The major duties of these personnel is as follows:

(1) Executive manager: In addition to managing GCFL, the executive manager will take part in policy meetings and confirmation of policy with the Ministry of Agriculture, Ministry of Finance and the board of directors. Another important job is to conduct fishing promotion education activities at schools, and commercial fishing promotion activities at fishing villages.

(2) Plant manager: The plant manager supervises and manages the series of processes at the facilities, including landing, processing, packing and exporting. The selection of fish is an especially important job for the plant manager. The plant manager is also involved in negotiating with purchasers and developing new sales routes along with exective manager.

(3) Chief engineer: The chief engineer is in charge of the maintenance and control of ice making facilities, cold storage and other equipment at the project site, Gouyave, and Grenville. When fishermen repair fishing equipment and their fishing vessels, the chief engineer gives instruction and advices.

(4) Accountant: The accountant is in charge of the accounting work involved in the purchasing, sales and export of fish. The accountant also manages the sales of ice and other daily accounting work to make sure that it is conducted smoothly.

(5) Laborers/drivers/sales clark: Full time workers divide a wide range of work among them, including the landing of fish, measuring the temperatures, separating fish, weighing, cleaning, processing, transporting and other necessary work.

Note: The Calliste fish box making plant will be operated by Grand Mal workers as required.

3-3-6 Management plan

(1) Management policy

In order to promote commercial fishing, GCFL, which operates on a for profit basis, which will be in charge of buying and selling the target fish. Therefore, it will generate operating funds, salaries for (established and unestablished) workers, and other expenditure. In addition, in order to depreciate ice making machines and other machinery with relatively short service lives and maintain a business posture over a long period, an appropriate profit is necessary.

Because the production costs of fish and their sales prices must be maintained at a suitable level based on the fluctuations of the market prices of marine products, it is true that setting a margin of profits is very difficult. Therefore, efficient and rational management which holds down the management costs of the facilities as much as possible is necessary. Specifically, the following must be done: increase the sales volume of tuna for export which has a high profit ratio, in addition to fish for export, fish for domestic sales must be purchased in order to increase the willingness of fishermen to work, work efficiency must be increased and the freshness of the fish purchased must be maintained, expenses must be reduced by controlling operating times of equipment according to the quantity of catches and stored fish, accounting documents such as purchase vouchers and payment vouchers must be recorded in detail, so that there are no missing expenses, efforts must be made to sell ice and educate about maintaining freshness, new customers must be developed, etc.

(2) Income and expenditures

GCFL will manage and operate the project facility upon completion. The Gouyave and Grenville Fishermen's Centers are currently under the control of GCFL, therefore, the project facility will be the base for collection of the fish handled in both Fishermen's Centers. It is therefore necessary to study the balance, including both Fishermen's Centers, in order to study the operation plan for the project facility.

When the management expenses for the new fishing-related facilities and existing Fishermen's Centers are calculated, they are as follows:

Unit: EC$

Business income and expenditures	1) Fish sales business	[A]	Fish sales		3,697,505
			Ice sales		143,000
			Subtotal		3,794,855
		[B]	Expenditure :	Fish purchase expenses	2,303,510
				Business expenses	900,451
			Subtotal		3,203,961
			Income and expenditure		590,894
	2) Interest payments				0
	3) Depreciation				451,090
	4) Business losses : Above 1) + 2) - 3) =				139,804

After interest is paid, 5) Interest for the current outstanding debt of EC $275,000 is :

(If interest is paid at an annual interest rate of 14 percent)		38,500
Profit	4) - 5) =	101,304

The details of the above business income and expenditures are as follows :

[A] Income

1 US$ = EC$2.68

Units : EC dollars (September 1993)

	Item	Amount	Percentage
[1]	Export fish sales amount	2,823,005	(74.4)
[2]	Domestic fish sales amount	828,850	(21.8)
[3]	Ice sales amount	143,000	(3.8)
	Income total	3,794,855	

[1] Export fish sales amount : Calculated from estimated purchases of 221 tons/year, 95 percent yield, and export quantity of 210 tons/year for 1996.

	Percentage	Export quantity (tons/year)	Units : US$/Pound	Pound → Ton conversion rate	Amount (EC$)
Grade I	20	42.0	2.40	2200	594,317
Grade II	80	168.0	2.25	2200	2,228,688
Subtotal					2,823,005

[2] Domestic fish sales amount : Calculated from estimated purchases of 105 tons/year, 95 percent yield, and export quantity of 99.8 tons/year for 1996.

	Percentage	Sales quantity (tons/year)	Units : US$/Pound	Pound → Ton conversion rate	Amount (EC$)
Grade A	10	10.0	4.00	2200	88,000
Grade B	90	89.8	3.75	2200	740,850
Subtotal					828,850

[3] Ice sales amount

	Export quantity (tons/year)	Units : US$/Pound	Pound → Ton conversion rate	Amount (EC$)
Grand Mal	290	0.10	2200	63,800
Gouyave	250	0.10	2200	55,000
Grenville	110	0.10	2200	24,200
Subtotal				143,000

[B] Expenditures

	Item	Amount	Percentage
[1]	Export fish sales amount	1,726,010	(53,9)
[2]	Domestic fish sales amount	577,500	(18.0)
[3]	Electricity charges	286,066	(8.9)
[4]	Water charges	24,715	(0.8)
[5]	Vehicle fuel expenses	16,170	(0.5)
[6]	Personnel cost	322,000	(10.0)
[7]	Boxes for export and packing materials	176,500	(5.5)
[8]	Maintenance cost for equipment & machinery	75,000	(2.4)
	Total expenditures	3,203,961 EC$	

[1] Export fish purchases : Projected purchase quantity in 1996, 221 tons/year

	Percentage	Export quantity (tons/year)	Units : US$/Pound	Pound → kg conversion rate	Amount (EC$)
Grade I	20	44.2	3.75	2200	364,650
Grade II	80	176.8	3.50	2200	1,361,360
Subtotal					1,726,010

[2] Domestic fish purchases : Projected purchase quantity in 1996,105 tons/year.

	Export quantity (tons/year)	Units : US$/Pound	Pound → kg conversion rate	Amount (EC$)
Grade III	105.0	2.50	2200	577,500

[3] Electricity charges : (The operating days for various machinery indicate the total of the actual operating times of motors. In reality, cold storage, chilled storage, the blast freezer, and ice making machines are run semi-automatically, so that starting/stopping is repeated.)

1. Grand Mal			Output (KW)	Load rate (%)	Operