drain outlet, it is proved that the soil with involvement of iron sand exists in the northwest of Grenada Island.

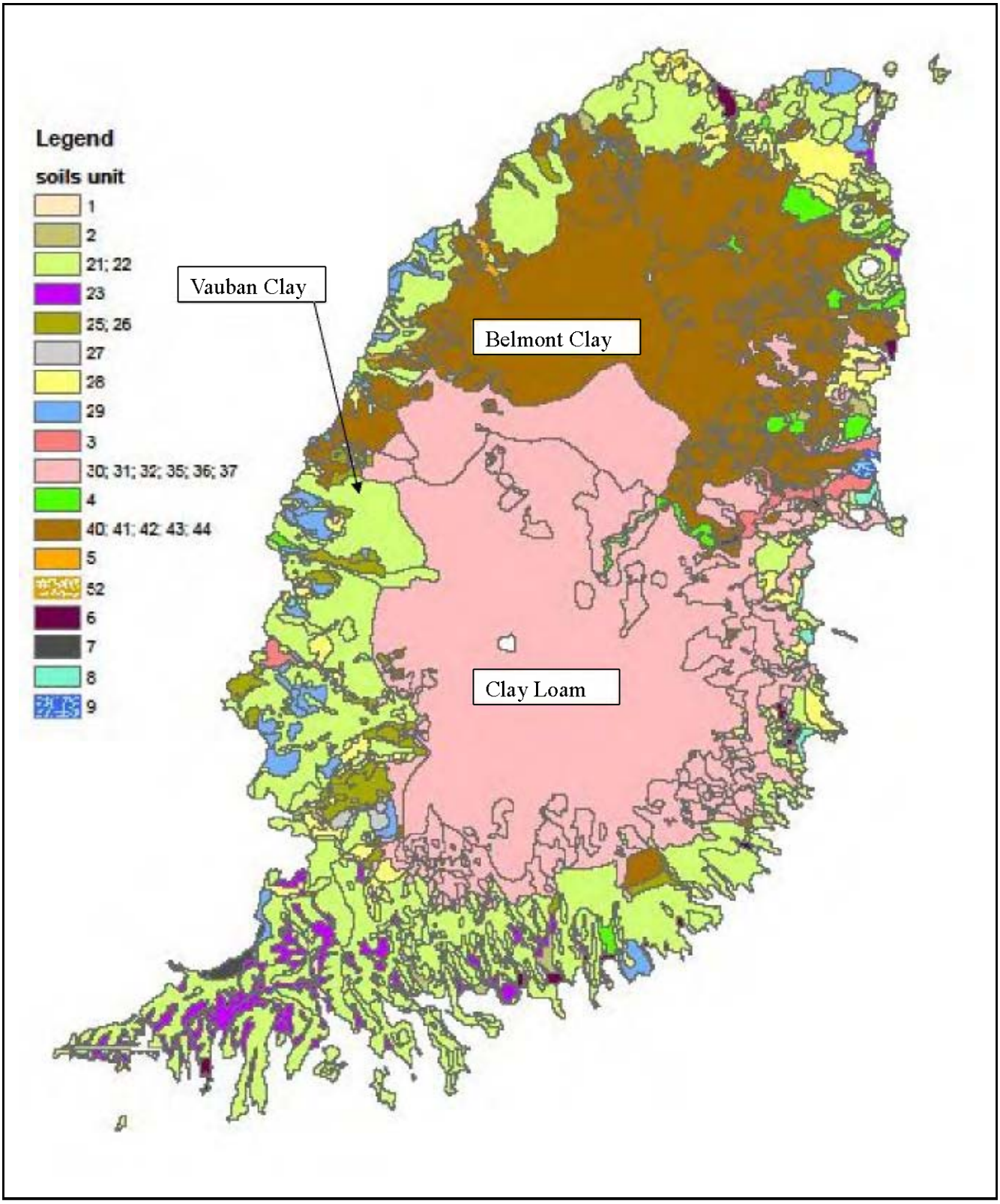


Figure 1-3(1) Topographical Distribution Chart of Grenada

(3) Meteorological Phenomena

The climate of Grenada is steamy tropical maritime climate and the season can be roughly classified as rainy season from June to December and dry season from January to May. Around North Atlantic Ocean where Grenada is located comes under the influence of trade wind and E and ENE wind is dominant through the year. And, Grenada is affected by hurricane that is generated in North Atlantic Ocean from July through November. Especially, Grenada was heavily damaged by well known, two biggest hurricanes "LENNY" hit in November, 1999 and hurricane "IVAN" hit in September, 2004 due to the strong winds and the tidal waves. In this study, meteorological phenomena was confirmed with the collection and sorting out of the data from Global Analytic Value which is the climate data (every 6 hours) of each location (every 1.25° in both longitude and latitude) based on the observed value or predicted value published by Japanese Meteorological Office and Point Salinas International Airport about 20 km off from the edge of southwest of Grenada and south-southwest of Gouyave.

Table 1-3(1) and Table 1-3(2) sorted out the average value in month and year from the result of local observation for average temperature, minimum temperature, maximum temperature and precipitation.

1) Temperature

The temperature is mild with that maximum temperature is from 30 to 32°C through the year and the average temperature is from 26 to 28°C and minimum temperature is from 22 to 25°C. And, the seasonal fluctuation is next to nothing.

2) Precipitating water

Annual precipitation at Point Salinas Airport is about 1,300 mm in average. January to May which is dry season is about 20 to 90 mm in average and June to December which is rainy season is about 100 to 170 mm in average. According to planar distribution (Figure 1-3(2)), mountainous lands in the center of island has more than coastal area with its annual precipitation exceeds 4,000 mm. The point of Gouyave is in coastal area but its precipitation is relatively heavy which reaches to about 2,500 mm in a year.

Figure 1-3(2) Planar Distribution of Precipitation

Table 1-3(1) Monthly average of maximum temperature(Point Salinas Air Port)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ave
2003	29.6	29.9	30.2	30.5	31.5	30.4	30.7	30.8	31.7	31.6	30.8	30.0	30.6
2004	30.4	30.4	30.3	30.5	30.1	30.7	30.5	30.8	31.6	31.7	31.1	30.8	30.7
2005	30.0	31.0	31.4	31.5	31.7	30.8	30.9	31.7	32.4	32.0	30.7	30.4	31.2
2006	29.8	29.6	30.1	30.6	31.1	30.9	30.9	31.4	31.9	31.5	31.1	30.1	30.7
2007	29.7	29.7	29.9	30.4	30.8	30.7	31.0	30.9	31.5	31.1	30.6	30.3	30.6
Ave.	29.9	30.1	30.4	30.7	31.0	30.7	30.8	31.1	31.8	31.6	30.8	30.3	30.8

Table 1-3(2) Monthly average of minimum temperature (Point Salinas Air Port)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ave
2003	23.4	23.5	23.8	25.0	25.4	24.5	24.5	24.1	25.2	25.5	24.6	23.7	24.4
2004	22.9	23.3	23.2	24.1	24.4	24.1	24.1	24.1	25.3	25.2	23.9	23.3	24.0
2005	23.1	23.0	24.2	25.4	25.5	24.5	24.2	24.9	25.2	25.3	23.7	23.0	24.3
2006	22.5	22.6	23.7	24.4	25.0	24.6	24.9	24.6	24.7	25.3	24.6	23.9	24.2
2007	23.3	23.3	24.3	25.1	25.8	25.1	24.9	24.5	25.0	24.9	24.1	23.2	24.5
Ave.	23.1	23.1	23.9	24.8	25.2	24.6	24.5	24.5	25.1	25.2	24.2	23.4	24.3

Table 1-3(3) Monthly average of average temperature (Point Salinas Air Port)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ave
2003	26.5	26.7	27.0	27.7	28.5	27.4	27.6	27.5	28.5	28.5	27.7	26.9	27.5
2004	26.6	26.8	26.8	27.3	27.3	27.4	27.3	27.5	28.4	28.4	27.5	27.0	27.4
2005	26.6	27.0	27.8	28.4	28.6	27.7	27.5	28.3	28.8	28.6	27.2	26.7	27.8
2006	26.2	26.1	26.9	27.5	28.1	27.8	27.9	28.0	28.3	28.4	27.9	27.0	27.5
2007	26.5	26.5	27.1	27.8	28.3	27.9	27.9	27.7	28.2	28.0	27.3	26.7	27.5
Ave.	26.5	26.6	27.1	27.7	28.1	27.6	27.6	27.8	28.5	28.4	27.5	26.9	27.5

Table 1-3(4) Monthly average of Precipitation (Point Salinas Air Port Unit: mm)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
2003	50.4	23.3	2.2	11.8	10.7	178.5	136.7	189.9	75.6	73.8	163.2	174.6	1090.7
2004	45.6	21.5	19.5	224.2	178.8	135.8	119.2	159.6	192.5	118.0	183.8	114.8	1513.3
2005	152.8	12.0	19.1	5.9	87.5	219.1	304.3	105.9	59.6	92.5	178.2	165.5	1402.4
2006	164.0	63.7	40.7	3.2	30.9	173.5	132.8	119.1	143.3	92.2	132.2	153.6	1249.2
2007	29.2	58.0	15.1	30.6	23.8	84.2	84.5	278.7	43.3	204.7	122.1	120.3	1094.5
Ave.	88.4	35.7	19.3	55.1	66.3	158.2	155.5	170.6	102.9	116.2	155.9	145.8	1270.0

3) Wind

Wind feature around Grenada was confirmed by Global Objective Analysis which was obtained from Meteorological Office in Japan. Average wind vector is shown at Figure 1-3(3) Planar Distribution. And, wind rose at Figure 1-3(4) and wind direction and frequency table of wind speed class at Table 1-3(5) in point of Grenada from the analyzed value. According to this, the wind feature of Grenada area occupy more than about 80 % of the total by two wind directions which are ENE and E generated mostly through a year affected by trade wind. Seasonal fluctuation of wind direction distribution is relatively small and the occurrence ratio of ENE and E are specifically high but, the occurrence ratio of E is high in winter season. The annual occurrence ratio of exceeding the wind speed of 5.0m/s, 7.5m/s, 10.0m/s are 81.4%, 8.3%, 4.7% respectively. The same arrangement was executed based on the observation value from Point Salinas Air Port.

While, the same study was done based on the observation value in Point Salinas Air Port. The wind rose is shown at Figure 1-3(5) by the result of this. Judging from this, the occurrence ratio of the wind directions of E～SE which are affected by trade wind is high and these 3 directions occupy about 80% of the total.

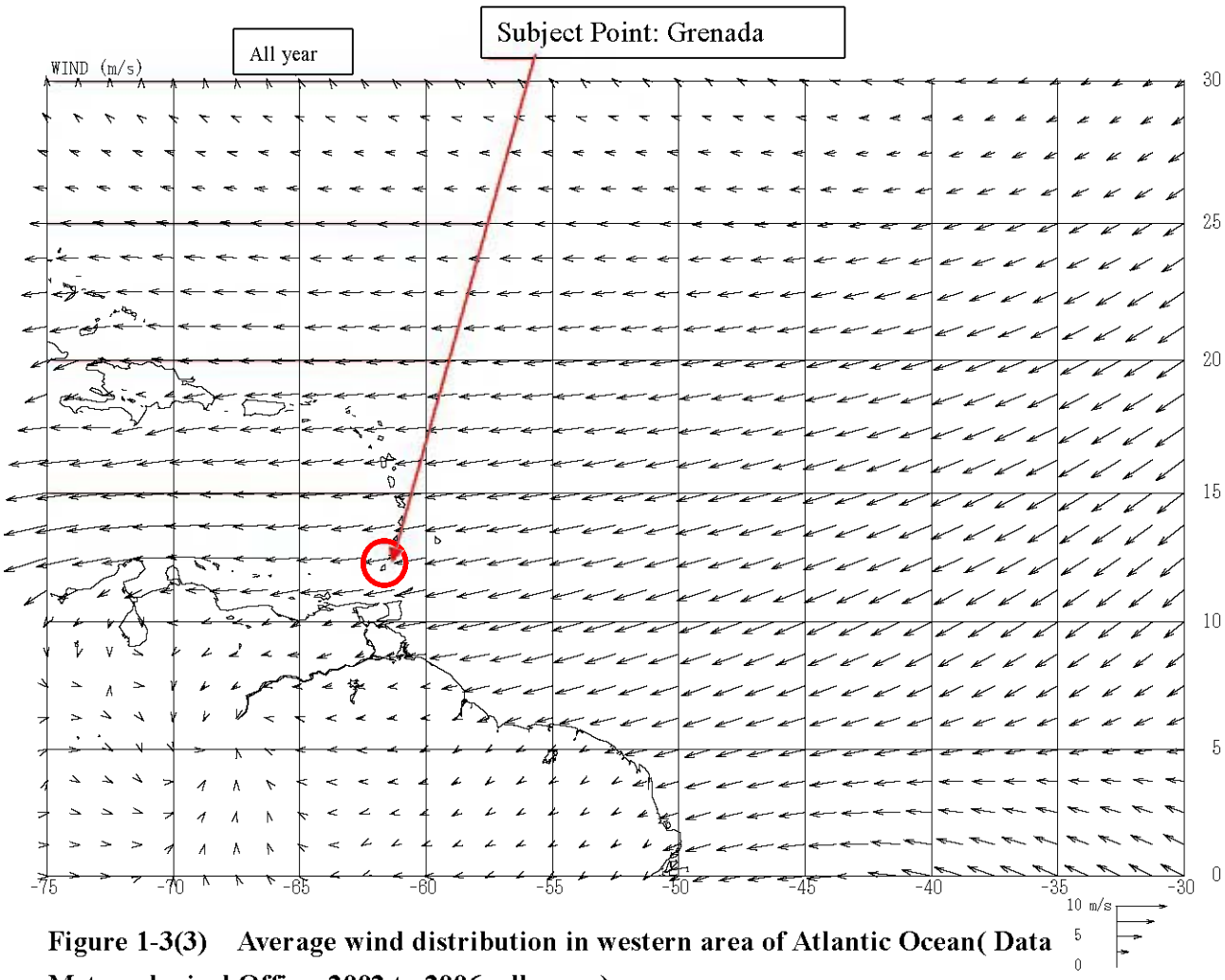


Figure 1-3(3) Average wind distribution in western area of Atlantic Ocean(Data Meteorological Office, 2002 to 2006, all years)

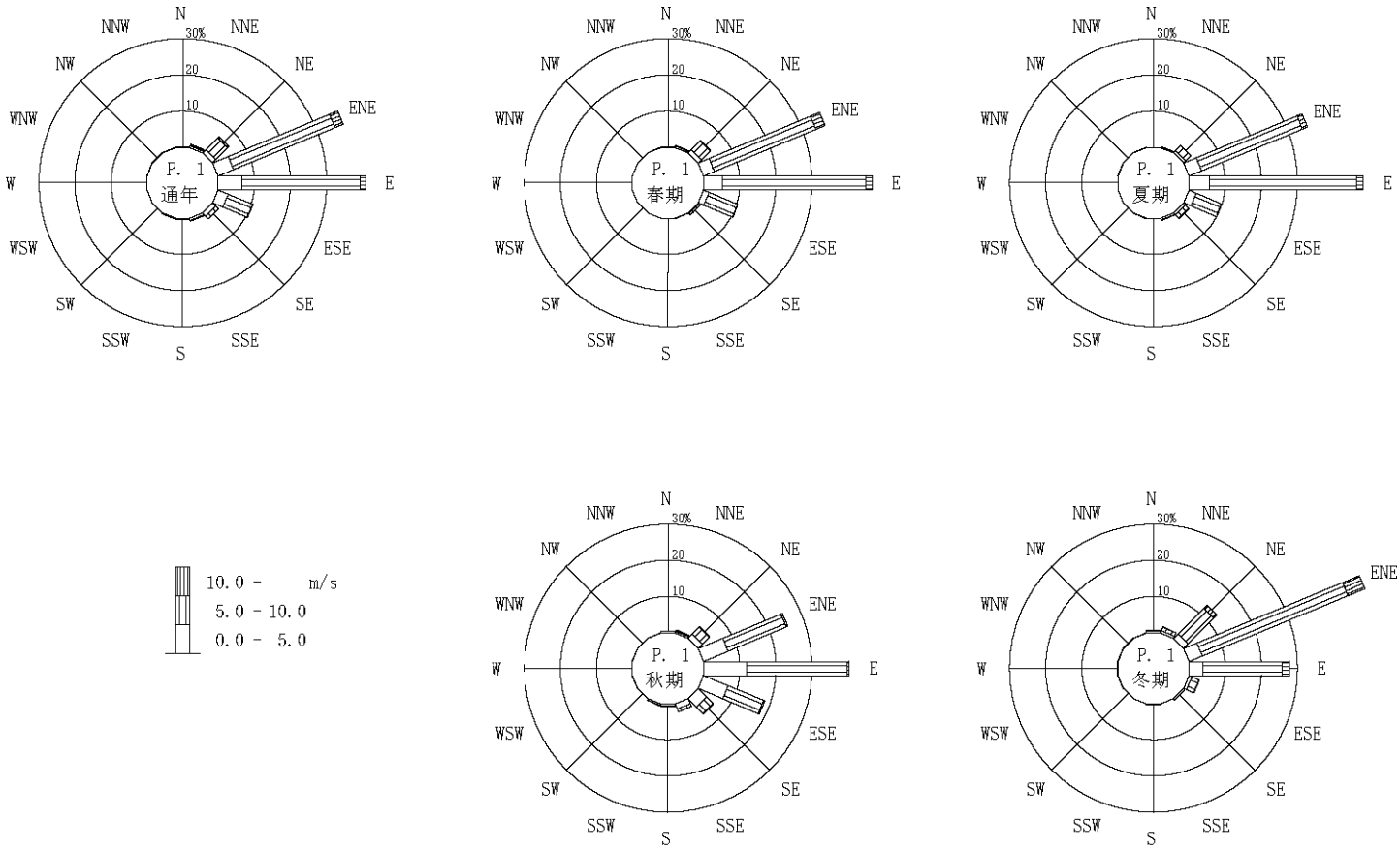


Figure 1-3(4) Wind rose at the point of Grenada (2002 ～2006 from Meteorological Office)

Table 1-3(5) All years wind direction and wind speed frequency table at the point of Grenada (2002～2006 all years from Meteorological Office)

Direction / U(m/s)	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW		Total
0.0 - 0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.1 - 2.5	7	11	15	26	29	22	11	7	5	7	0	2	2	4	2	4	0	154
	0.10	0.15	0.21	0.36	0.40	0.30	0.15	0.10	0.07	0.10	0.00	0.03	0.03	0.05	0.03	0.05	0.00	2.11
2.5 - 5.0	9	22	84	313	456	200	73	31	6	3	1	1	1	0	1	1	0	1202
	0.12	0.30	1.15	4.29	6.24	2.74	1.00	0.42	0.08	0.04	0.01	0.01	0.01	0.00	0.01	0.01	0.00	16.46
5.0 - 7.5	3	23	209	1093	1345	388	64	18	4	0	0	0	1	0	0	0	0	3148
	0.04	0.31	2.86	14.96	18.41	5.31	0.88	0.25	0.05	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	43.10
7.5 - 10.0	2	7	125	1125	1040	140	16	2	0	1	0	0	0	0	0	0	0	2458
	0.03	0.10	1.71	15.40	14.24	1.92	0.22	0.03	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	33.65
10.0 - 12.5	0	2	26	165	111	14	4	0	0	0	0	0	0	0	0	0	0	322
	0.00	0.03	0.36	2.26	1.52	0.19	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.41
12.5 - 15.0	0	1	3	11	2	1	1	0	0	0	0	0	0	0	0	0	0	19
	0.00	0.01	0.04	0.15	0.03	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.26
15.0 - 17.5	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1
	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
17.5 - 20.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
20.0 - 22.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
22.5 - 25.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
25.0 - 27.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
27.5 - 30.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
30.0 - 100.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	21	66	462	2733	2984	765	169	58	15	11	1	3	4	4	3	5	0	7304
	0.3	0.9	6.3	37.4	40.9	10.5	2.3	0.8	0.2	0.2	0.0	0.0	0.1	0.1	0.0	0.1	0.0	100.0

Upper : Number of contents
Lower : Percentage of occurrence

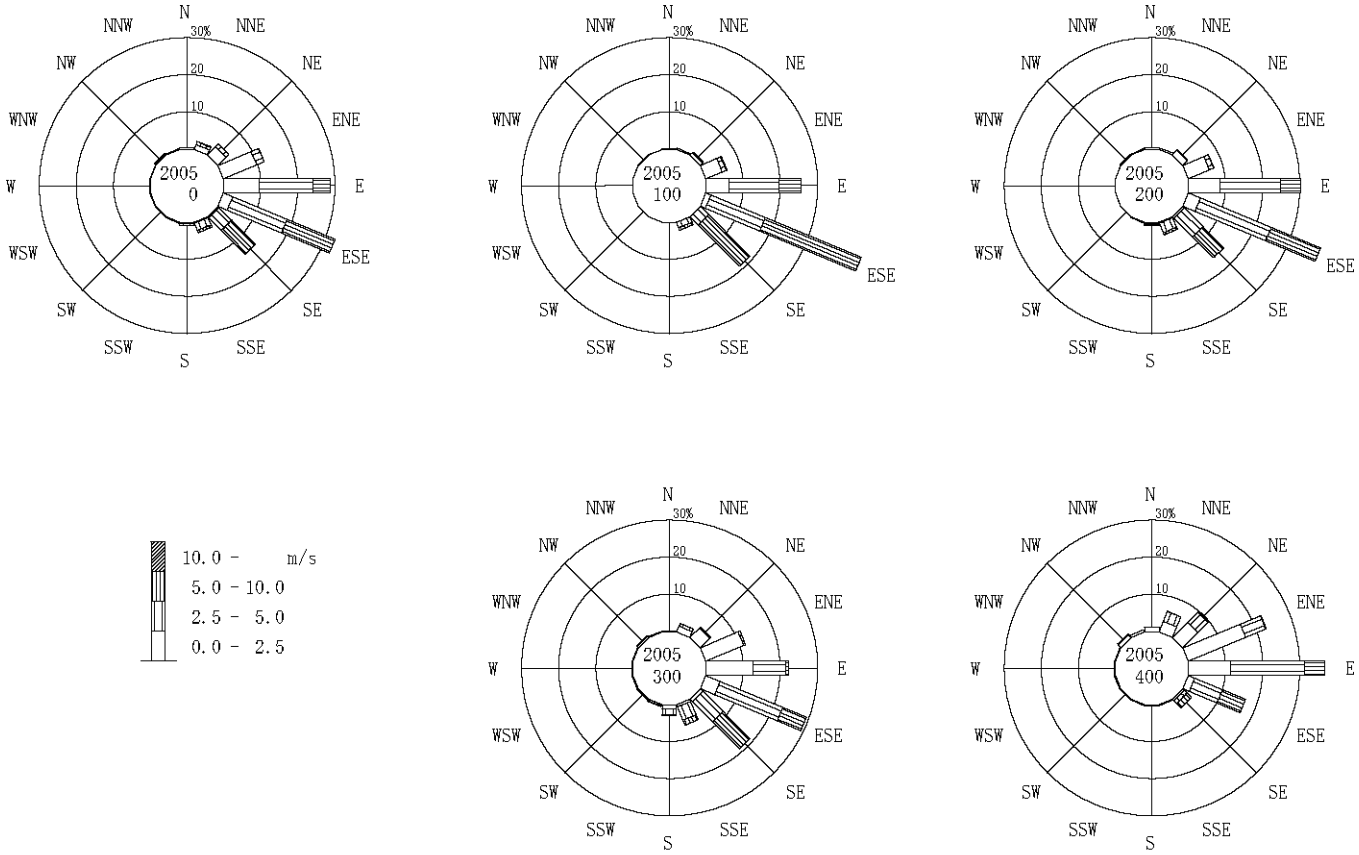


Figure 1-3(5) Wind rose in Point Salinas Airport

(4) Oceanographic Phenomenon

The general picture of wave coming to local sea site area was once sought by wave forecasting and hind casting adopting "One-Point Model". Taking collected wave data at the time of Field Survey, wave observation result, local hearing result and so forth into consideration, the waves coming to subject sea area were confirmed.

"One-Point Model" is the model to obtain wave sizes at the point synthesizing calculating result of each component wave which wave direction and frequency are divided adopting physics model reproduced the process of wave generation, development, damp and propagation. This is one of the spectrum component method for wave forecasting and hind casting adopting wave irregularity and calculation model to improve on saving calculation volume and time and long time wave forecasting and hind casting which can be relatively simple by setting one point as wave forecasting and hind casting point. What needed in the wave forecasting and hind casting is basically wind data only. In the wave forecasting and hind casting of normal time, the wave was predicted inputting wind data of all the sea area including project sea point using wind data by Global Objective Analysis previously described.

1) Ordinary Wave

At first, ordinary wave in the Atlantic Ocean side of Grenada has predicted with the offshore wave condition using "One-Point Model" and Global Objective Analysis. The frequency table was made as per Table 1-3(6) from the result of wave forecasting and hind casting. This result shows that wave direction is responded to the wind occurrence ratio and the occurrence ratio of wind direction ENE and E occupies about 70% of the total. Wave height is about 6 m at maximum. And the period is widely distributed as up to 6 to 12 seconds but, 5 to 9 seconds are dominant. These waves reach to project site diffracting from the south end or north end of Grenada Island. The waves are damped and as wave height ratio becomes below 0.1, the influence to project site is considered to be small in comparison with the occurrence wave in Caribbean Bay as described later.

On the contrary, the same forecasting and hind casting for waves generated within Caribbean Sea was executed. Table 1-3(7) shows wave frequency table made from wave forecasting and hind casting result. The direction of incident waves is dominant by N wave which occupies about 90% of the total. The wave height is relatively low and the occurrence ratio of waves exceeding 1 m and 0.5 m are about 5.8% and 84.9% respectively and the maximum wave height becomes about 2 m. And, the period is dominant by 4 to 7 seconds. In view of seasonal aspect, the occurrence ratio of high wave is significant in winter season (December to February) and the occurrence ratio of the wave height exceeding 1 m goes up to 15.3% in this season.

Wave frequency table at the point of Gouyave (water depth is about 10 m) was made adopting the result of wave deformation calculation at the point of Gouyave for invading wave

occurred in Atlantic Ocean and wave occurred in Caribbean Sea. Table 1-3(8) shows the frequency table for annual, seasonal, monthly, wave direction and wave height classes and the Table 1-3(9) shows frequency table for wave period classes. According to these, the wave from NNW is dominant through the year and it occupies over 80% of the total. The occurrence of wave from NNW is high in winter and it is over 90% of the total. While in autumn, the occurrence ratio of wave from WSW becomes about 20%.

The occurrence ratio of wave height exceeding 1 m is about 4 % in winter but in other seasons it becomes less than 1 %. The wave height from WSW becomes less than 0.5 m.

Table 1-3(6)-1 Frequency table in wave direction and wave height class (offshore wave at east coast of Grenada, all year, during 2002 to 2006)

WAVE DIRECTION / WAVE HEIGHT(M)	U.K.	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
CALM	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 .0	0 .0	0 .0	0 .0	0 .0
0.00 - 0.50	0 .0	0 .0	14 .0	14 .0	90 .2	23 .1	35 .1	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	176 .4
0.50 - 1.00	0 .0	0 .0	1200 2.7	621 1.4	2058 4.7	680 1.6	549 1.3	10 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	5118 11.7
1.00 - 1.50	0 .0	0 .0	1417 3.2	905 2.1	3180 7.3	2486 5.7	745 1.7	75 .2	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	8808 20.1
1.50 - 2.00	0 .0	0 .0	1361 3.1	1358 3.1	3295 7.5	3622 8.3	369 .8	10 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	10015 22.9
2.00 - 2.50	0 .0	0 .0	1089 2.5	890 2.0	3134 7.2	3880 8.9	240 .5	3 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	9236 21.1
2.50 - 3.00	0 .0	0 .0	744 1.7	657 1.5	2670 6.1	2465 5.6	106 .2	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	6642 15.2
3.00 - 3.50	0 .0	0 .0	372 .8	214 .5	1314 3.0	820 1.9	32 .1	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	2752 6.3
3.50 - 4.00	0 .0	0 .0	92 .2	30 .1	416 .9	192 .4	5 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	735 1.7
4.00 - 5.00	0 .0	0 .0	29 .1	33 .1	135 .3	62 .1	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	259 .6
5.00 - 6.00	0 .0	0 .0	0 .0	3 .0	68 .2	5 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	76 .2
6.00 - 7.00	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 .0	0 .0	0 .0	0 .0	0 .0
7.00 -	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 .0	0 .0	0 .0	0 .0	0 .0
TOTAL	0 .0	0 .0	6318 14.4	4725 10.8	16360 37.3	14235 32.5	2081 4.7	98 .2	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	43817 100.0

Table 1-3(6)-2 Frequency table in wave height and period class (offshore wave at east coast of Grenada, all year, during 2002 to 2006)

WAVE PERIOD(S) / WAVE HEIGHT(M)	CALM	0- 1	1- 2	2- 3	3- 4	4- 5	5- 6	6- 7	7- 8	8- 9	9-10	10-11	11-12	12-13	13-14	14-	TOTAL
CALM	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 .0	0 .0	0 .0	0 .0
0.00 - 0.50	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	1 .0	13 .0	29 .1	88 .2	37 .1	6 .0	2 .0	0 .0	0 .0	0 .0	176 .4
0.50 - 1.00	0 .0	0 .0	0 .0	0 .0	0 .0	12 .0	527 1.2	932 2.1	1184 2.7	1289 2.9	726 1.7	239 .5	90 .2	11 .0	28 .1	80 .2	5118 11.7
1.00 - 1.50	0 .0	0 .0	0 .0	0 .0	0 .0	57 .1	2882 6.6	2733 6.2	1360 3.1	787 1.8	428 1.0	315 .7	203 .5	23 .1	20 .0	0 .0	8808 20.1
1.50 - 2.00	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	2672 6.1	3826 8.7	1605 3.7	634 1.4	587 1.3	475 1.1	145 .3	60 .1	11 .0	0 .0	10015 22.9
2.00 - 2.50	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	1220 2.8	5127 11.7	1617 3.7	738 1.7	265 .6	128 .3	65 .1	51 .1	23 .1	2 .0	9236 21.1
2.50 - 3.00	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	13 .0	4350 9.9	1594 3.6	493 1.1	145 .3	29 .1	8 .0	5 .0	0 .0	5 .0	6642 15.2
3.00 - 3.50	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	1402 3.2	1008 2.3	270 .6	51 .1	7 .0	0 .0	1 .0	11 .0	2 .0	2752 6.3
3.50 - 4.00	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	112 .3	527 1.2	82 .2	14 .0	0 .0	0 .0	0 .0	0 .0	0 .0	735 1.7
4.00 - 5.00	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	180 .4	79 .2	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	259 .6
5.00 - 6.00	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	76 .2	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	76 .2
6.00 - 7.00	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 .0	0 .0	0 .0	0 .0
7.00 -	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 .0	0 .0	0 .0	0 .0
TOTAL	0 .0	0 .0	0 .0	0 .0	0 .0	69 .2	7315 16.7	18495 42.2	9104 20.8	4536 10.4	2253 5.1	1199 2.7	513 1.2	151 .3	93 .2	89 .2	43817 100.0

Table 1-3(7)-1 Frequency table in wave direction and wave height class (offshore wave at Caribbean Sea of Grenada, all year, during 2002 to 2006)

WAVE DIRECTION / WAVE HEIGHT (M)	U.K.	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
CALM	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 .0	0 .0	0 .0	0 .0	0 .0
0.00 - 0.25	0 .0	645 1.5	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	151 .3	5 .0	0 .0	32 .1	24 .1	80 .2	199 .5	1136 2.6
0.25 - 0.50	0 .0	3666 8.4	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	984 2.2	0 .0	0 .0	106 .2	68 .2	215 .5	428 1.0	5467 12.5
0.50 - 0.75	0 .0	20013 45.7	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	2615 6.0	0 .0	0 .0	62 .1	61 .1	67 .2	297 .7	23115 52.8
0.75 - 1.00	0 .0	11392 26.0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	22 .1	0 .0	0 .0	0 .0	0 .0	2 .0	118 .3	11534 26.3
1.00 - 1.25	0 .0	1950 4.5	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	1 .0	22 .1	1973 4.5
1.25 - 1.50	0 .0	353 .8	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	2 .0	10 .0	365 .8
1.50 - 1.75	0 .0	153 .3	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	3 .0	8 .0	164 .4
1.75 - 2.00	0 .0	44 .1	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 .0	2 .0	46 .1
2.00 - 2.25	0 .0	17 .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	0 .0	0 .0	17 .0
2.25 - 2.50	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 .0	0 .0	0 .0	0 .0	0 .0
2.50 - 2.75	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 .0	0 .0	0 .0	0 .0	0 .0
2.75 - 3.00	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 .0	0 .0	0 .0	0 .0	0 .0
3.00 -	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 .0	0 .0	0 .0	0 .0	0 .0
TOTAL	0 .0	38233 87.3	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	3772 8.6	5 .0	0 .0	200 .5	153 .3	370 .8	1084 2.5	43817 100.0

Table 1-3(7)-2 Frequency table in wave height and period class (offshore wave at Caribbean Sea, all year, during 2002 to 2006)

WAVE PERIOD (S) / WAVE HEIGHT (M)	CALM	0- 1	1- 2	2- 3	3- 4	4- 5	5- 6	6- 7	7- 8	8- 9	9-10	10-11	11-12	12-13	13-14	14-	TOTAL
CALM	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 .0	0 .0	0 .0	0 .0
0.00 - 0.25	0 .0	0 .0	0 .0	0 .0	0 .0	479 1.1	490 1.1	107 .2	43 .1	8 .0	2 .0	7 .0	0 .0	0 .0	0 .0	0 .0	1136 2.6
0.25 - 0.50	0 .0	0 .0	0 .0	0 .0	0 .0	3602 8.2	1333 3.0	377 .9	98 .2	43 .1	13 .0	1 .0	0 .0	0 .0	0 .0	0 .0	5467 12.5
0.50 - 0.75	0 .0	0 .0	0 .0	0 .0	0 .0	13563 31.0	8881 20.3	548 1.3	62 .1	44 .1	8 .0	9 .0	0 .0	0 .0	0 .0	0 .0	23115 52.8
0.75 - 1.00	0 .0	0 .0	0 .0	0 .0	0 .0	1135 2.6	9925 22.7	464 1.1	10 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	11534 26.3
1.00 - 1.25	0 .0	0 .0	0 .0	0 .0	0 .0	4 .0	1441 3.3	515 1.2	13 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	1973 4.5
1.25 - 1.50	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	112 .3	249 .6	4 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	365 .8
1.50 - 1.75	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	16 .0	78 .2	70 .2	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	164 .4
1.75 - 2.00	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	1 .0	30 .1	15 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	46 .1
2.00 - 2.25	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	16 .0	1 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	17 .0
2.25 - 2.50	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 .0	0 .0	0 .0	0 .0
2.50 - 2.75	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 .0	0 .0	0 .0	0 .0
2.75 - 3.00	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 .0	0 .0	0 .0	0 .0
3.00 -	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 .0	0 .0	0 .0	0 .0
TOTAL	0 .0	0 .0	0 .0	0 .0	0 .0	18783 42.9	22199 50.7	2384 5.4	316 .7	95 .2	23 .1	17 .0	0 .0	0 .0	0 .0	0 .0	43817 100.0

Table 1-3(8)-1 Frequency table in wave direction and wave height at the point of Gouyave (all year, season)

Season	Wave direction / Wave height(m)	WSW	W	WNW	NW	NNW	Total
All year	0.00-0.25	1.8	0.0	0.1	0.4	1.0	3.3
	0.25-0.50	7.5	0.0	0.4	1.7	21.0	30.7
	0.50-0.75	0.1	0.0	0.3	0.8	53.6	54.8
	0.75-1.00	0.0	0.0	0.0	0.1	9.4	9.5
	1.00-1.25	0.0	0.0	0.0	0.0	1.2	1.2
	1.25-1.50	0.0	0.0	0.0	0.0	0.4	0.4
	1.50-1.75	0.0	0.0	0.0	0.0	0.1	0.1
	1.75-2.00	0.0	0.0	0.0	0.0	0.0	0.0
	Total	9.4	0.0	0.8	3.1	86.7	100.0
High season (Oct to Jun)	0.00-0.25	1.3	0	0.1	0.4	0.6	2.5
	0.25-0.50	6.4	0	0.5	1.9	17.3	26.2
	0.50-0.75	0	0	0.4	1	56.5	58
	0.75-1.00	0	0	0	0.1	11	11.1
	1.00-1.25	0	0	0	0	1.5	1.6
	1.25-1.50	0	0	0	0.1	0.5	0.6
	1.50-1.75	0	0	0	0	0.1	0.1
	1.75-2.00	0	0	0	0	0	0
	Total	7.8	0	1	3.6	87.6	100
Low season (Jul to Sep)	0.00-0.25	3.1	0	0	0.5	2.4	6
	0.25-0.50	10.8	0	0	1.1	32	43.9
	0.50-0.75	0.2	0	0	0.2	44.9	45.3
	0.75-1.00	0	0	0	0	4.8	4.8
	1.00-1.25	0	0	0	0	0	0
	1.25-1.50	0	0	0	0	0	0
	1.50-1.75	0	0	0	0	0	0
	1.75-2.00	0	0	0	0	0	0
	Total	14.1	0	0.1	1.7	84.1	100

Table 1-3(8)-2 Frequency table in wave direction and wave height at the point of Gouyave (monthly, during Jan. to Jun.)

Month	Wave direction / Wave height (m)	WSW	W	WNW	NW	NNW	Total
1	0.00-0.25	0.2	0.0	0.0	0.0	0.4	0.6
	0.25-0.50	0.8	0.0	0.0	1.7	9.4	11.9
	0.50-0.75	0.0	0.0	0.0	1.5	55.6	57.1
	0.75-1.00	0.0	0.0	0.0	0.2	21.8	22.0
	1.00-1.25	0.0	0.0	0.0	0.3	5.8	6.1
	1.25-1.50	0.0	0.0	0.0	0.0	1.9	1.9
	1.50-1.75	0.0	0.0	0.0	0.0	0.6	0.6
	1.75-2.00	0.0	0.0	0.0	0.0	0.0	0.0
	Total	1.0	0.0	0.0	3.6	95.4	100.0
2	0.00-0.25	0.9	0.0	0.0	1.2	0.1	2.2
	0.25-0.50	0.2	0.0	0.0	5.2	10.6	16.0
	0.50-0.75	0.0	0.0	0.0	3.9	53.3	57.1
	0.75-1.00	0.0	0.0	0.0	0.2	20.3	20.5
	1.00-1.25	0.0	0.0	0.0	0.0	3.0	3.0
	1.25-1.50	0.0	0.0	0.0	0.0	1.1	1.1
	1.50-1.75	0.0	0.0	0.0	0.0	0.0	0.0
	1.75-2.00	0.0	0.0	0.0	0.0	0.0	0.0
	Total	1.1	0.0	0.0	10.5	88.4	100.0
3	0.00-0.25	0.1	0.0	0.0	0.5	0.6	1.1
	0.25-0.50	1.9	0.0	0.0	1.2	14.5	17.6
	0.50-0.75	0.0	0.0	0.0	0.1	69.2	69.4
	0.75-1.00	0.0	0.0	0.0	0.0	9.7	9.7
	1.00-1.25	0.0	0.0	0.0	0.0	1.6	1.6
	1.25-1.50	0.0	0.0	0.0	0.0	0.6	0.6
	1.50-1.75	0.0	0.0	0.0	0.0	0.0	0.0
	1.75-2.00	0.0	0.0	0.0	0.0	0.0	0.0
	Total	1.9	0.0	0.0	1.9	96.2	100.0
4	0.00-0.25	0.6	0.0	0.0	0.3	0.6	1.4
	0.25-0.50	10.4	0.0	0.0	0.1	21.1	31.6
	0.50-0.75	0.1	0.0	0.0	0.3	61.8	62.2
	0.75-1.00	0.0	0.0	0.0	0.4	3.8	4.3
	1.00-1.25	0.0	0.0	0.0	0.0	0.5	0.5
	1.25-1.50	0.0	0.0	0.0	0.0	0.0	0.0
	1.50-1.75	0.0	0.0	0.0	0.0	0.0	0.0
	1.75-2.00	0.0	0.0	0.0	0.0	0.0	0.0
	Total	11.1	0.0	0.0	1.1	87.8	100.0
5	0.00-0.25	0.7	0.0	0.5	0.3	0.1	1.6
	0.25-0.50	10.3	0.0	1.4	1.0	13.0	25.6
	0.50-0.75	0.0	0.0	0.0	0.2	58.0	58.2
	0.75-1.00	0.0	0.0	0.0	0.0	14.1	14.1
	1.00-1.25	0.0	0.0	0.0	0.0	0.5	0.5
	1.25-1.50	0.0	0.0	0.0	0.0	0.0	0.0
	1.50-1.75	0.0	0.0	0.0	0.0	0.0	0.0
	1.75-2.00	0.0	0.0	0.0	0.0	0.0	0.0
	Total	11.0	0.0	1.9	1.5	85.7	100.0
6	0.00-0.25	0.0	0.0	0.0	0.0	0.3	0.3
	0.25-0.50	6.8	0.0	0.0	0.0	11.0	17.8
	0.50-0.75	0.0	0.0	0.0	0.0	74.9	74.9
	0.75-1.00	0.0	0.0	0.0	0.0	7.0	7.0
	1.00-1.25	0.0	0.0	0.0	0.0	0.0	0.0
	1.25-1.50	0.0	0.0	0.0	0.0	0.0	0.0
	1.50-1.75	0.0	0.0	0.0	0.0	0.0	0.0
	1.75-2.00	0.0	0.0	0.0	0.0	0.0	0.0
	Total	6.8	0.0	0.0	0.0	93.2	100.0

Table 1-3(8)-3 Frequency table in wave direction and wave height at the point of Gouyave (monthly, during Jul. to Dec.)

Month	Wave direction / Wave height (m)	WSW	W	WNW	NW	NNW	Total
7	0.00-0.25	0.3	0.0	0.0	0.0	0.2	0.6
	0.25-0.50	6.0	0.0	0.0	0.0	17.7	23.6
	0.50-0.75	0.2	0.0	0.0	0.0	63.2	63.4
	0.75-1.00	0.0	0.0	0.0	0.0	12.4	12.4
	1.00-1.25	0.0	0.0	0.0	0.0	0.0	0.0
	1.25-1.50	0.0	0.0	0.0	0.0	0.0	0.0
	1.50-1.75	0.0	0.0	0.0	0.0	0.0	0.0
	1.75-2.00	0.0	0.0	0.0	0.0	0.0	0.0
	Total	6.6	0.0	0.0	0.0	93.4	100.0
8	0.00-0.25	1.4	0.0	0.0	0.2	2.9	4.5
	0.25-0.50	6.7	0.0	0.0	0.5	38.9	46.0
	0.50-0.75	0.0	0.0	0.0	0.0	48.2	48.2
	0.75-1.00	0.0	0.0	0.0	0.0	1.3	1.3
	1.00-1.25	0.0	0.0	0.0	0.0	0.0	0.0
	1.25-1.50	0.0	0.0	0.0	0.0	0.0	0.0
	1.50-1.75	0.0	0.0	0.0	0.0	0.0	0.0
	1.75-2.00	0.0	0.0	0.0	0.0	0.0	0.0
	Total	8.1	0.0	0.0	0.7	91.3	100.0
9	0.00-0.25	7.6	0.1	0.0	1.2	4.2	13.1
	0.25-0.50	20.1	0.0	0.0	2.9	39.8	62.8
	0.50-0.75	0.3	0.0	0.1	0.5	22.5	23.5
	0.75-1.00	0.0	0.0	0.0	0.0	0.6	0.6
	1.00-1.25	0.0	0.0	0.0	0.0	0.0	0.0
	1.25-1.50	0.0	0.0	0.0	0.0	0.0	0.0
	1.50-1.75	0.0	0.0	0.0	0.0	0.0	0.0
	1.75-2.00	0.0	0.0	0.0	0.0	0.0	0.0
	Total	28.0	0.1	0.2	4.6	67.1	100.0
10	0.00-0.25	6.4	0.0	0.7	1.5	2.2	10.8
	0.25-0.50	18.2	0.0	2.4	2.1	37.6	60.3
	0.50-0.75	0.0	0.0	1.7	0.1	25.1	26.9
	0.75-1.00	0.0	0.0	0.0	0.0	2.0	2.0
	1.00-1.25	0.0	0.0	0.0	0.0	0.0	0.0
	1.25-1.50	0.0	0.0	0.0	0.0	0.0	0.0
	1.50-1.75	0.0	0.0	0.0	0.0	0.0	0.0
	1.75-2.00	0.0	0.0	0.0	0.0	0.0	0.0
	Total	24.6	0.0	4.8	3.7	66.9	100.0
11	0.00-0.25	2.3	0.0	0.1	0.2	0.6	3.1
	0.25-0.50	8.0	0.0	0.7	4.9	25.1	38.7
	0.50-0.75	0.3	0.0	0.1	2.3	52.7	55.3
	0.75-1.00	0.0	0.0	0.0	0.0	2.9	2.9
	1.00-1.25	0.0	0.0	0.0	0.0	0.0	0.0
	1.25-1.50	0.0	0.0	0.0	0.0	0.0	0.0
	1.50-1.75	0.0	0.0	0.0	0.0	0.0	0.0
	1.75-2.00	0.0	0.0	0.0	0.0	0.0	0.0
	Total	10.6	0.0	0.8	7.3	81.2	100.0
12	0.00-0.25	0.6	0.0	0.0	0.1	0.3	0.9
	0.25-0.50	0.8	0.0	0.2	1.3	13.3	15.6
	0.50-0.75	0.0	0.0	1.3	1.3	58.4	61.0
	0.75-1.00	0.0	0.0	0.0	0.1	17.7	17.8
	1.00-1.25	0.0	0.0	0.0	0.1	2.5	2.6
	1.25-1.50	0.0	0.0	0.0	0.5	1.2	1.7
	1.50-1.75	0.0	0.0	0.0	0.1	0.3	0.3
	1.75-2.00	0.0	0.0	0.0	0.0	0.0	0.0
	Total	1.4	0.0	1.6	3.3	93.7	100.0

Table 1-3(9)-1 Frequency table in wave height period class at the point of Gouyave (all year, season)

Season	Period(s) / Height(m)	4-5	5-6	6-7	7-8	8-9	9-10	10-	Total
All year	0.00-0.25	0.6	1.2	0.8	0.3	0.3	0.2	0	3.3
	0.25-0.50	17.4	11	1.7	0.5	0.1	0	0	30.7
	0.50-0.75	12.9	38.8	2.8	0.2	0.1	0	0	54.8
	0.75-1.00	0	6.5	2.9	0.1	0	0	0	9.5
	1.00-1.25	0	0.2	1	0	0	0	0	1.2
	1.25-1.50	0	0	0.2	0.2	0	0	0	0.4
	1.50-1.75	0	0	0	0	0	0	0	0.1
	1.75-2.00	0	0	0	0	0	0	0	0
	Total	30.9	57.6	9.3	1.3	0.5	0.2	0.1	100
High Season (Oct.～ Jun.)	0.00-0.25	0.4	0.8	0.5	0.3	0.2	0.2	0	2.5
	0.25-0.50	13.7	10	1.7	0.6	0.1	0.1	0	26.2
	0.50-0.75	12.6	42.3	2.7	0.2	0.1	0	0	58
	0.75-1.00	0	7.6	3.4	0.1	0	0	0	11.1
	1.00-1.25	0	0.3	1.3	0.1	0	0	0	1.6
	1.25-1.50	0	0	0.2	0.3	0	0	0	0.6
	1.50-1.75	0	0	0.1	0	0	0	0	0.1
	1.75-2.00	0	0	0	0	0	0	0	0
	Total	26.8	61	9.9	1.5	0.5	0.2	0.1	100
Low Season (Jul. ～ Sep.)	0.00-0.25	1.2	2.2	1.6	0.3	0.5	0.1	0	6
	0.25-0.50	28.1	13.9	1.6	0.2	0.1	0	0	43.9
	0.50-0.75	13.9	28.3	2.9	0.1	0	0	0	45.3
	0.75-1.00	0	3.4	1.4	0	0	0	0	4.8
	1.00-1.25	0	0	0	0	0	0	0	0
	1.25-1.50	0	0	0	0	0	0	0	0
	1.50-1.75	0	0	0	0	0	0	0	0
	1.75-2.00	0	0	0	0	0	0	0	0
	Total	43.2	47.8	7.6	0.7	0.6	0.1	0	100

Table 1-3(9)-2 Frequency table in wave height period class at the point of Gouyave (monthly, during Jan. to June)

Month	Period(s) / Wave height (m)	4-5	5-6	6-7	7-8	8-9	9-10	10-	Total
1	0.00-0.25	0.0	0.3	0.1	0.0	0.2	0.0	0.0	0.6
	0.25-0.50	5.7	5.2	0.9	0.0	0.0	0.0	0.0	11.9
	0.50-0.75	13.1	39.7	4.2	0.1	0.0	0.0	0.0	57.1
	0.75-1.00	0.2	11.7	9.6	0.4	0.0	0.0	0.0	22.0
	1.00-1.25	0.0	0.5	5.3	0.3	0.0	0.0	0.0	6.1
	1.25-1.50	0.0	0.0	0.2	1.6	0.0	0.0	0.0	1.9
	1.50-1.75	0.0	0.0	0.2	0.3	0.0	0.0	0.0	0.6
	1.75-2.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Total	19.0	57.4	20.6	2.8	0.2	0.0	0.0	100.0
2	0.00-0.25	0.0	0.3	0.8	0.6	0.5	0.0	0.0	2.2
	0.25-0.50	6.6	6.7	2.6	0.1	0.0	0.0	0.0	16.0
	0.50-0.75	10.0	42.3	4.8	0.0	0.0	0.0	0.0	57.1
	0.75-1.00	0.1	13.4	7.0	0.0	0.0	0.0	0.0	20.5
	1.00-1.25	0.0	0.4	2.6	0.0	0.0	0.0	0.0	3.0
	1.25-1.50	0.0	0.0	1.1	0.0	0.0	0.0	0.0	1.1
	1.50-1.75	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	1.75-2.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Total	16.8	63.2	18.9	0.7	0.5	0.0	0.0	100.0
3	0.00-0.25	0.4	0.1	0.2	0.1	0.3	0.1	0.0	1.1
	0.25-0.50	10.9	5.2	0.5	0.9	0.0	0.0	0.0	17.6
	0.50-0.75	19.6	47.9	1.9	0.0	0.0	0.0	0.0	69.4
	0.75-1.00	0.0	6.7	2.9	0.1	0.0	0.0	0.0	9.7
	1.00-1.25	0.0	0.1	1.6	0.0	0.0	0.0	0.0	1.6
	1.25-1.50	0.0	0.0	0.4	0.2	0.0	0.0	0.0	0.6
	1.50-1.75	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	1.75-2.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Total	30.9	59.9	7.5	1.3	0.3	0.1	0.0	100.0
4	0.00-0.25	0.1	0.9	0.2	0.2	0.0	0.0	0.0	1.4
	0.25-0.50	17.6	13.7	0.3	0.0	0.0	0.0	0.0	31.6
	0.50-0.75	19.8	41.0	1.3	0.1	0.0	0.0	0.0	62.2
	0.75-1.00	0.0	3.8	0.4	0.0	0.0	0.0	0.0	4.3
	1.00-1.25	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.5
	1.25-1.50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	1.50-1.75	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	1.75-2.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Total	37.6	59.9	2.2	0.3	0.0	0.0	0.0	100.0
5	0.00-0.25	0.1	0.8	0.5	0.2	0.0	0.0	0.0	1.6
	0.25-0.50	14.0	8.5	2.7	0.3	0.0	0.0	0.0	25.6
	0.50-0.75	10.0	46.7	1.4	0.0	0.0	0.0	0.0	58.2
	0.75-1.00	0.0	10.7	3.4	0.0	0.0	0.0	0.0	14.1
	1.00-1.25	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.5
	1.25-1.50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	1.50-1.75	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	1.75-2.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Total	24.1	66.8	8.5	0.6	0.0	0.0	0.0	100.0
6	0.00-0.25	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.3
	0.25-0.50	9.9	7.8	0.1	0.0	0.0	0.0	0.0	17.8
	0.50-0.75	10.0	63.0	1.9	0.0	0.0	0.0	0.0	74.9
	0.75-1.00	0.0	5.4	1.5	0.0	0.0	0.0	0.0	7.0
	1.00-1.25	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	1.25-1.50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	1.50-1.75	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	1.75-2.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Total	19.9	76.6	3.5	0.0	0.0	0.0	0.0	100.0

Table 1-3(9)-3 Frequency table in wave height period class at the point of Gouyave (monthly, during July to Dec.)

Month	Period (s) / Wave height (m)	4-5	5-6	6-7	7-8	8-9	9-10	10-	Total
7	0.00-0.25	0.0	0.2	0.3	0.0	0.0	0.0	0.0	0.6
	0.25-0.50	12.0	10.0	1.3	0.3	0.0	0.0	0.0	23.6
	0.50-0.75	11.2	46.5	5.8	0.0	0.0	0.0	0.0	63.4
	0.75-1.00	0.0	8.5	3.9	0.0	0.0	0.0	0.0	12.4
	1.00-1.25	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	1.25-1.50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	1.50-1.75	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	1.75-2.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Total	23.2	65.2	11.3	0.3	0.0	0.0	0.0	100.0
8	0.00-0.25	0.6	2.6	0.6	0.6	0.0	0.0	0.0	4.5
	0.25-0.50	29.4	15.2	1.5	0.0	0.0	0.0	0.0	46.0
	0.50-0.75	19.4	27.0	1.7	0.0	0.0	0.0	0.0	48.2
	0.75-1.00	0.0	1.2	0.1	0.0	0.0	0.0	0.0	1.3
	1.00-1.25	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	1.25-1.50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	1.50-1.75	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	1.75-2.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Total	49.4	46.0	3.9	0.6	0.0	0.0	0.0	100.0
9	0.00-0.25	2.9	3.8	4.0	0.4	1.5	0.3	0.1	13.1
	0.25-0.50	43.4	16.7	2.1	0.2	0.3	0.1	0.0	62.8
	0.50-0.75	11.1	10.8	1.3	0.4	0.0	0.0	0.0	23.5
	0.75-1.00	0.0	0.3	0.1	0.1	0.0	0.0	0.0	0.6
	1.00-1.25	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	1.25-1.50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	1.50-1.75	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	1.75-2.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Total	57.3	31.6	7.5	1.1	1.8	0.4	0.1	100.0
10	0.00-0.25	3.0	3.3	2.1	0.5	0.6	1.1	0.2	10.8
	0.25-0.50	38.6	18.3	1.5	1.3	0.6	0.0	0.0	60.3
	0.50-0.75	11.5	12.5	1.7	1.0	0.2	0.0	0.0	26.9
	0.75-1.00	0.0	1.3	0.7	0.0	0.0	0.0	0.0	2.0
	1.00-1.25	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	1.25-1.50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	1.50-1.75	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	1.75-2.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Total	53.1	35.4	6.0	2.7	1.5	1.1	0.2	100.0
11	0.00-0.25	0.0	1.1	0.5	0.7	0.2	0.3	0.2	3.1
	0.25-0.50	14.1	16.1	5.6	2.0	0.4	0.4	0.1	38.7
	0.50-0.75	10.7	40.5	3.9	0.1	0.0	0.0	0.0	55.3
	0.75-1.00	0.0	2.9	0.0	0.0	0.0	0.0	0.0	2.9
	1.00-1.25	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	1.25-1.50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	1.50-1.75	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	1.75-2.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Total	24.8	60.6	10.1	2.8	0.6	0.6	0.3	100.0
12	0.00-0.25	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.9
	0.25-0.50	5.4	8.2	1.3	0.4	0.2	0.1	0.0	15.6
	0.50-0.75	8.7	47.6	3.4	0.1	0.8	0.2	0.2	61.0
	0.75-1.00	0.0	12.5	5.2	0.1	0.0	0.0	0.0	17.8
	1.00-1.25	0.0	0.8	1.6	0.2	0.0	0.0	0.0	2.6
	1.25-1.50	0.0	0.3	0.4	1.0	0.0	0.0	0.0	1.7
	1.50-1.75	0.0	0.0	0.2	0.1	0.0	0.0	0.0	0.3
	1.75-2.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Total	14.2	69.6	12.3	1.9	1.1	0.4	0.3	100.0

In this study, wave recorder was installed at offshore of this site (at the point of about 9.5m water depth and about 200m off from the land) and the waves have been observed for about 19 days (from August 22, 2008 to September 10, 2008). From the survey result, the change over time of waves and the current are shown at Figure 1-3(6). Maximum value (wave height: 0.84m, period: 9.4 seconds, wave direction: WNW) of significant wave was observed on September 5. The period is distributed at 5 to 8 seconds and the wave direction of NW～NNW is dominant. And, in this survey, the observation of tide level and tidal current are observed at the same time using this wave recorder.

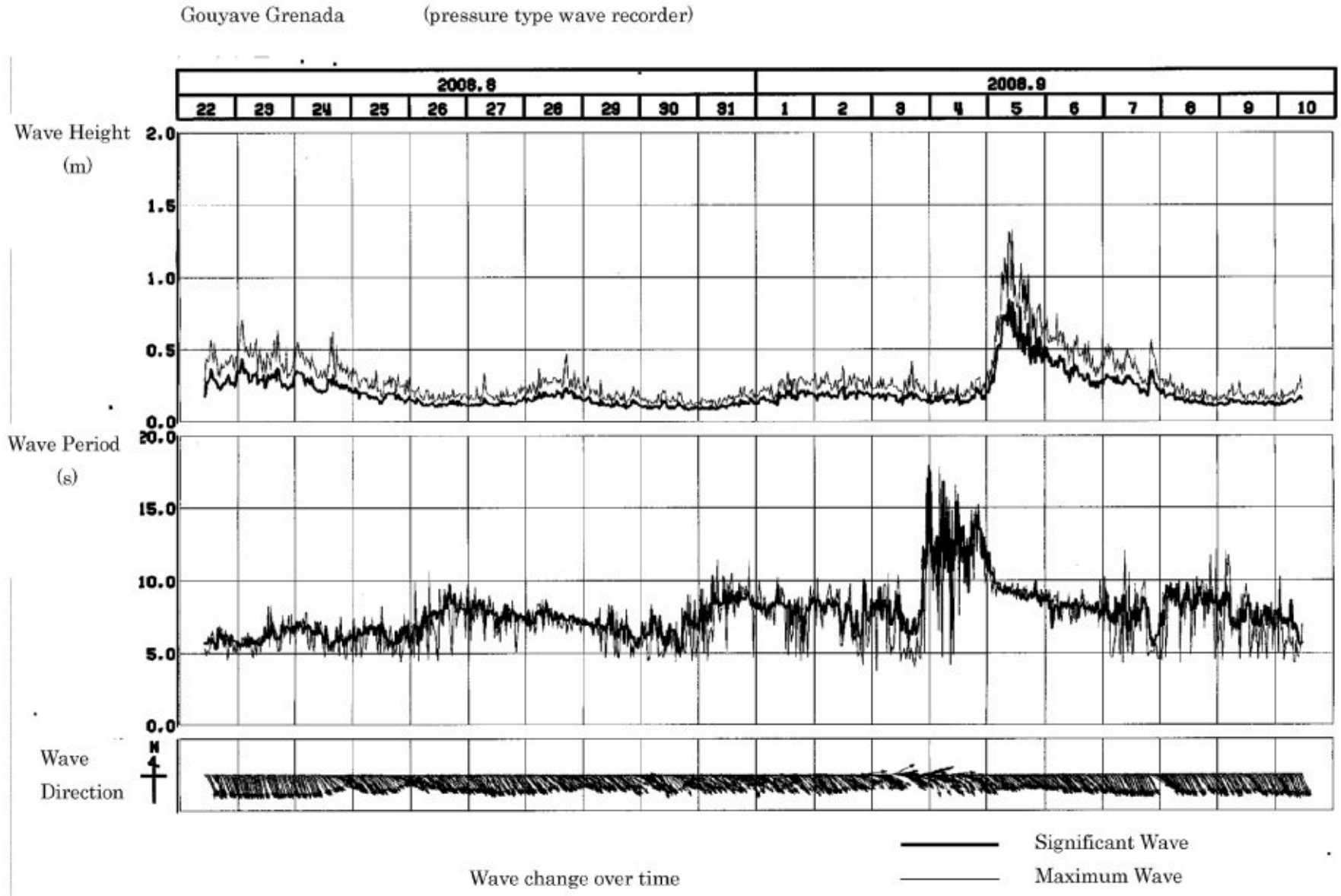


Figure 1-3(6)-1 Observation result of waves at the point of Gouyave (Wave change over time)

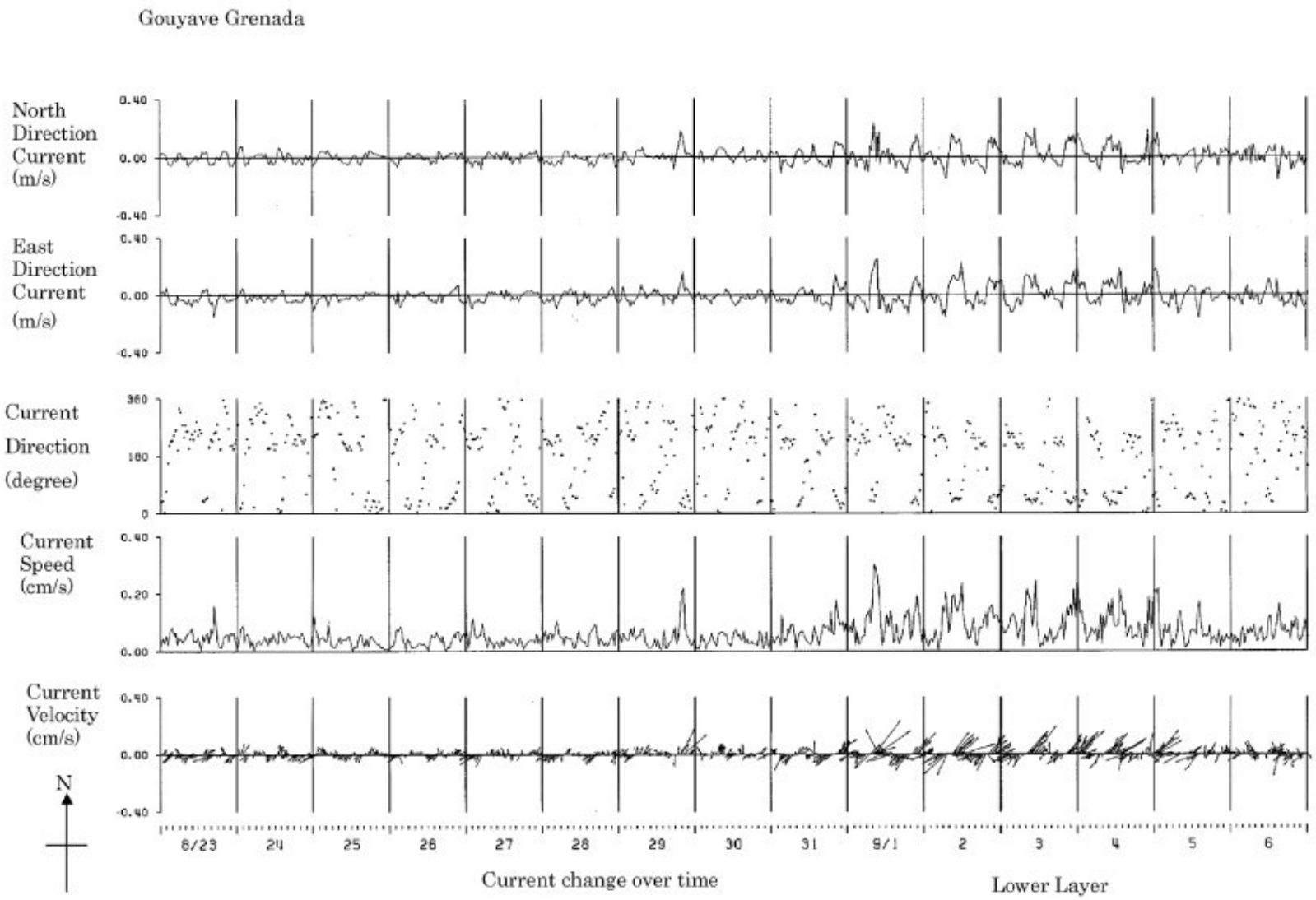


Figure 1-3(6)-2 Observation result of waves at the point of Gouyave (Current change over time-1)

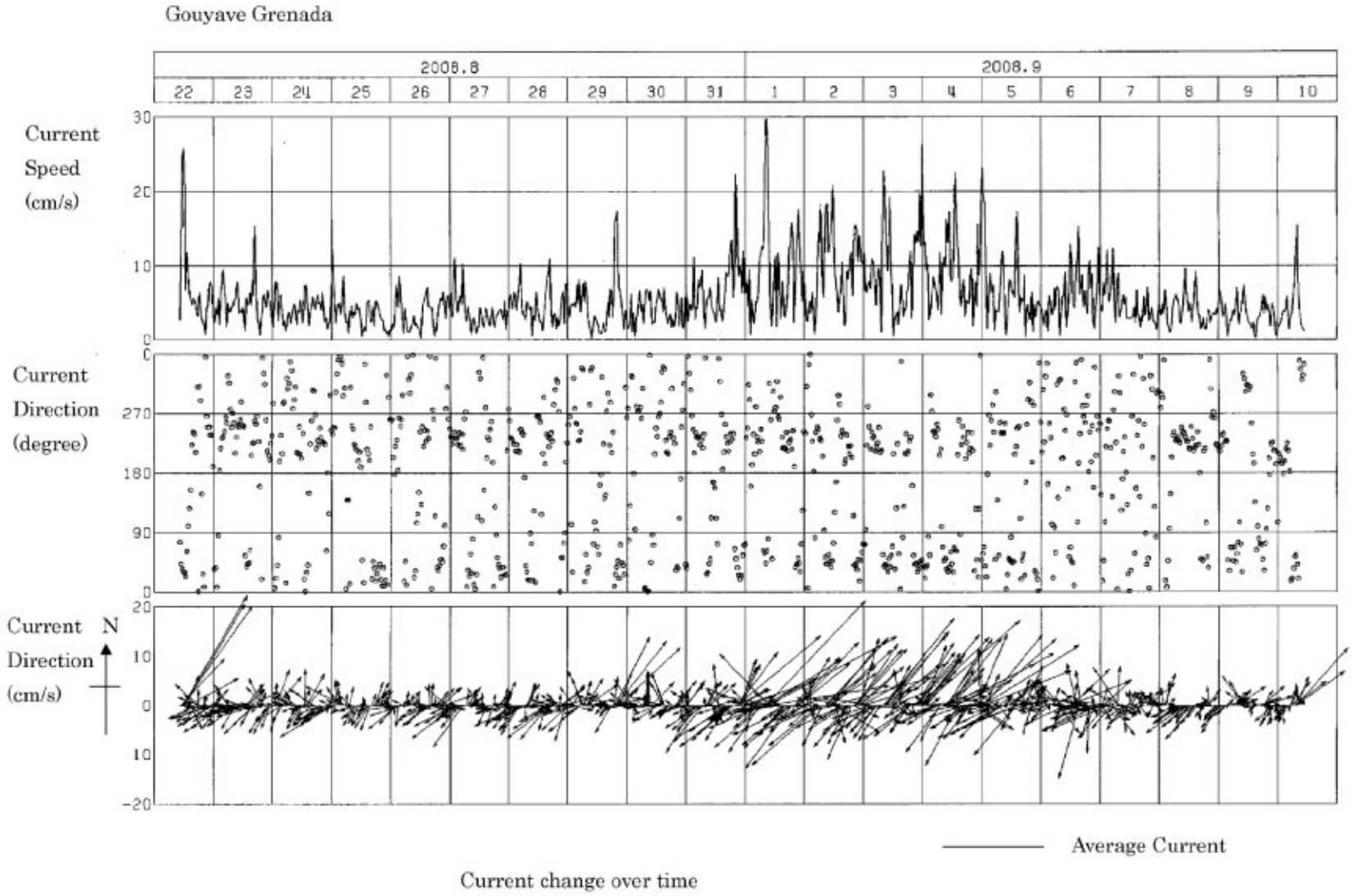


Figure 1-3(6)-3 Observation result of waves at the point of Gouyave (Current change over time -2)

2) Anomalous Wave

(a) Offshore wave conditions

The waves affected by hurricane advancing westward in Atlantic Ocean reach to Grenada sea area. The waves generated on Atlantic Ocean do not reach to the sea site directly however, in case that a hurricane passes through northern part of Caribbean Sea, wind fetch to W direction is generated in Caribbean Sea and tidal wave reaches by this influence. As the traveling direction of hurricane and waves is different, although tidal wave is smaller than waves generated on Atlantic Ocean. However, as the waves to West directly reach to project site, this wave was considered to be the study subject. Hurricane " LENNY" (Hurricane No. 9912- front two figures show year struck and latter two figures show hurricane generation order) who struck in November, 1999 was a extremely rare one that went eastward on Caribbean Sea. Since the traveling direction of hurricane and waves was met each other, stronger tidal waves has reached in comparison with the hurricane size and made serious damages on Caribbean Sea Coast, Lesser Antilles. Here, the above into consideration, design hurricane was selected based on the hurricane sizes, distance from project site, traveling route and so forth and the design wave has been obtained by statistical analysis of the result.

Figure 1-3(7) shows the route map of hurricane passed through Grenada in recent 57 years (1951 to 2007) out of which considered to bring high waves to Grenada (hurricanes to satisfy following three conditions).

① Nearest distance between project site and hurricane center is less than 500 km.
② Maximum wind speed around hurricane exceeds 30 m/s.
③ Maximum parameter(Kt) shows below exceeds 5.

$K_t = U^2/D$

Where U : maximum wind speed of each hour(m/s)

D :Distance of hurricane center and project site of each hour (km) however minimum distance is set as 50 km.

According to the standard of above Kt parameter, the biggest hurricane was "JANET" No. 5510 struck in September, 1955 and the value of Kt parameter reached to 54. The second one was "FLORA" No. 6307 struck in October, 1963 and Kt parameter was 38. Here, total 8 hurricanes who considered to bring high waves to project site including "LENNY" were selected and shown at Figure 1-3(8). These were calculated with the conditions of offshore wave using "One-Point Model".

The wave forecasting and hind casting by hurricane being different from wave at normal time, as the wind by hurricane can be calculated by the center barometric pressure, radius of hurricane and traveling route, more accurate calculation is possible. As the result of calculation, Table 1-3(10) shows the maximum wave sizes of each hurricane obtained from traveling route and the time-sequence diagram using the calculation result. According to this,

hurricane "JANET" has 7.0m of wave height which was the most, 11.3 seconds of period and N of wave direction.

This result was statistically analyzed and calculated wave height corresponding to recurrence interval and obtained the sizes of offshore design wave. Table 1-3(11) shows the result. Here, the wave corresponding to 30 years reoccurrence interval is set as design wave and the design wave height is set as 5.0 m. Concerning period, 12 seconds which is the maximum value obtained from calculation result was set. Wave direction is set as N～W～SSW since incident wave direction is widely distributed obtained from calculation result.

Table 1-3(12) shows specification of design wave to be used for the design of structures.

Table 1-3(10) Result of wave forecasting and hind casting (Maximum wave)

Hurricane					Size of offshore waves		
Name	No.	Year	Month	Day	Wave height (Ho) m	Period (T) s	Wave direction
JANET	5510	1955	9	23	7.00	11.31	N
DOG	5104	1951	9	2	5.36	9.34	WNW
LENNY	9912	1999	11	18	4.81	11.54	NW
IVAN	0409	2004	9	7	4.21	10.31	N
ALLEN	0505	1980	8	4	3.77	8.35	WSW
DAVID	7904	1979	8	30	3.39	7.89	NNW
FLORA	6307	1963	10	1	3.24	10.06	SSW
EMILY	0505	2005	7	14	3.14	8.73	N

Table 1-3(11) Recurrence interval (effective statistical years: 57 years during 1951 to 2007)

Wave height with a return period (m)	
Recurrence interval (yr)	Wave height(m)
10	3.37
20	4.40
30	5.00
40	5.42
50	5.75

Table 1-3(12)　Sizes of design wave height (wave height with a return period of 30 years: offshore condition)

Offshore wave size	
Wave height(Ho)	5.0m
Period （T）	12s
Wave direction	N～SSW

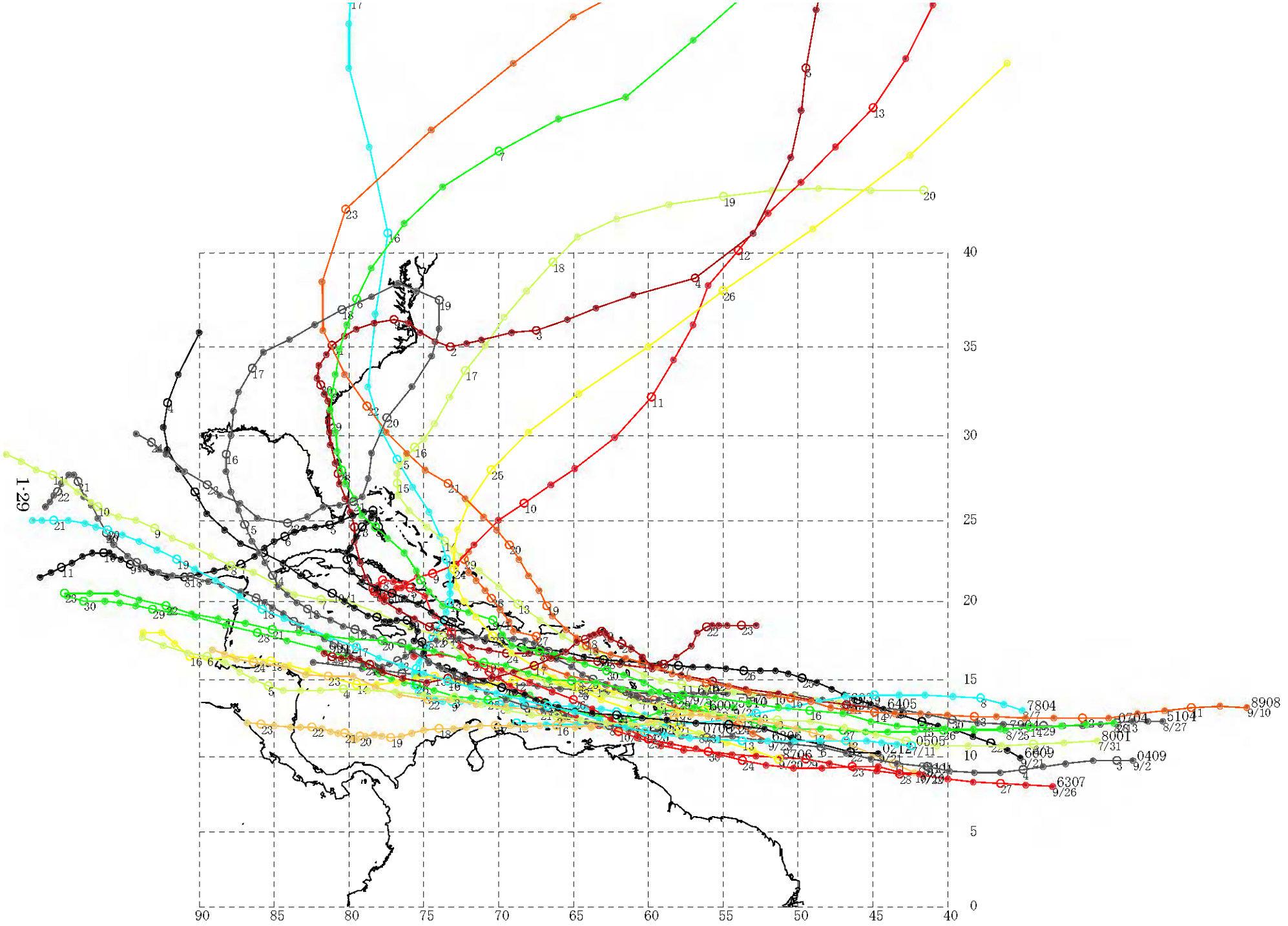


Figure 1-3（7） Traveling route of big scale hurricane

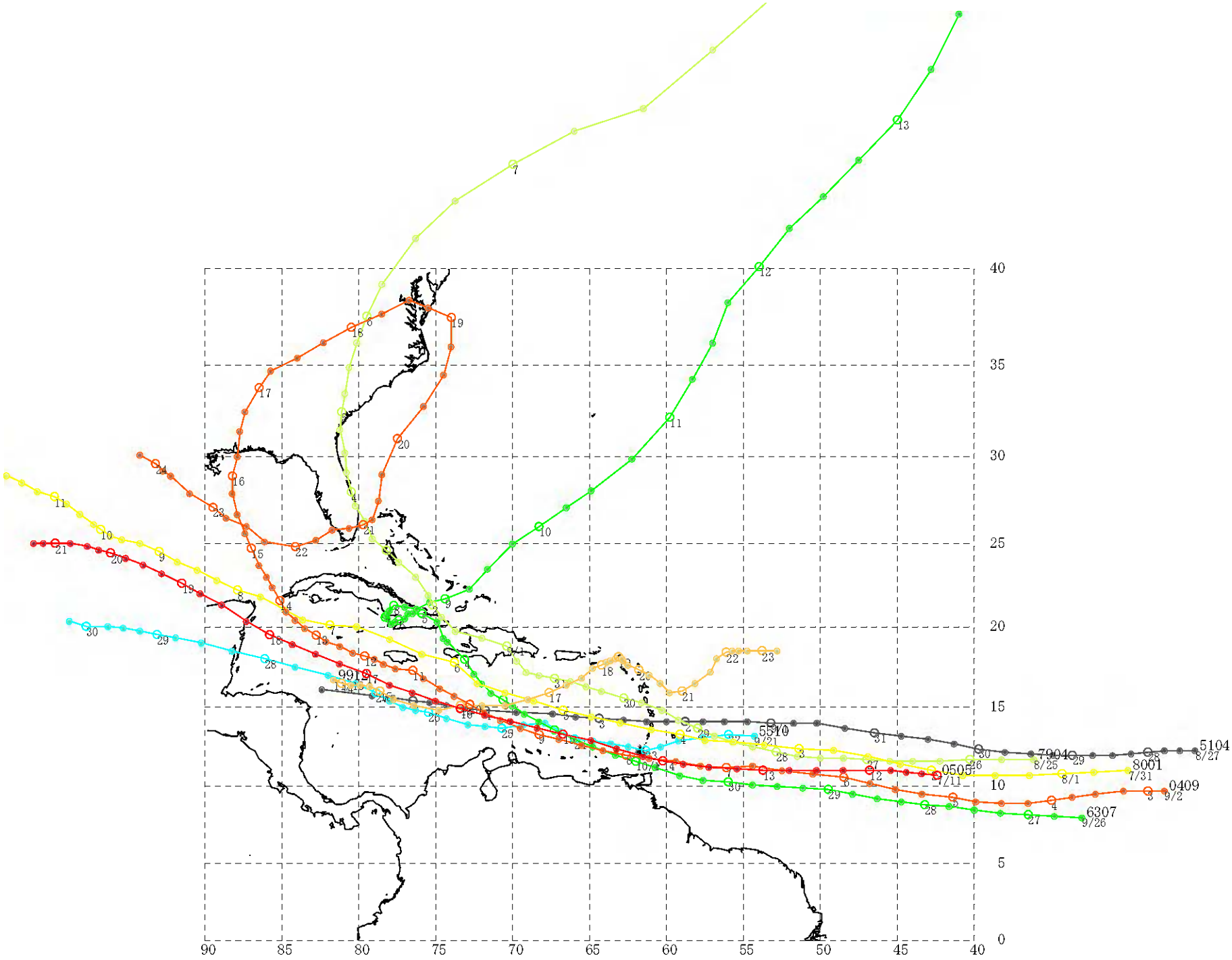


Figure 1-3（8） Hurricane traveling route of object calculation

3) Waves in front of structures

(a) Estimated offshore waves

Front waves to be used for structural design has been studied in detail executing refraction calculation, shallow water or breaking calculation and wave deformation calculation and etc. on reef when necessary. In refraction calculation, the method to solve energy balance equation which is commonly used as wave deformation calculation by irregular wave was used.

The calculation is calculating its deformation according to the change of bottom topography providing the design wave conditions which was previously described at offshore boarder of the site area. And, wave height ratio, refraction coefficient and wave direction on each grid point are out-put. Here, it was intended for wave direction NW which is considered to be the biggest wave height judging from topographical conditions of the site. The water depth condition was set based on the result of the site sounding survey. From the calculation result, the dimensions of estimated offshore wave in front of structures are shown in Table 1-3(13). The maximum value of estimated offshore wave height at the site is 4.75 m (in case of wave direction WNW). And, the incident wave direction is N40°W.

Table 1-3(13) Result of wave deformation calculation(estimated offshore wave at the site)

Offshore wave dimension		Refraction coefficient	Dimension of estimated offshore wave (Project site)	
Wave height (Ho)	5.0m	0.95	Incident wave height(Ho')	4.75m
Period (T)	12		Period	12
Wave direction	NW		Incident wave direction	N40.5°W

(b) Arrival wave

In estimated offshore waves calculated, the wave in front of structures was estimated using shoaling or breaking deformation calculation. The installation water depth is studied in case that the installation water depth of structures (average water depth: below MSL) is set as 4 -6 m. In the tide level, the water depth was studied with the assumption of high tide level +0.54m i.e. above average water depth +0.27m plus water level rising 0.8m by hurricane or others. The bottom slope was set as 1/30 from the result of sounding survey.

The calculation conditions are as follows.

Estimated offshore wave height (Ho') :4.75m

Period (T) :12 seconds

Offshore wave length (Lo) : 225m

Installation water depth including tide level (h) : 4～6m (below MSL)

Tide level: The water depth d is 5.07-7.07m (refer to data B1 for water rising) = HWL

+0.54m, above MSL+0.27m plus water rising volume

Bottom slope: 1/30 (estimated at water depth zone with about 1.5 – 2.5 times of estimated offshore wave height based on the sounding survey)

In this condition, as the front area of structures is wave breaking zone, the arrival wave height uses the wave height calculation view at breaker zone (significant wave height). The result is as per Table 1-3(14).

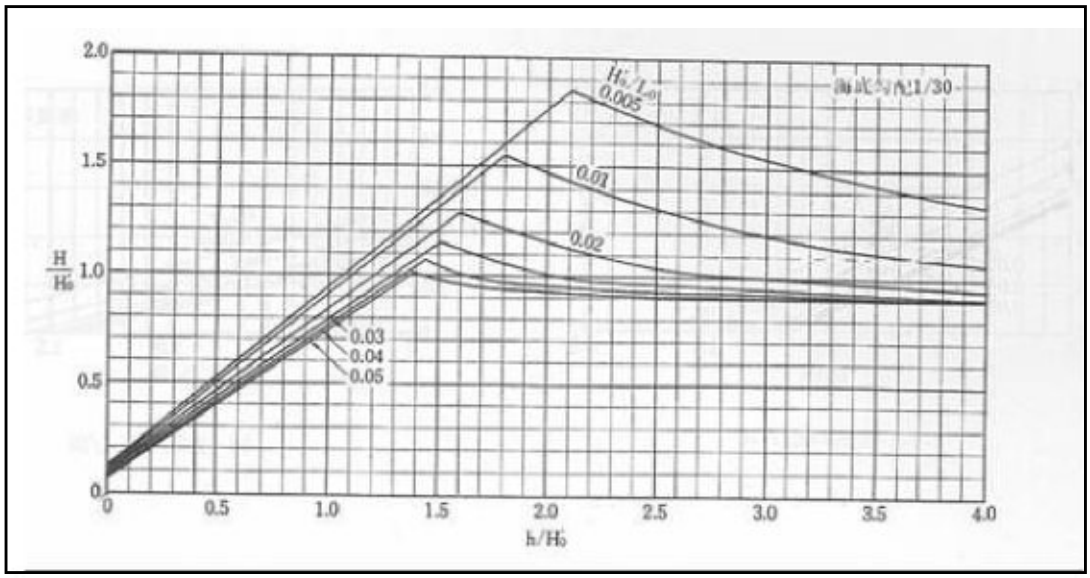


Figure 1-3(9) Wave height calculation view at breaker zone

Table 1-3(14) Arrival wave height list

Water Depth (MSL)	Water Depth (tide level, water rising)	Period	Estimated offshore wave height	Bottom slope (inverse)	Wave steepness	Ratio for water depth//wave height			Significant wave height	Water rising volume
(m)	h(m)	T(s)	Ho'(m)	1/slope	Ho'/Lo	h/Ho'	H1/3/Ho'	eta/Ho'	H1/3(m)	eta(m)
1	2.07	12	4.75	30	0.021	0.436	0.422	0.099	2.005	0.471
1.5	2.57	12	4.75	30	0.021	0.541	0.500	0.090	2.375	0.428
2	3.07	12	4.75	30	0.021	0.646	0.578	0.081	2.746	0.385
2.5	3.57	12	4.75	30	0.021	0.752	0.656	0.072	3.116	0.342
3	4.07	12	4.75	30	0.021	0.857	0.734	0.063	3.486	0.299
3.5	4.57	12	4.75	30	0.021	0.962	0.812	0.054	3.856	0.256
4	5.07	12	4.75	30	0.021	1.067	0.890	0.045	4.227	0.213
4.5	5.57	12	4.75	30	0.021	1.173	0.968	0.036	4.597	0.170
5	6.07	12	4.75	30	0.021	1.278	1.046	0.027	4.967	0.127
5.5	6.57	12	4.75	30	0.021	1.383	1.124	0.018	5.337	0.084
6	7.07	12	4.75	30	0.021	1.488	1.202	0.009	5.708	0.041

4） Tide level

The result of harmonic analysis from observed water level is as follows.

Water area: Front water face of jetty at Gouyave in Grenada

Latitude: North latitude 12°10' 15"

Longitude: West longitude 61°43' 45"

Observation period: Aug. 22, 2008 through Sep. 10, 2008

Tidal constituent		Amplitude (cm)	Tide lag (degree)
K1	Luni-solar diurnal tide	0.099	175.2
O1	Principal lunar diurnal tide	0.076	169.2
P1	Principal solar diurnal tide	0.033	175.2
Q1	Principal lunar elliptic tide	0.009	186.6
M2	Principal lunar semi-diurnal tide	0.045	52.9
S2	Principal solar semi-diurnal tide	0.010	344.3
K2	Luni-solar semi-diurnal tide	0.003	344.3
N2	Principal lunar elliptic tide	0.015	6.5
M4	Principal lunar 1/4 diurnal tide	0.002	34.2
MS4	M2+S2 composite tide	0.004	104.4

Adding 4 main tidal constituent, it becomes 0.23m. And, the amplitude of semi-diurnal tide is smaller than diurnal tide at the project site. Thus, the tide level in the project water area will be as follows.

- Nearly Highest High Water Level (NHHWL) + 0.840 m
- Mean High Water Spring (MHWS) + 0.665 m
- Mean High Water Neap (MHWN) + 0.645 m
- Mean Sea Level (MSL) + 0.610 m
- Mean Low Water Neap (MLWN) + 0.575 m
- Mean Low Water Spring (MLWS) + 0.555 m
- Chart Datum Line (CDL) + 0.000 m

5） Tidal current

Current status at the site has been observed using the data obtained from the current meter equipped with a wave gauge. Figure 1-3(10) shows the time variation of current speed, current direction and current vector. According to this, the maximum current speed is about 30 cm/sec. The current is directed to NE and SW. However, the relationship between the tide level change and the tidal current change is unclear.

Current ellipse from current observation value is shown in Figure 1-3(10). The maximum current speed is about 8 cm/sec. While, current observation was executed using a float at the spring tide during study period. The float location at certain hour (about 5 minutes) is measured by GPS. Figure 1-3(11) shows the float movement. The average current speed was about 8 cm/sec. There observed mostly the current directed to SW from NE. And, other than this, current observation has been done near seashore using the float and found the current near coast line was mostly directed to south west direction (left hand side to offshore).

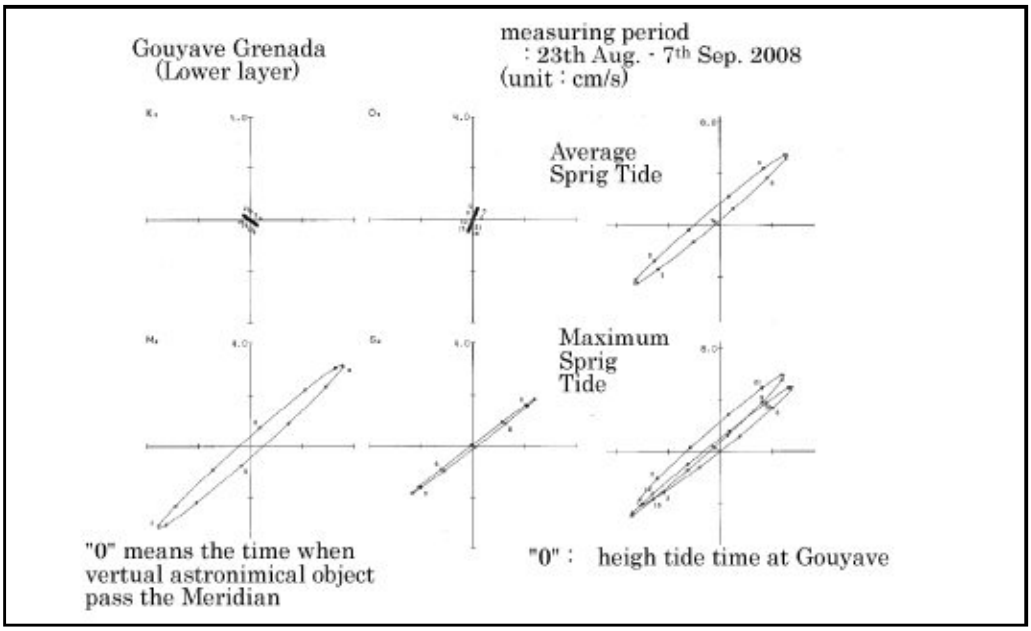


Figure 1-3(10) Current Ellipse from current observation value

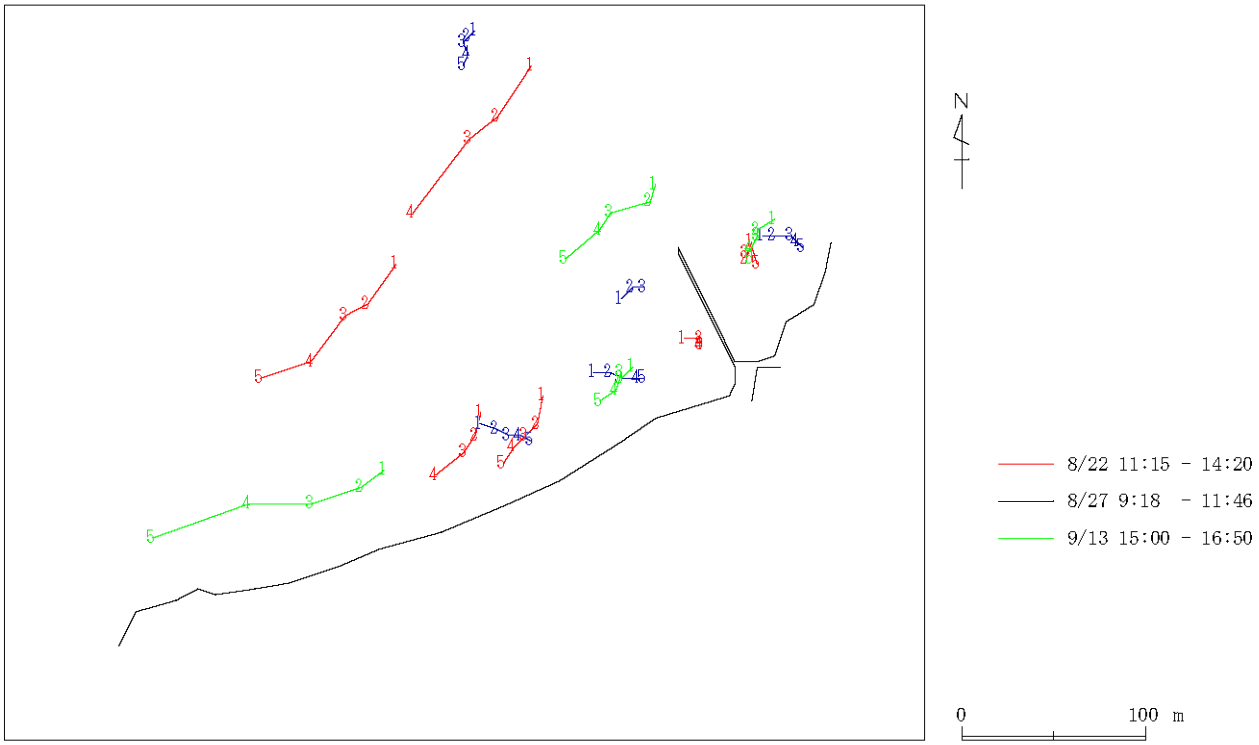


Figure 1-3(11) Observation result of current following float

(3) Sounding Survey and Topographic Survey

Sounding survey and topographic survey was carried out at around Gouyave point. The sounding survey covering the area of 2000m×1000m was carried out during August 21, 2008 through August 22., 2008. While, the topographic survey was carried out during August 21 through August 26, 2008 with the area of 300m×300m. The topographic survey of Grand Etang district (with the area of 10m x 10m) where is planned to construct a radio facility was carried out on September 11, 2008. All of the survey results are shown in Figure 1-3(12)-1, Figure 1-3(12)-2 and Figure 1-3(12)-3.

Figure 1-3(12)-1　Result of sounding survey and topographic survey

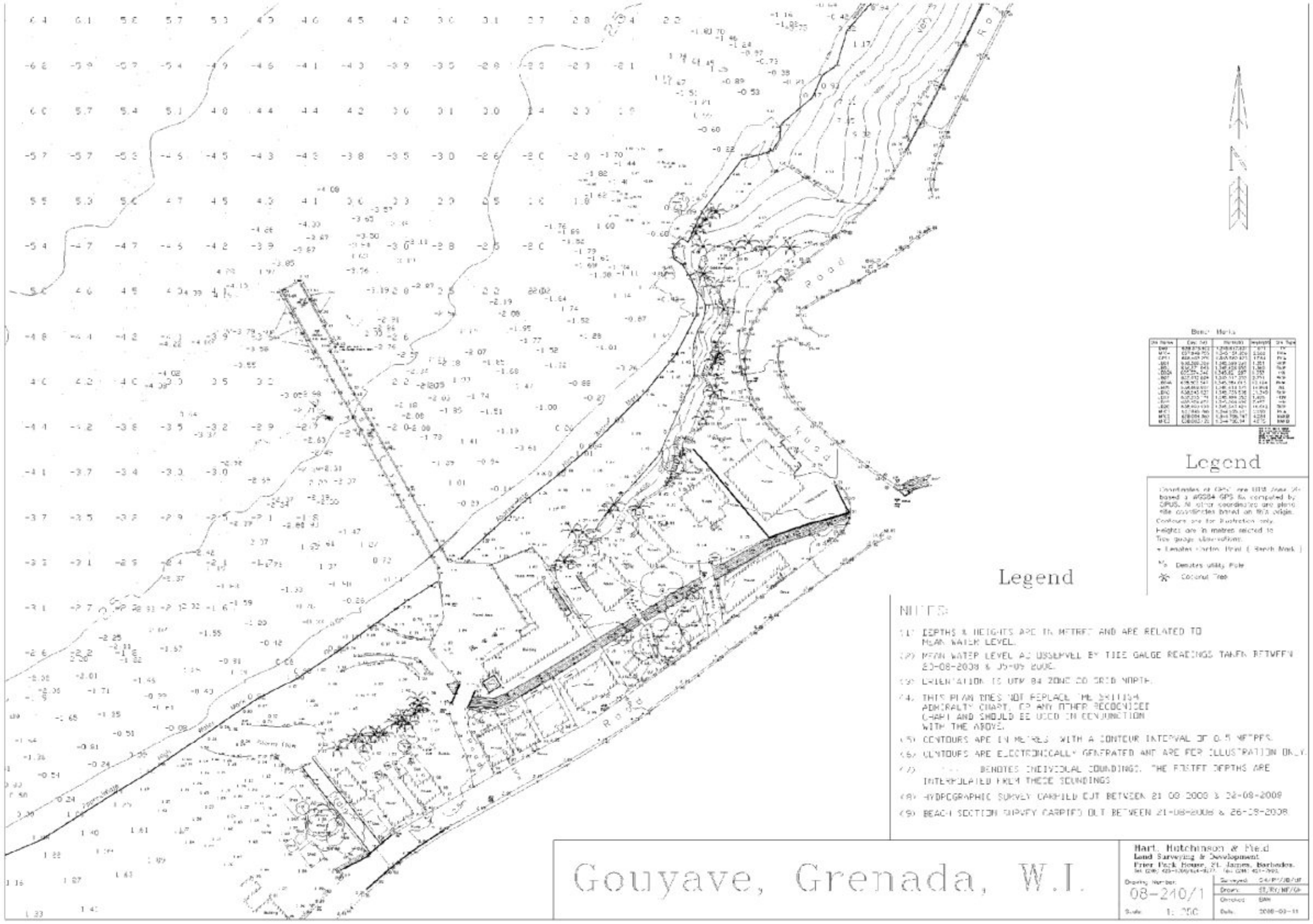


Figure 1-3(12)-2 Result of sounding survey and topographic survey

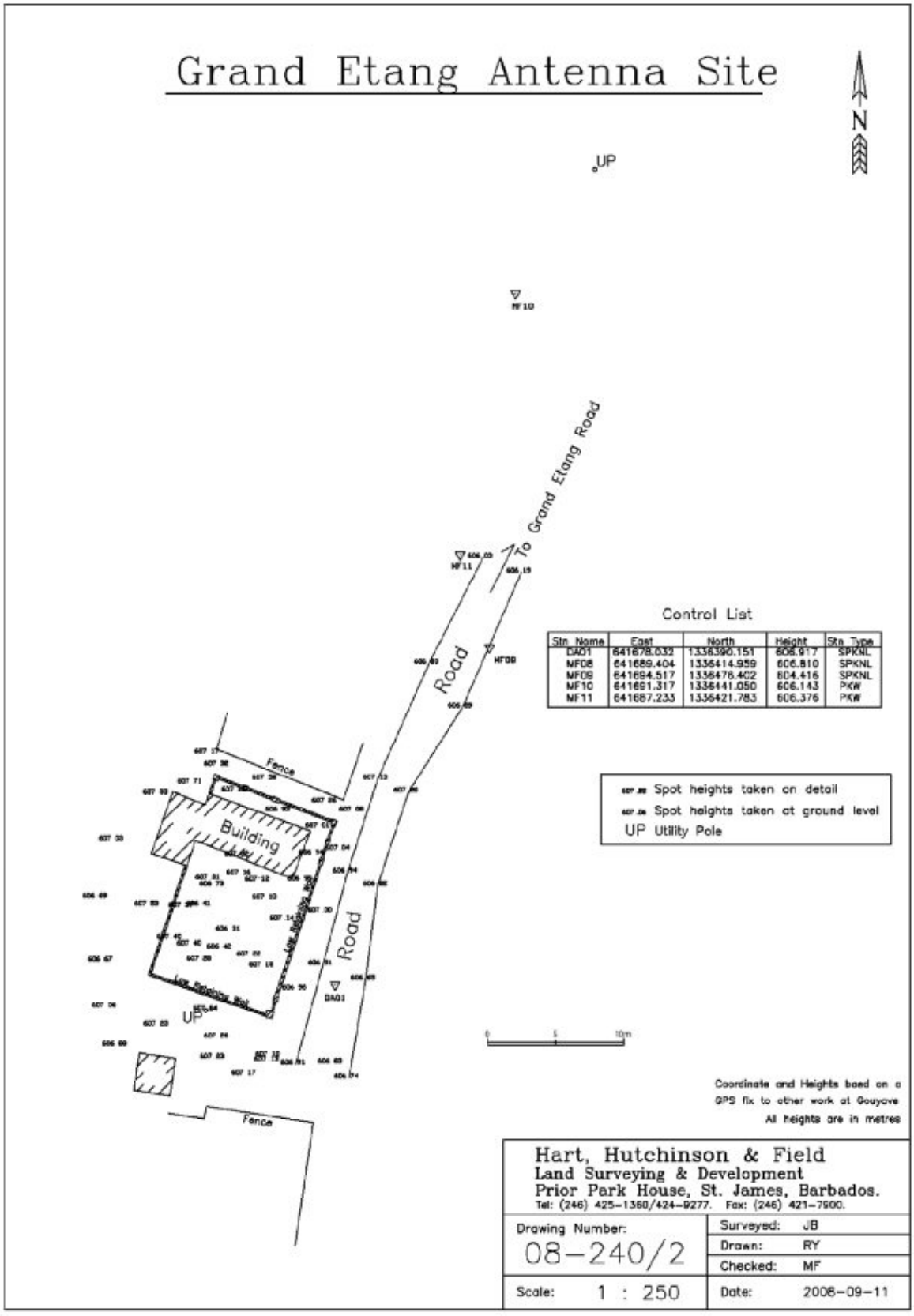


Figure 1-3(12)-3 Result of topographic survey (Location of radio facility at Grand Etang)

(4) Sediment Survey

Bottom sampling was taken out from total 42 points (as shown in Figure 1-3(13) in front of the facilities construction site and the laboratory test was done. The median grain size (D50) and the gravity according to the test result are shown in Table 1-3(13).

According to this, the sediment is mainly composed of sand and the median grain size is about 0.1 to 1.00 mm at land (water depth +1m or 0 m) but it is a little bit smaller around 0.1 mm at deeper water. However, the grain size at the point of -1 m water depth in traverse lines L-1, L-3, L-4 and at the point of – 7m water depth in traverse line L-2 is about 40 mm. And, remarkable trend of the grain size change among traverse lines is not confirmed. As the gravity of sediment is about 2.5 to 3.1 as a whole, the average is about 2.7.

Table 1-3(15) Sediment survey result

Survey point / w. depth(m) / Transverse line	1 +1.0	2 0.0	3 -1.0	4 -2.0	5 -3.0	6 -4.0	7 -5.0	8 -6.0	9 -7.0
L-1	0.286	0.402 (2.803)	40.45	0.157	0.132 (2.458)	0.107	0.121	0.077 (2.711)	0.064
L-2	0.245	0.268 (2.901)	10.319	0.101	0.113 (2.772)	0.100	0.192	0.07*1 (2.682)	0.021
L-3	0.318	1.282 (2.692)	0.221	0.098	0.089 (2.626)	0.014	0.039	0.087 (2.668)	43.258
L-4	- *2	- *2	43.258	0.229	0.109 (2.612)	0.086	0.086	0.096 (2.668)	0.033
EX *3	0.139	0.224							

S-1 (W.depth -3.6m)	0.212 (2.668)
S-4 (W. depth -2.4m)	0.195 (2.741)
S-5 (W. depth -2.4m)	0.194 (2.756)
S-7 (W.depth -1.0m)	12.51

Upper figure in the above table means sediment grain size (unit: mm) and lower figure means the gravity.

*1 shows D60 value（ ratio passed through mesh of 0.074 mm is 60.5% and D50 cannot be determined）

*2 As the grain size is rough, the median grain size cannot be measured.

*3 Additional survey points

Figure 1-3(13) Sediment sampling location map

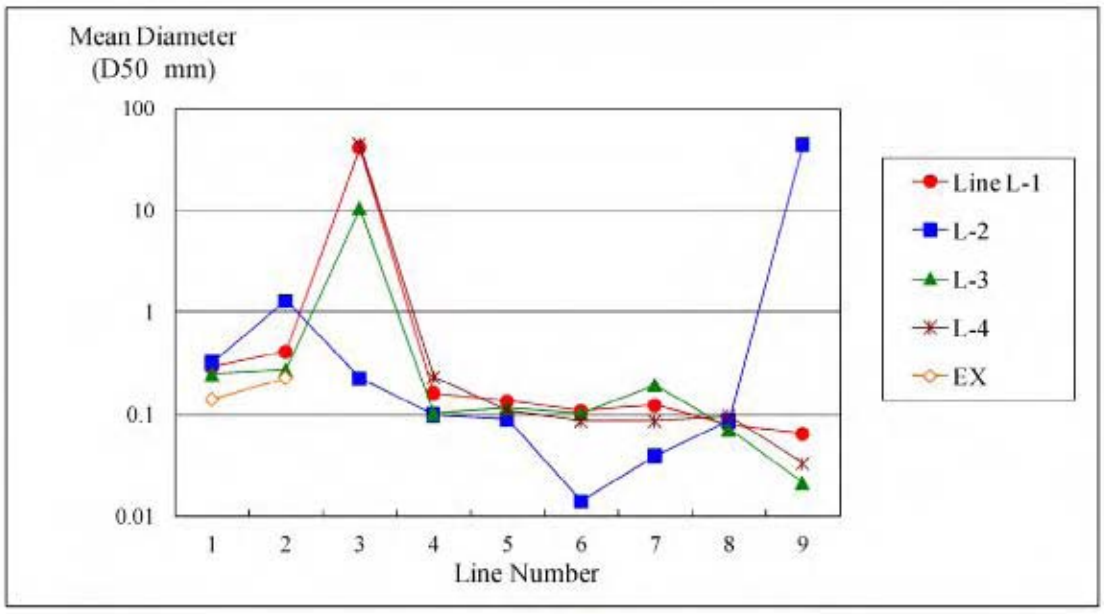


Figure 1-3(14) Distribution chart of average sediment grain size

(5) Soil Investigation

The summary of standard penetration test result obtained from boring investigation result and the soil conditions around facilities construction site is shown below.

Boring investigations were carried out at 4 places (BH1: head of jetty, BH2: in front of the existing fisheries center, BH3: around slipway area, BH4: Antenna construction site) in facilities construction sites and BH5 and BH6 where are west side of the existing jetty. Boring location maps are shown in Figure 1-3(15)-1 to Figure 1-3(15)-3. And, Figure 1-3(16)-1 to Figure 1-3(16)-6 show boring logs in each point.

The head part of jetty (BH1) is composed of sand with gravel and the N value is about 20 from ground to around – 3m and more than 100 at deeper than – 4m.

Two places in front of the existing fisheries center were investigated and N values shows more than 40 at 1 m shallower points from ground and 100 for deeper points with all sand with gravels.

3 places (BH3) to be slipway were investigated and show very dense gravels than land surface and N value is more than 100.

With the survey results around the existing jetty (BH2) and slipway (BH3), the water contents of these points are all about 20% and the gravity are about 2.2 to 2.8. And, the median grain size is distributed from 0.2 mm to 20 mm and the maximum grain size is about 40 mm.

The land (BH4) for antenna construction is composed of silty gravel sand from ground level to around 6m and N value is below 10. There still silty gravel sand for deeper than 6m but N value becomes gradually bigger and shows more than 50 at -15m or deeper. The water content is about 40 to 60% and the gravity is about 2.2 to 2.8. The median grain size is about 0.25 mm and the maximum is about 40 mm.

While, with the result of soil investigation at the two places (BH5, BH6) to be the new jetty, the N value is more than 50 at – 6m or deeper from sea bottom and the maximum is more than 100 where have hard soil conditions. The water content is about 20 to 30% and the gravity is about 2.7 to 2.9. And, concerning the median grain size, while it is 0.2 to 0.3 mm at BH5 where is at the jetty head, BH6 where is comparatively shallow is distributed around 0.2 to 30 mm. The maximum grain size is about 10 mm in BH5 and about 40 mm in BH6.

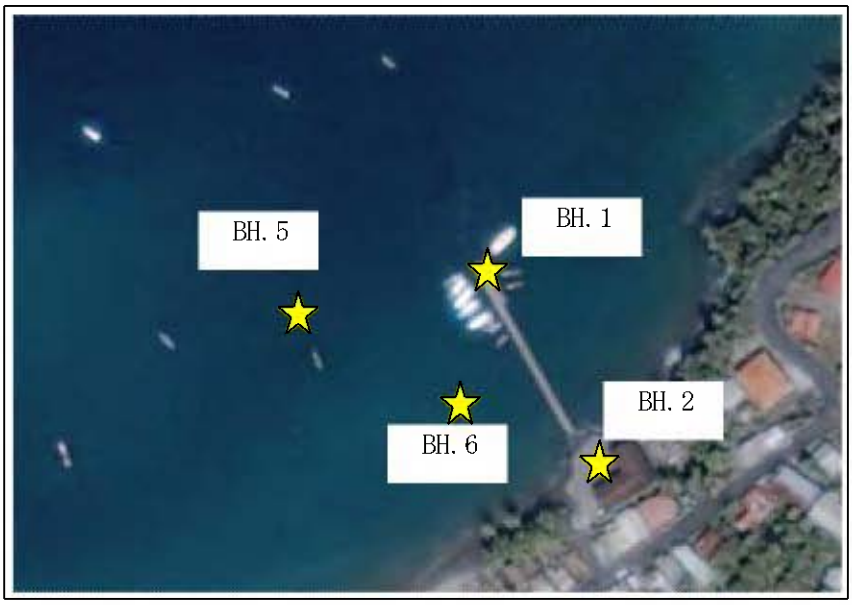


Figure 1-3(15)-1 Boring location map（BH.1、BH.2、BH.5、BH.6）

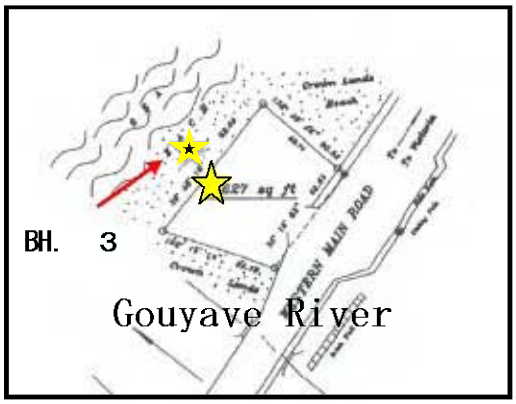


Figure 1-3(15)-2 Boring location map (Point to be slipway BH.3）

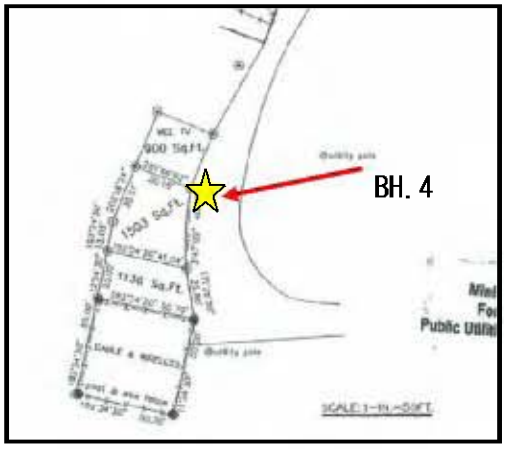


Figure 1-3(15)-3　Boring location map (Point to be Antenna facility, BH.4)

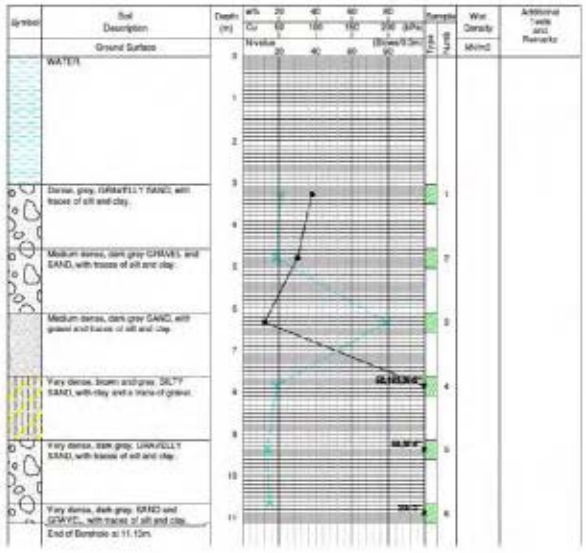


Figure 1-3(16)-1 BH.1 Borehole log
(Jetty head)

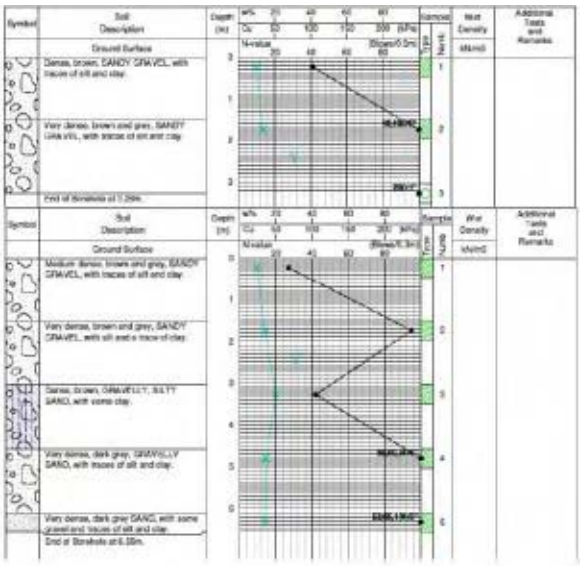


Figure 1-3(16)-2 BH.2 Borehole log
(In front of existing fisheries center -2 points)

Figure 1-3(16)-3 BH.3 Borehole log
(Planned site for slipway- 3 points)

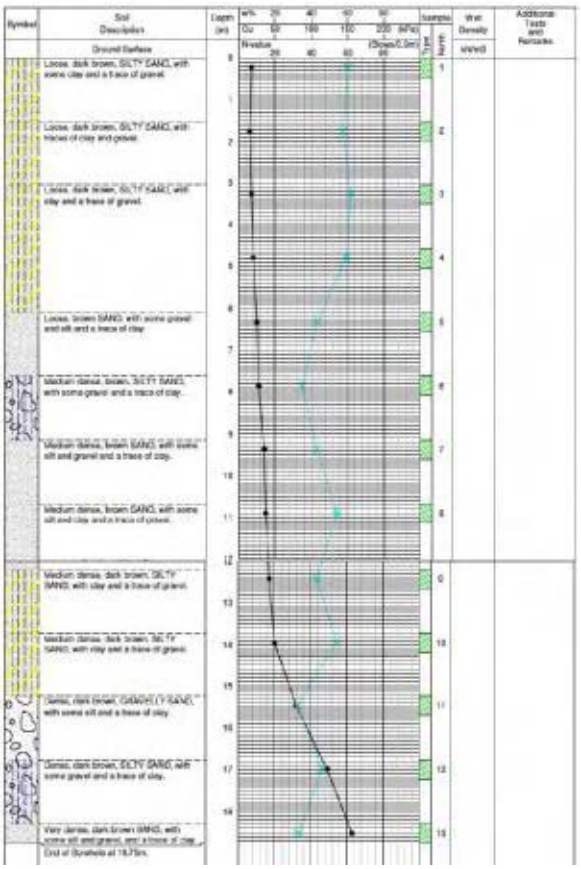


Figure 1-3(16)-4 BH.4 Borehole log
(Planned site for antenna facility)

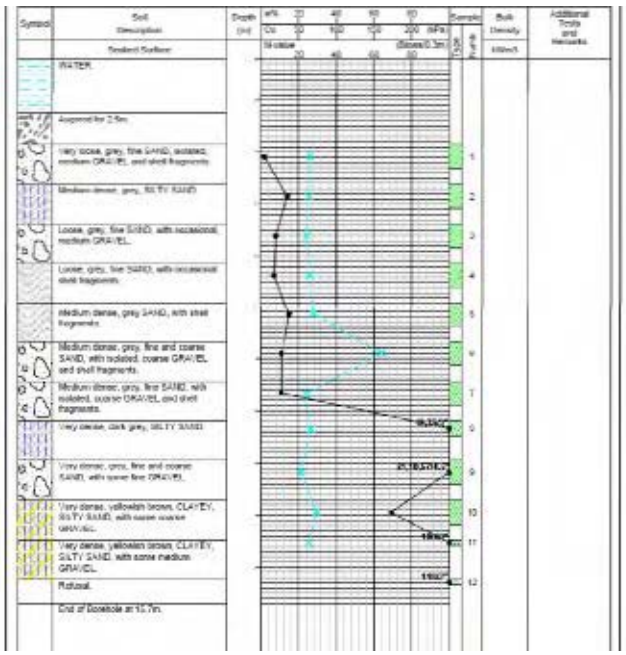


Figure 1-3(16)-5 BH.5 Borehole log
New jetty head

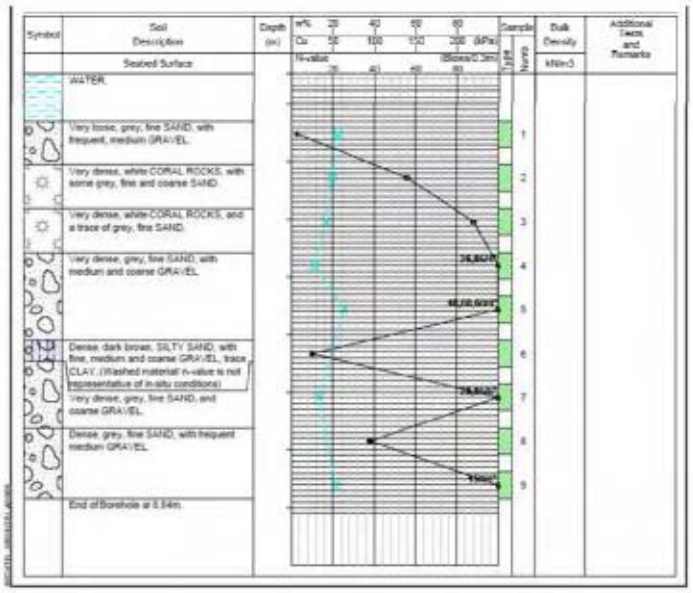


Figure 1-3(16)-6 BH.6 Borehole log
New jetty center

And, Figure 1-3(17) shows the boring log of the soil investigation carried out in 1989 in addition to the result of this Preparatory Survey. With this result, the summary of soil conditions of planned site for the new jetty construction is as follows.

On the whole, the area from 5 to 8 m from sea bottom is sandy gravel and the N value is more than 20. There is a tendency that N value is getting bigger with increase in depth although it is vary slightly and the deeper area than this sand layer is the firm sandy ground with N value more than 100.

With above, the soil conditions to be used for the design of marine facilities are set as follows. The soil conditions of object point is changed not with the water depth but with the depth from the sea bottom and the N value is about 20 to 40 at the upper layer with about 3m layer thickness and N value is about 40 to 60 at the lower layer with the thickness of 2.5m soil also by sand with gravel. The deeper area from this is set more than 100 as N value which is firm sand soil.

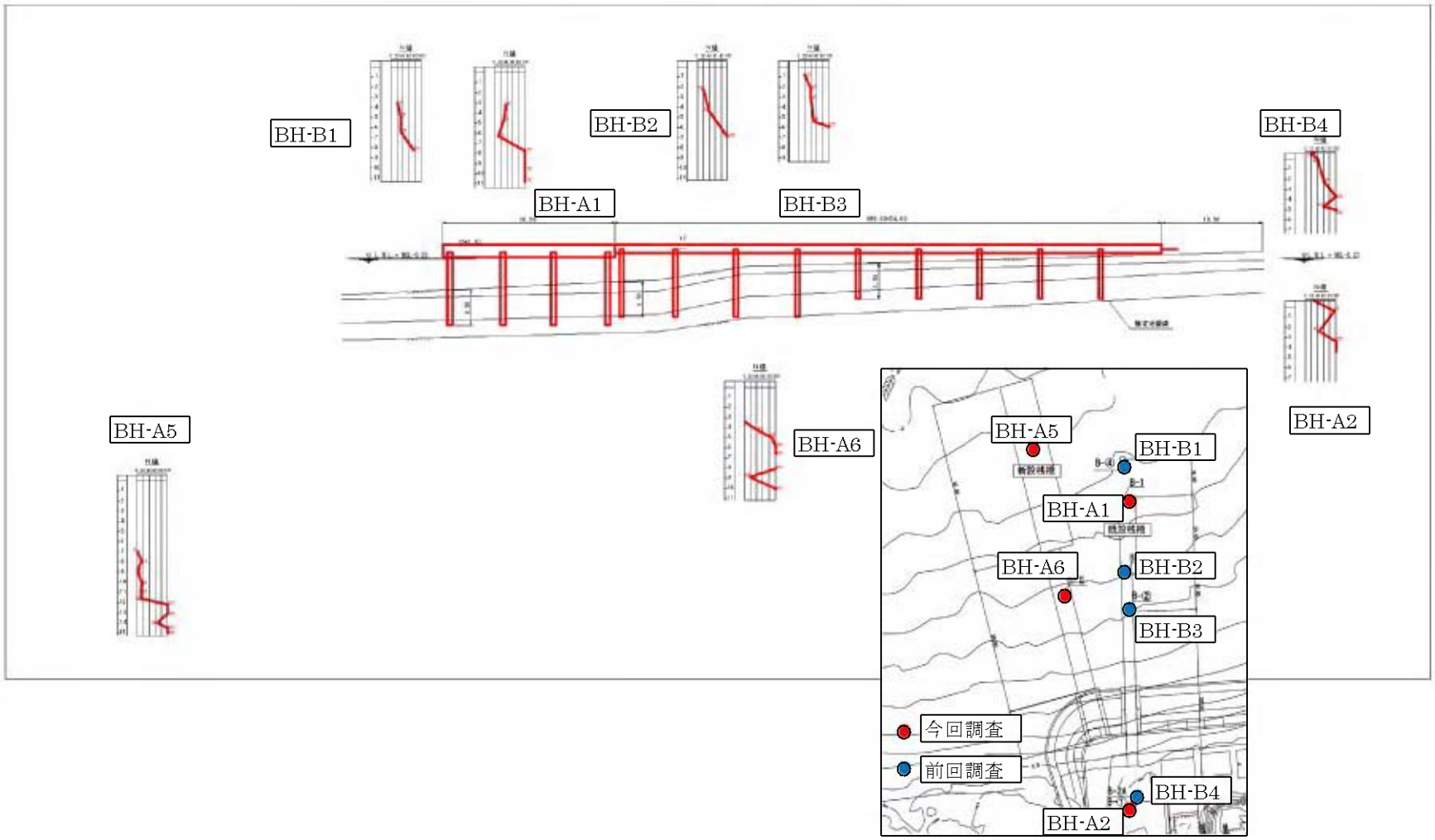


Figure 1-3(17)　　Add-up of soil investigation (1989 and this time)

(6) Analysis of Construction Materials

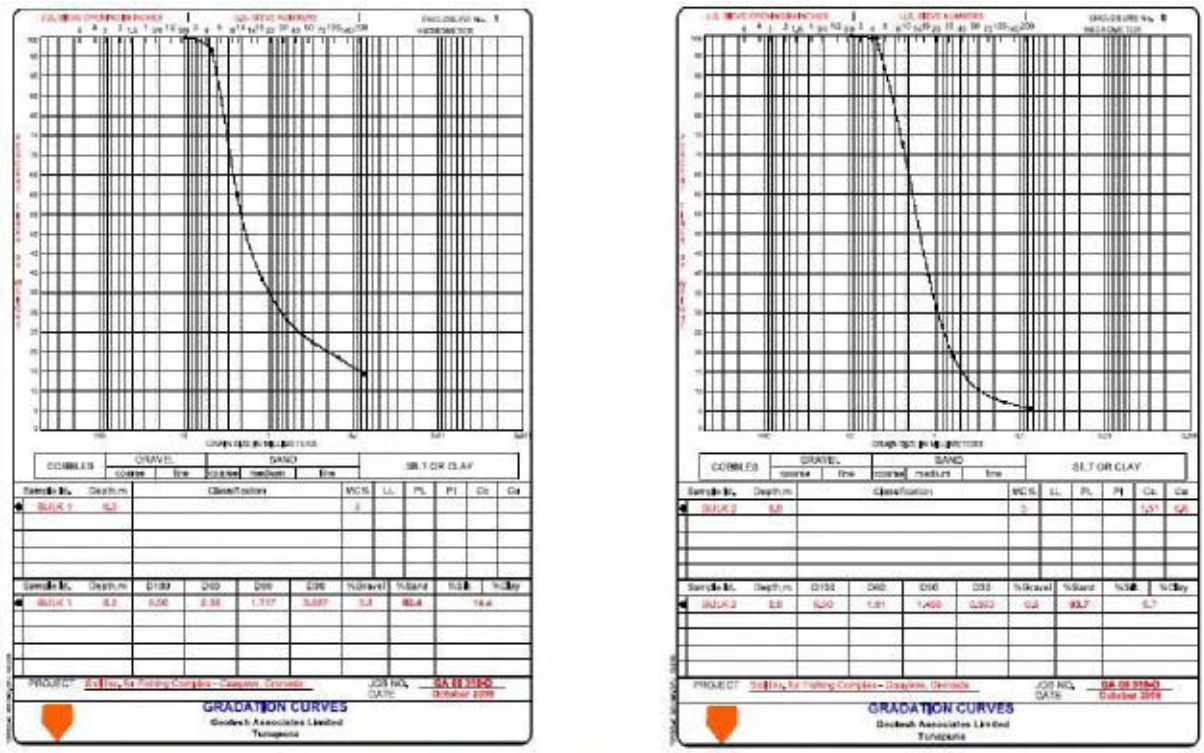
The aggregate for main material of concrete and stone materials for foundation work of structure in Grenada are collected at the following two quarries.

Telescope Quarry

Mt. Hartman Quarry

Three specific samples (sand, gravel and cobble) were retrieved and analyzed from each quarry. With the analysis, the gravity of sand in two quarries were about 2.8～3.0t/m^3.

The distribution of sand grain size of each quarry is shown in Figure 1-3(18) and a list of material test result is shown in Table 1-3(16).



Quarry (Telescope)　　Quarry (Mt. Hartman)

Figure 1-3(18)　Gradation curves of sand grain size

Table 1-3(16) List of material test result

Table 4.1 Sieve Analyses Results

ID	Source	Description	Percentage				Encl. No.
			Gravel	Sand	Silt	Clay	
Bulk 1	Mt. Hartman	3/ 8in & finer	3.3	82.4	14.4		1
Bulk 2	Telescope	3/ 8in & finer	0.6	93.7	5.7		7

Table 4.2 Direct Shear Test

ID	Source	Description	Friction Angle (•)	Encl. No.
Bulk 1	Mt. Hartman	3/ 8in & finer	42.0	2
Bulk 2	Telescope	3/ 8in & finer	43.0	8

Table 4.3 Specific Gravity of Fine Aggregate

ID	Source	Ave S.G.	Encl. No.
Bulk 1	Mt. Hartman	2.886	3
Bulk 2	Telescope	2.874	9

Table 4.4 Specific Gravity of Coarse Aggregate

ID	Source	Absorption	Ave S.G.	Encl. No.
Bulk 1	Mt. Hartman	1.632	2.947	4
Bulk 1	Mt. Hartman	1.739	2.953	5
Bulk 2	Telescope	1.899	2.876	10
Bulk 2	Telescope	1.377	2.880	11

Table 4.5 Los Angeles Abrasion Test Results

ID	Source	Percentage Wear	Encl. No.
Bulk 1	Mt. Hartman	12.0	6
Bulk 2	Telescope	18.4	12

Table 4.6 Density Test Results

ID	Source	Average Loose Density (kN/m^3)	Encl. No.
Bulk 1	Mt. Hartman (3/4")	16.62	13
Bulk 1	Mt. Hartman (3/8" and finer)	16.19	13
Bulk 2	Telescope (3/4")	17.00	14
Bulk 2	Telescope (3/8" and finer)	15.94	14

(7) Water quality survey

Table 2-2-2(17) shows the result of water quality survey (sampling location plan is shown in Figure 1-3(19)). From the result, the following can be confirmed for the drinking water and sea water.

Sea water has contained high Dis Oxygen and the number of Coliform. This is assumed from the domestic waste water (domestic waste water, enteruria and etc.) However, analysis value of extract agent of n-Hexane is small and it is expected that contamination is not proceeded by oil and grease leakages from ships or boats.

Table 1-3(17) Water quality analysis result

Analyzed item	W01		W02		W03	
Sampling date	8/27	8/27	8/27	8/27	8/27	8/27
Sampling time	9:20	11:28	9:20	11:40	9:52	11:55
Dissolved Oxygen (% saturation)	184.1	196.3	187.2	187.3	175.3	183.6
Suspended Solids (SS) (mg/l)	120	126	125	124	124	127
Coliform count (Cfu/100ml)	0	5	6	8	0	0
Extract agent of n-Hexane (mg/l)	4.89	<1.6	<1.5	1.79	<1.6	1.8
Chemical Oxygen Demand(mg/l)	110	86	89	80	105	93
Salinity (ppm)	35.2	35.3	35.2	35.4	35.3	35.6
Ph	8.17	8.165	8.17	8.17	8.17	8.17

Figure 1-3(19) Water sampling location plan

(8) Feature of littoral drift around Gouyave coast

The feature of littoral drift was studied around the Gouyave coast with the site reconnaissance. Estimating average wave direction being incident to this district judging from the beach status existed in each district of north western of Grenada Island and also from the conditions of neighboring topography and water lines, the dominant direction of long shore sediment transport, the sand supply source of littoral drift and etc. were estimated.

1) Estimation of average wave direction being incident to north western coast of Grenada

Based on the aerial photo and topographic chart, the points where sand beaches are there in north western of Grenada were picked out. As the result of actual site reconnaissance, it was confirmed that the small size sand beaches do exist at the point marked red in the Photo 1-3(1). The small size sand beach with the length of a few hundred meters to 2,000 meters is called as pocket beach and there is no specific sand supply source but there is the feature of very stable sand beach keeping right angle against incident wave direction which shoreline direction is predominant.

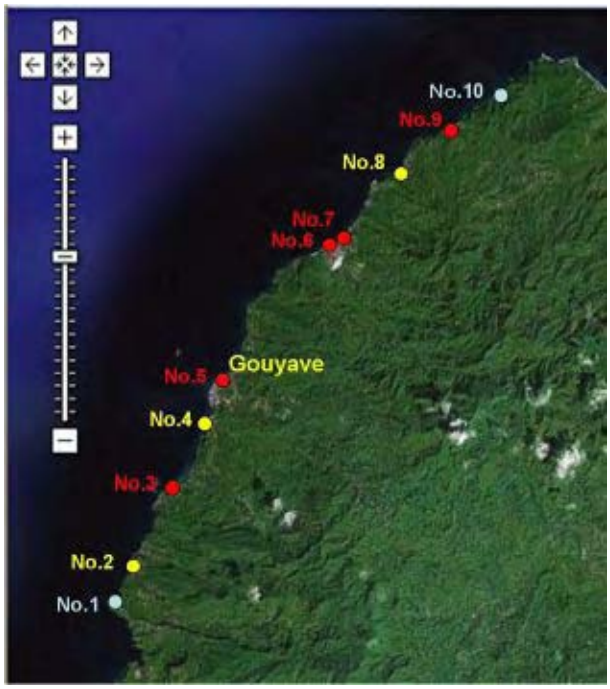


Photo 1-3(1) Satellite photo of north western coast of Grenada Island (location of pocket beaches)

While, the dotted line in Photo 1-3(2) shows shoreline direction of the existing sand beach on the aerial photo. It is understood that the shore lines of 6 sand beaches (pocket beach) are nearly parallel each other with these photos.

Right angle direction (An arrow direction shown in Photo No.3 : around N 30 degree W) to these shoreline directions can be estimated as average wave direction of incident waves around neighboring coast.

Photo 1-3(2)　Shoreline direction of pocket beach

2)　Predominant direction of littoral drift in north west of Grenada coast

The average wave direction reaching to west coast of Grenada main island is the direction shown in Photo 1-3(3) with a yellow arrow. And, as the angle with general direction of shoreline and incident wave direction is not the right angle but about 45 degree, the littoral transport directed to go southward (red color arrow shown in Photo 1-3 (3)) has been generated. That is, in north western coast, littoral drift to go southward is predominant as a whole, however it is estimated that small scale sand beaches (pocket beach) are formed by trapping sand at the places where the direction of shorelines become right angle against the direction of incident waves.

Photo 1-3(3) Average wave direction and predominant direction of long shore sediment transport in north west coast of Grenada Island

3) Sand supply source to north west coast

Photo 1-3(4) shows the location of littoral drift sources in North West coast (or possible locations of the sources). Each is explained below.

(Rivers R1 to R5)

Grenada Island is small is island having the area of about 310 km^2. Therefore, as the scales of either river length or contributory area are small, sand supply from the rivers are not necessarily big. Up to 3 largest rivers in its contributory area is defined as R5＞R4＞R3. However, all the river contributory area are small as it is shown with the scale of 1 km x 1 km.

(Cliff Slide)

There are two places where massive landslides were lead in the past. The land slide was confirmed to compare aerial photos taken in 1951 and 1992 at the point of LS1. And, the land slide was supposed to lead even after 1992 since the coastal road in this area has widely subsided and unpaved and it is the situation that vehicles except 4WD cars have to get around. The road at the point of LS2 is constructed along with coast and it is protected by rubble mound seawall. There formally was asphalt paving old road in above the level but the road shoulder was collapsed. It will be the supply source of littoral drift to coast if cliff slide is lead in coast. In case of cliff slide, the supply volume for littoral drift is not constant each year but it is supplied considerable volume once in a few years or decades.

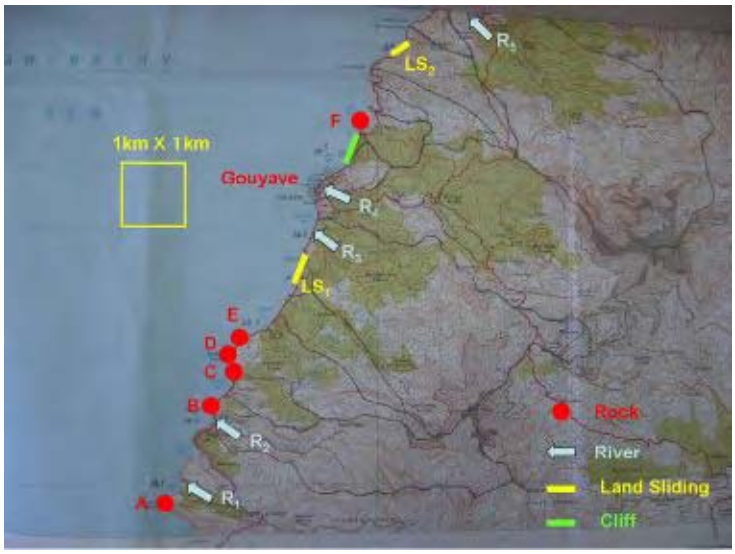


Photo 1-3(4)　Supply source of littoral drift in north west coast

(Rocks lying down at sea bottom)

There described small circles with grey color line at the point of A through F in the topographic chart of 1/25,000 and they are marked down as "Rock". It was confirmed when visited the site that rocks with the diameter of about 3 to 5 m are lying down in the area of about 3 m water depth and about 50 m offshore from the cliff. (Refer to Photo 1-3(5)).

It is considered that several cliff slides were lead in the past where rolling rocks exist (A to F). Slide mud and sand when cliff slide was lead once is piled up at front water area , thereafter the fine component like sand is transferred to south direction receiving wave actions. And, big grain diameter stone like cobble stone is gradually transferred to south direction by high wave sometimes generated at the storm. It is appropriate to consider that only big rocks were remained there as the result.

Photo 1-3(5)　Bottom situation of front water of north side coast (about 250m north from jetty)

(Crumbling Sea Cliff)

Judging from the exposed part (Photo 1-3(6)) of cliff shown with the green line in the Photo 1-3(4), it is estimated that the ground composing around these coast has been formed by .elevated sand and gravel stones including various sizes of rounded stones without squares in the sand. It looks structurally weak and it may be gradually eroded by weather. There is no sand existed in the foot of cliff although there laid down cobble stones and some big rocks. The sand falling down from cliff could be transported earlier by wave being incident at an angle. The sand supplied by cliff like this, is small in volume but it is continued consistently without stopping.

With that, collapse or corrosion of rivers and cliffs are considered to be the sources of littoral drift. Just suppose that there is the feature to continue forever without stopping although the volume is small. There is a possibility to supply mud and sand in large quantity temporarily by large scale cliff slide although it is less often.

Photo 1-3(6) Coastal situation around Gouyave (Point at about 300m north from jetty)

1-4 Environmental and Social Considerations

1-4-1 Environmental Survey

(1) Biological Survey

Visual biotic survey was conducted around project water area. And, the interview to the officer for environment in Fisheries Division was conducted about local environment conditions. The survey results are as follows.

① Terrestrial biota

Vegetation is not so many around project area since there are many houses in Gouyave district. As residential houses for fishermen are constructed on the beach in the coast hinterland, only coconut palm is planted in the spaces of houses. In south side of the cost, houses are clustered up to the shoreline and there is almost no vegetation. While, north side of the cost is the cliff and there, coconut palm, bread fruit tree, white cedar and other bushy trees are grew. And, in the vertical part of the cliff, there are many parts covered by vines. However, these vegetations are generally observed in Grenada and they are not precious species.

Concerning animals, although there live wood slave (alias name: house gecko) which is a kind of gecko and one of endangered species in Grenada, it is the animal as its name shows, to live in houses therefore, it is judged that the impact on this animal by this project is small.

② Marine biota

There live two kinds of crabs, one is white ghost crab and brown hermit crab in the coastal area and beach. Both are small size crabs with about 10 cm in length and burrow holes in the beach and usually live its inside. Both are crabs observed many in Grenada and they are not precious species.

Jacks which are small size fish are observed many in the water near Gouyave. The jack is used as food and in addition, there is the case that they are put into basket at sea after catch by beach seine and other method to be live prey for tuna long line fishing.

Large rocks which have supposed to be generated from annihilated corals are happened to be observed in the sea around Gouyave but the live corals are not observed. According to an officer in charge of environment, Fisheries Division, corals have lived in Gouyave district some time ago, but they were annihilated long time ago for some unknown reason. Like this, there observe no special precious animate beings in the sea around Gouyave.

(2) Social Considerations

Residential houses are dense in the beach of Gouyave coast. About 50 houses were confirmed only in front of center road between Little River and the existing Fisheries Center.

The most of them are considered to be houses for fishermen excepting restaurants, shops and others. And there also seen quite a simple cabin style houses. There are many houses along with coast with raised floor structure against shore erosion. The distance from the house closest to the coast to the existing coast line is about 30 m taking care of the wave runup as Figure 1-4-1(1) shows.

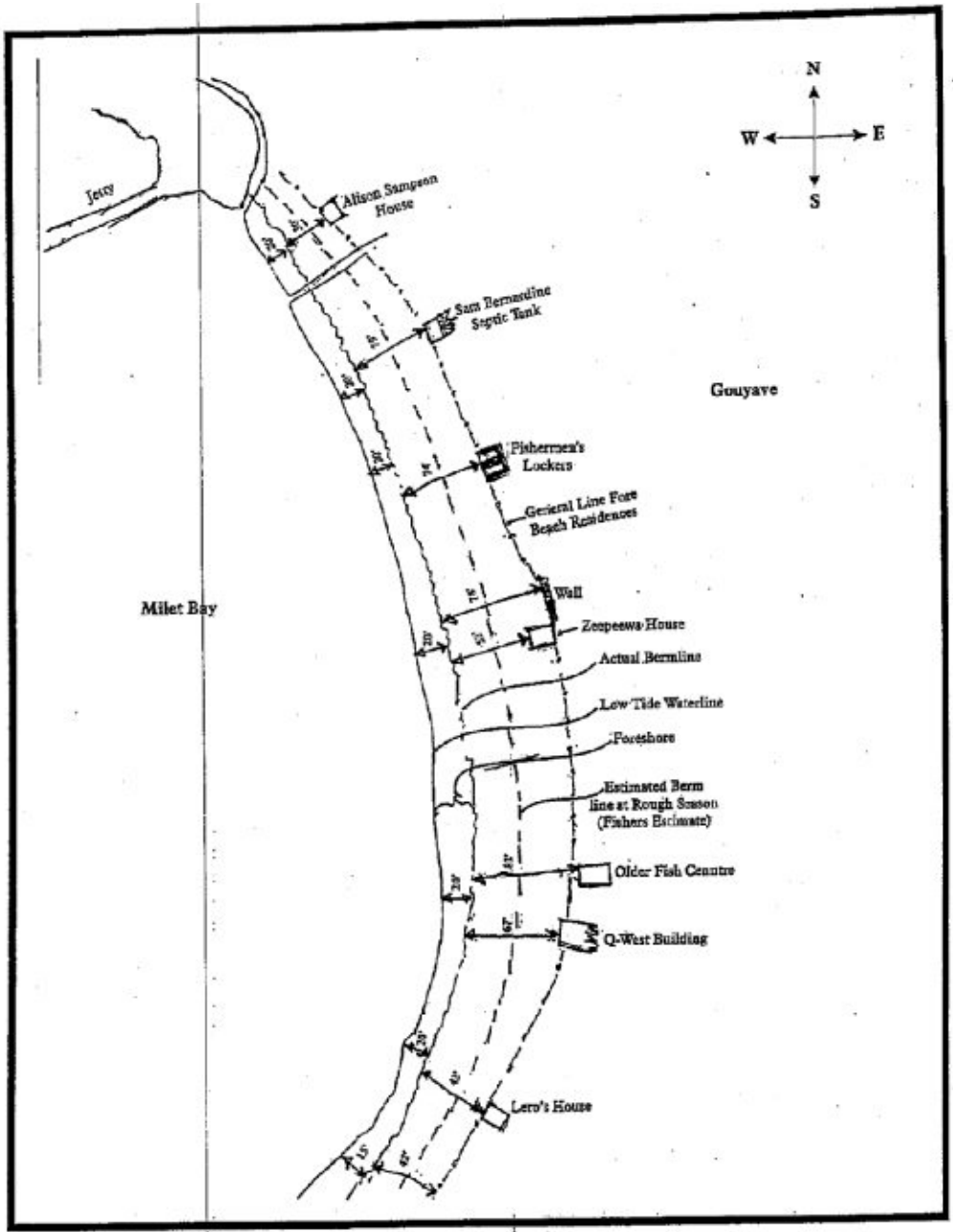


Figure 1: MEASUREMENTS OF THE BEACH WIDTH AT THE L'ANSE-NORMAL SWELLS SEASON. *(11TH SEPTEMBER, 2006)*

Figure 1-4-1(1) Relation between run up height of long period wave in L'ANSE and fishermen's facilities (EIA report of Grenada)

1-4-2 Approval procedures for environment in this project

The responsible organization for implementing development plan in Grenada is Land Development Control Authority and it is necessary to get a permit from Physical Planning unit: PPU in accordance with the regulation of Land Development (Control) Act 1968、Land Development (Control) (Amendment) Law 1983 and Physical Planning and Development Control Act 25 (2002). There are 18 classified projects which require EIA and as this project is classified as "Coastal Area Development", EIA is required. The flow from the application to getting permission in this project is shown in Figure 2-2-3(2). Fisheries Division is going to apply the permission to PPU after making the Environmental Impact Statement to be expected when this project is executed as well as planning project components, its construction schedule and so forth with the below mentioned documents. And, it was confirmed that the procedure to get the permission and approval by PPU supposed to be completed in about one month since this is the Government Project. Fisheries Division has executed IEE of this project already in 2006 employing an individual consultant and understood the significance and its contents of IEE/EIA. Grenada has already conducted EIA based on the request letter and IEE upon the preliminary study and hereafter, the development permit is to be approved based on the structural calculation sheets and detailed design drawings at the detailed design study (It shall be planed to implemented from December, 2009 to January, 2010) after completion of EIA of the development plan upon needs based on the preparatory survey report.

- Application Form
- Location Plan
- Site Plan
- Floor, Elevation and Section Plans
- Structural/Engineering Plans

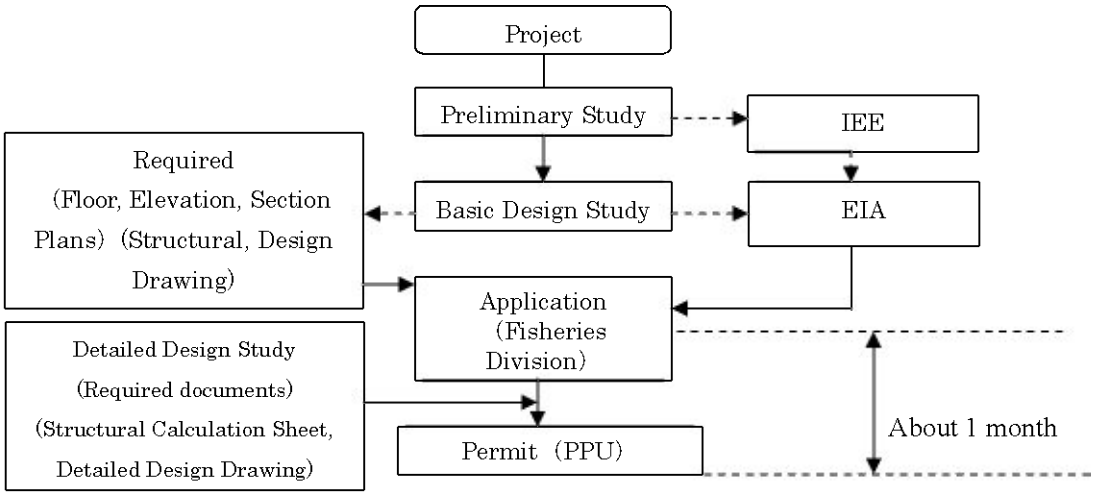


Figure 1-4-2(1) Procedure of Approval and Permission for Environment in Development Project

1-4-3 Adverse Environmental and Social Impacts

The following matters were studied as main matters of environmental impact assessment in this project.

(1) Physical impacts

①The condition of littoral drift will be changed by the construction of offshore facilities such as revetment. Present Gouyave coast is in so called dynamic stable condition which sediment budget is stable as a total coast although there exists the littoral drift. In case of dynamic stable condition, sand sedimentation is generated in upstream side and shore erosion is generated in downstream side when the littoral drift is blocked by the construction of offshore facilities.
In case of this project, the main offshore facilities are the new jetty and the revetment which have an influence on littoral drift. As the new jetty of which structure is the permeable structure by steel pipe piles, the littoral drift will not be blocked. And as the revetment is constructed being parallel to shoreline and the water depth in front edge is about 1.5m that is shallow, the possibility to block littoral drift is small and its impact is minor.

②As the jetty has the structure that waves pass through, the influence by reflected waves is considered to be almost never. While, reflected waves are generated by the construction of revetment and the situation of wave and current in surrounding sea will be changed but, the influence is minor since the reflection coefficient is small due to the sloping type revetment.
However, it is necessary to inform that fishing boats when berthing may be swayed by reflecting waves to the landing section of the new jetty although they are minor together with teaching the proper utilization method of fishing port (such as boat operation method).

③Waste water, rubbish and blood from treatment of fisheries product, drainage water like machine oil and etc. in repairing engines are generated from land facilities like Fisheries Center, Fish Market, Work Shop and so forth. In order to restrain the discharge of waste water as much as possible, in this project the proper treatment is conducted by installing septic tank therefore, the impact will be small.

④Slight impacts are expected on surrounding environment (micro topographical weather and others) and landscape by the construction of Radio Antenna Tower. However, as the scale of facility is small (the height is about 55 m) and several radio antenna facilities already constructed around there (their scales are almost the same as this time) and others, the impact by this project is considered to be almost nothing.

⑤The impact by air pollution, noise, water and soil pollution by oil and etc. vibration and so

forth are anticipated during construction. It is necessary to minimize these impacts by ingenuity of construction methods. The concrete methods are as follows.

a) Selecting construction methods and construction machinery to decrease generation of floating pollution and lower air pollution, noise and vibration.
b) Conducting monitoring survey regarding the above environmental items and always confirms the situation. Table 1-4-3(1) shows the monitoring item and its standard, monitoring place, frequency. And, as there is no concrete environmental standard in Grenada, the monitoring is conducted based on the situation before the construction. And the items which the monitoring is impossible in Grenada are to be asked to the third country organization.
c) Waste oil from boats shall collect and store in tank and the oil is incinerated after segregation of oil and water. Residual waste water flows to sea after conducting proper chemical treatment.
d) Concerning nonproliferation of floating pollution generated by offshore construction, generation, dissipation and proliferation of muddy water are minimized by installing silt curtain.

Table 1-4-3(1) Monitoring Study Plan

1. Air pollution (at the time of heavy vehicle operated, demolition and removal of existing structures, dump truck and etc. operated)

Item	Standard	Remarks
SO_2	Standard before construction	In front of houses around site, at the time of heavy vehicle under operation, demolition and removal of existing structures
NO_2	Standard before construction	In front of houses around site, at the time of heavy vehicle under operation, demolition and removal of existing structures
CO	Standard before construction	In front of houses around site, at the time of heavy vehicle under operation, demolition and removal of existing structures
O_2	Standard before construction	In front of houses around site, at the time of heavy vehicle under operation, demolition and removal of existing structures
Dust	Standard before	In front of houses around site, at the time of

	construction	heavy vehicle under operation, demolition and removal of existing structures
Floating particle	Standard before construction	In front of houses around site, at the time of heavy vehicle under operation, demolition and removal of existing structures
Powder dust	Standard before construction	In front of houses around site, at the time of heavy vehicle under operation, demolition and removal of existing structures
Note: Monitoring is conducted based on the standard before the construction work since the pollution is potential by the operation of heavy vehicles, demolition and removal of structures and the operation of dump truck and etc.		

2. Noise and vibration (at the time of heavy vehicle operated, demolition and removal of existing structures, dump truck and etc. operated)

Item	Standard	Remarks
Noise level	Standard before construction	In front of houses around site, at the time of heavy vehicle under operation, demolition and removal of existing structures
Vibration level	Standard before construction	In front of houses around site, at the time of heavy vehicle under operation, demolition and removal of existing structures
Note: Monitoring is conducted based on the standard before the construction work since the pollution is potential by the operation of heavy vehicles, demolition and removal of structures and the operation of dump truck and etc. And, Project site is the mixed place of housing and commercial area.		

3. Water and Soil (by works of reclamation, jetty construction and revetment construction)

Item(unit)	Standard	Remarks
Dissolved oxygen(%, saturation)	Standard before construction	monthly monitoring during construction work at offshore of jetty construction site and land construction site
Suspended substance (SS) (mg/l)	Standard before construction	monthly monitoring during construction work at offshore of jetty construction site and land construction site

Coliform count (Cfu/100ml)	Standard before construction	monthly monitoring during construction work at offshore of jetty construction site and land construction site
n- hexane soluble matter(mg/l)	Standard before construction	monthly monitoring during construction work at offshore of jetty construction site and land construction site
Biochemical oxygen demand (mg/l)	Standard before construction	monthly monitoring during construction work at offshore of jetty construction site and land construction site
Salinity concentration (ppm)	Standard before construction	monthly monitoring during construction work at offshore of jetty construction site and land construction site
PH	Standard before construction	monthly monitoring during construction work at offshore of jetty construction site and land construction site
Note: Monitoring is conducted based on the standard before construction since the water quality and soil pollution are potential by the works of reclamation, jetty construction and revetment construction.		

(2) Impacts on biological environment

①Marine and land facilities are constructed by this project. On land, the area with the length of about 60m with the water depth of 1.0 m where are located in front of the existing fisheries center are reclaimed and it will be for the New Fisheries Center, work shop, septic tank and fuel supply facility. Vegetation is grown on the cliff of hinterland however, these are quite popular vegetation in Grenada and as these will not be cut down, the direct impact to vegetation is considered to be nil. Concerning land-dwelling creatures, although there live wood slaves (alias name: house gecko) which is one of endangered species in Grenada and a kind of gecko, it is the animal to live in houses therefore, it is judged that the impact on this animal by this project is small. Other animates than this animal are commonly seen in Grenada and the impact is considered to be small.

About 60 m length of sea shore will be vanished by the reclamation and construction of groin in the marine area. This marine area is not living area for the rare spices and the vanishing area is only about 20% of total Gouyave coast and the impact concerning vanish of sea shore is supposed to be quite limited and small. While, it is anticipated that wave current and geological formation will be a little bit changed by the construction of marine structures (jetty and

revetment) in surrounding marine area and the biological habitant may be influenced. However, the jetty is permeable structure and there is small given impact on wave and current and therefore, it will be considered that almost no impact is expected on the loss of sea shore by topographic change. And as the revetment will have 1.5m water depth at maximum, there will be small impact by reflected wave and current from revetment and topographic change is small and the impact on biological habitant environment is considered to be relatively small.
As above, it is judged that the impact to habitant environment by this project is small.

② Discharged water like waste water is generated from land facilities constructed this time. Sea water, ground water, soil and others are polluted and it is also anticipated the impact on animate beings and their habitat environment if proper treatment is not conducted. According to the result of water quality survey of the project site, the analysis value of oil content (n-hexane extracts) 4.89 as maximum value that is small and it is assumed that pollution by oil leakage from boats is not proceeded however the numerical values of dissolved oxygen(175.3%-196.3%) and coliform bacillus (5-8 Cfu/100 ml) are high. This is supposed to be the influence from discharge of untreated effluent of partial domestic waste water (human sewage and enteruria and etc.) near the project site. It is possible to minimize this impact by proper treatment like installation of septic tank.

(3) Impacts on Social Environment

①The length of beach in front of project site is about 380m. Residential houses are there in the beach. About 50 houses were confirmed in front of center road between Little River and the existing Fisheries Center. The most of them are the houses for fishermen. And, for the resident who lives Gouyave district where has a little flat area, the coast and beach are the good heeling place for them. And, beach seining is done at the south side (about 300m) of existing jetty out of beach. It is considered that the topographic change like vanishing beach width will not be generated since marine structures in this project is permeable structure and the installed water depth is shallow. At this moment, the distance from the house closest to sea to shoreline is about 30m and it is considered that there will be almost no impact to residential area by the construction of marine structures. Some impact on beach seining by the construction of jetty and revetment are anticipated. However, the location difference between the new jetty and the existing one is about maximum 30m and the impact to south side beach (300 m) where the main area for seining is done is considered to be small.

②The improvement of fishing port facilities and the centralization of fishing port facilities, Fisheries Center and Fish Market are expected to increase the fishing boat, fishermen and fish related persons. And the treatment and buying and selling of caught fishes under the sanitary

and clean environment become possible and the working environment for fishermen and the related industry workers are improved. It is expected the promotion of quality and increase of volume of handling caught fishes by the enhancement of cold, chilled and ice making facilities. And this possibly makes fisheries industry further develop and create new employment opportunity.
While, going with this, surrounding traffic will be increased and car parking in the facilities area, roads and other places will be congested. Therefore, there will be the possibilities of increase of waste, expansion of polluted area and other and also the traffic accident may be increased. The countermeasures for the treatment of waste and the traffic control are necessary.

③Although the fisheries activities will be vitalized by improving fishing port facilities, there will be fishermen who dissatisfy for not receiving profit without proper setting of the rules and regulations on facilities use. It is necessary to establish proper rules on use so as to receive equal profit for all fishermen and disclose, explain and follow it.

④ The jetty and the existing fisheries center will not be used during construction period.
Concerning landing of fisheries products, it is possible to pull up to beach by human power if it is a small fishing boat but even its landing cannot be possible when the beach may be used as a construction area or middle size fishing boat is necessary to use other landing place(Melville Street). And, at the time of building expansion of fisheries center, the ice making machine and refrigerator of the existing fisheries center cannot be used. Therefore, the other place (Melville Street) is used for the ice supply and cold storage of fisheries products to be necessary for fishing boat operation and the treatment of fisheries products. While, the existing fish market is remain to be used for the treatment, sales or etc of fisheries products.

⑤ It is anticipated the impact from the increase of traffic and traffic accident by the transportation of material and equipment and the traveling of labors during construction. These impacts are necessary to be minimized by better construction method and the method of material procurement. And, in order to prevent construction disasters during construction, there will install fence and etc. to define construction area

Sorting out these, Table 1-4-3(2) shows the environmental impact items by the project and its extent. While the content of impact and the mitigation in each item to be influenced is shown in Table 1-4-3(3). Table 1-4-3(4) shows a checking list of environment.

Table 1-4-3(2) Study Result of Environmental Impacts Assessment

Main environmental impact factor	Environmental Impact	Impact extent + :Preferable impact			Mitigations
		C	B	A	
1. Impact by construction of jetty and revetment					
Blockage of littoral drift	Shore line change (advance, retreat)	○			Dredging, removal of sand and soil
Generation of reflection wave	Increase of wave height	○			Study for scale and impact area and its presentation and training of boat operation
Decrease of coastal area	Decrease of biological cultivation	○			
Decrease of coastal area	Fishing ground of beach seining is decreased ,	○			Supply of alternative relaxation place (Project site is already acquired)
	Land for housing and relaxation place are decreased	○			
2. Impact by construction of land facilities					
Discharge of waste water	Pollution of sea water and land		○		Installation of septic tank
Improvement of fisheries distribution environment	Vitalization of fisheries industry			○+	
	Health & sanitation			○+	
	Congestion of facilities & traffic		○		Presentation of traffic control
	Increase of waste		○		Presentation of water treatment
	Conflict of interest	○			Establishment of rules on use and its presentation
	Generation of malodor	○			
Involuntary Resettlement	Resident displacement	○			Completion of Land expropriation and assurance
Construction of facilities	Land subsidence	○			
	Landscape	○			Design study
3. Impact by construction of radio facility					
Construction of steel tower	Impact on climate and landscape	○			
4. Impact by construction					
Operation of boats and	Noise & vibration, Air	○			Study for construction method

machinery	pollution				and machinery
	Change of marine ecosystem	○			
	Malodor	○			
Roiling bottom soil by marine works	Sea water pollution by suspended substance		○		Utilization of silt fence
	Decrease of marine biology	○			Utilization of silt fence
	Pollution to marine resources	○			
Increase of working boats	Degradation in value of fisheries ground area	○			
Waste disposal by construction works	Deterioration of environment	○			Presentation of discharge after treatment of waste
Impact by marine construction works	Sea water pollution	○			Treatment of oil waste
	Decrease of living environment for marine biology	○			
Impact by removal of existing facilities during construction period	Construction of jetty		○		Utilization of other facility Utilization of beach
	Construction of fisheries center		○		Utilization of other facility
5. Impact on heritage and traditional culture					
Facility construction & implementation	Impact on heritage and others	○			There is no heritage around.

Impact extent A : large impact, B: medium impact, C: small impact

Table 1-4-3(3) Mitigation of Environmental Impact at each phase

Items	Mark	Impact	Mitigation
Natural Environment			
Littoral drift	C	Littoral drift condition will be slightly changed by construction of revetment	In Planning Rubble mound revetment type and parallel to shoreline in order not to disturb littoral drift
Reflection wave	C	Water area to slightly enlarge wave height by reflection wave from revetment is generated.	In Planning Reflection wave will be decreased by adopting rubble stones and gentle slope revetment. In Operation Estimation of scale of reflection wave and influenced area and demonstration to fishermen for berthing location and operation method when berthing.
Topography	C	Slight shoreline retreat is generated and impacts on residential area of fishermen	In Planning The normal line of revetment is planned being parallel to shoreline and avoid stoppage of longshore sediment transport .
Pollution			
Air	C	Air pollution by diffusion of pollutant during construction.	In Construction Studying construction method and machinery to minimize generation of pollutant.
Water	B	Water pollution by discharging of waste water and diffusion of pollutant during construction.	In Planning Polluted water generated from the New Fisheries Center is discharged after purifying below 20mg/l with septic tank. In Construction Studying construction method and machinery to minimize generation of pollutant. Silt fence is used at the time of sea bottom drilling, reclamation and piling pipes and complete treatment waste oil from boats.
Soil	B	Soil pollution by discharging waste water and diffusion of pollutant during construction.	In Planning Soil pollution is not generated since clear upper portion of discharged water treated at the septic tank is discharged into the sea. In Construction Studying construction method and machinery to minimize generation of pollutant.
Noise, Vibration	C	Generation of noise and vibration by construction machinery, working boats during construction.	In Construction Using construction method and machinery to minimize noise and vibration.
Social Environment			
Traffic congestion	B	Traffic is congested and traffic accident is increased by increase of construction vehicles and improvement	In Construction Arranging traffic controller for construction vehicles, Separation of construction site by installation of fence . And, arrangement

		of fisheries facilities due to vitalization of fisheries activities.	plan of construction vehicles considering rush hours is to be planned and executed. In Operation In order to mitigate the congestion by the increase of vehicles entering into the New Fisheries Center, traffic regulations or control are necessary to be firmly ordered.
Decrease of land space	C	Land space as fishing ground for beach seining and relaxation are decreased by construction of facilities.	In Operation To make fishermen agree to relocate setting place for beach seining. As a part of beach will be gone by the reclamation work, it is necessary to make resident understand the change of beach utilization place.
Removal of existing facility during construction period	B	The existing facilities can not be used.	In Construction Large size fishing boats use the other facilities like Grand Mal. Small fishing boats utilize beach for the landing.
Conflict of interest	C	It could lead to a conflict of interest among fishermen for utilization of facilities.	In operation The landing activities are done mixed with large size fishing boats and small one. The confusion is avoided with the proper correspondence to provide berthing place for each calling boat.

Table 1-4-3(4) Check List ofr Environmental

Group	Impact item	Main checking items	Confirmation result of environmental consideration
1 Permit approval	(1)EIA and approval for environment	① EIA report was made ② EIA report was approved by the Government of recipient country ③ EIA report was approved without any condition Or if any these conditions are met ④ Other than the above approval and license were already taken out from local government offices or agents when necessary	(1) EIA report is going to be made based on the preparatory study report (2) EIS finishing of preparatory study result has been already made
	(2)Explanation to community resident	① Concerning the contents and its impact the proper explanation to community resident is done including the disclosure of information and get their consents ② Proper responses for the comments from community residents and presiding offices are done	(1)The contents of community resident was changed at the stakeholders meeting held in site study stage of preparatory study. (2) Hearing of opinion from community resident and relevant agents at the time of site study of preparatory study and the explanation of draft report were conducted and incorporated to the plan
2 Pollution measure	(1)Water quality	① Anti-pollution in the vicinity water area by the discharged water from fisheries aquaculture pond or others can be considered Concerning feeding stuff chemicals antibiotic and etc proper usage standard can be stipulated and the system to keep everyone informed about it can be taken ② Discharging water from aquaculture pond process facilities fishing boats and etc and the water quality in the vicinity water can be met with the standard of waste water quality and environment standard in the country	(1)Discharging water from the fisheries center shall be the maximum pollution source and the discharging water with BOD 300mg/l is generated in the plan. The discharging water is treated through a septic tank and discharging BOD density will be 20mg/l and the water pollution will not be possible
	(2)Waste	① Waste can be properly treated and disposed in accordance with the country's standards (Especially process facilities)	(1) Residuum of fisheries products is considered to be the waste. These are to be stored at refrigerator waiting for the collection by waste disposer and the waste is to be treated properly in disposal field.
	(3)Noise and vibration	① Noise and vibration can be met with the country s standards (Especially process facilities)	(1)Although processing work at the New Fisheries Center is done, it is low-intensity processing without making noise.
	(4)Offensive odor	① There are offensive odor sources Measures to remove offensive odor can be taken (Especially process facilities)	(1)There is no offensive odor source.
3 Natural environment	(1)Sanctuary	① Project site is in the sanctuary where is restricted by the country s laws global treaties or others Project does not impact to the sanctuary	(1)There is no sanctuary or others in the project site.
	(2)Ecosystem	① Project site does include primary forest tropical natural forest and ecologically important habitat (coral reef mangrove coast tidal land and etc) ② Project site does include the habitat for precious spices which are necessary to be protected in the country's laws global treaties or others ③ In case that siginificant impact is considered the countermeausures to reduce the impact can be done ④ There is some adverse effect on aquatic organism In case of some there must be the mitigations ⑤ There is some adverse effect on vegitation and wild animal In case of some there must be the mitigations ⑥ There is some excessive catch of aquatic organism or fishes The fishing method is less impact one The fishing gears are left and impcat on ecosystem ⑦ There are a nutrient enrichment in the water area with feeding stuff for fishery aquaculture and a generation of red tides Mitigation for nutrient enrichment can be considered ⑧ Ecosystem is destroied by importation of foreign species(was not made their habitat in the past) pest infestation and etc The mitigation is prepared	(1)The project site is located at urban area and there is no ecologically important habitat. (2) Although endangered animal species are existed, it is expected to have no impact by this project. (3) There will be no serious impact to ecosystem. (4) There will be no fear of adverse effect on aquatic organisms. (5) There will be no fear of adverse effect on vegitation and wild animals. (6) There will be no excessive catch of aquatic organism or fishes. The fishing method at project site is the one having less impact on ecosystem and fishing gears will not be left and impact on ecosystem. (7) Fishery aquaculture will not be done at the project site. (8) There will be no importation of foreign species, pest infestation and etc.
	(3)Water environment	① There are adverse effects on the streams of surface water and groundwater according to the change of water system by installing inland and coastal aquaculture ponds and etc	(1)Although longshore current is ruled along with coast, the jetty is permeant with pipe-piles structure and as it does not block off littoral drift, there will be no shoreline change nor current direction change.
	(4)Topography and Geographical features	① Large scale change of topography and soil structure ground settlement and natural coast erosion around project site are generated with the coastal land filling	(1)About 100m land filling along with coast line in the coast but the scale will be small with 900 m^2 and the impacts to topography and soil are minor.
4 Social environment	(1)Involuntary resettlement	① Involuntary resettlement is required by the implementation of the project If so, the effort to minimize the impact is required ② Before the resettlement, the proper explanation on the resettlement and the compensation is required to the residents for resettlement ③ Resettlement plan has to be established including the repair of the local infrastructure after resettlement, right compensation with the study of resettlement ④ The plan is considered properly to socially vulnerable especially women children old persons poverty group minorities and aborigines and etc ⑤ The consent from resettlement people before the resettlement is taken ⑥ The framework to execute the resettlement properly can be made Sufficient implementation capability and budgetary step are taken ⑦ Monitoring on resettlement impact is planned	(1)Resettlement of 4 families will be required however they have already agreed on the resettlement and new address and the compensation have been agreed upon.
4 Social environment	(2)Livelihood	① There are some adverse impact to the livelihood of residents by the project Measures to mitigate the impacts is considered when necessary ② The rights concerning utilization of water area (fisheries rights and others) are properly allocated ③ Diseases caused of water or concerned with water (angiostrongyliasis malaria onchocercosis and etc) are taken Proper consideration to public health is conducted upon needs	(1) There is no adverse impact to community resident by the project.
	(3)Cultural heritage	①Archeological historically culturally and religiously precious heritage historic place and others are damaged by the project And the measures regulated by the laws of the country is considered	(1)There are no archeologically, historically, culturally and religiously precious heritage, historic places in the project site.
	(4)Landscape	① There are some adverse impacts which should be specially considered to landscape Necessary mitigation is taken	(1)There exist no landscape to be especially considered.
5 Others	(1)Impact during construction	① The mitigations against pollution during construction (noise vibration turbidity dust exhaust waste and etc) are prepared ② There are some adverse impacts to natural environment (eco-system) by the construction And the mitigations to the impact are prepared ③ There are some adverse impacts to social environment by the construction And the mitigations to the impact are prepared ④ Safety training (traffic safety public health and others) to project related people like labors is executed upon needs	(1)Pollution during construction (air, water quality, soil, noise and vibration) will be generated but the impacts will be mitigated by using construction machines to minimize the generation of polluted materials, adopting silt fence and through control of oil waste from ships. (2)Vehicles for construction and others will be increased but the impact will be mitigated by allocation of traffic controller, installation of fence and etc. (3)Safety training (traffic safety, public health, safety work and etc.) for the project related people shall be described in the technical specification at the detailed design in order to mitigate the impacts during construction.
	(2)Monitoring	① Monitoring is planned and conducted by the Client on the items that the impacts is considered out of the above written environment items ② Items methods frequency and etc of relesant plan are judged as proper one ③ Monitoring system of the Client (organization personnel equipment budget and etc) is established ④ The method frequency and etc of report from the Client to governing agencies are specified	(1)Monitoring during construction is to be conducted by the Contractor and supervised by the Consultant. (2)There is no monitoring plan after completion of construction.
6 Notes	Other environmental check list	① Process and storage facility are required to be evaluated adding relevant check items in the check list of general industry when necessary ② It is also required to evaluate adding check items in the check list of port and harbor if necessary (in case that port facilities are constructed at the same time)	(1)Not applicable
	Note on how to use environmental check list	①The impacts to environmental issues of cross boarder or global magnitude are confirmed if necessary (in case that the elements concerning cross boarder treatment of waste acid precipitation ozone depletion and climate change are considered)	(1)Not applicable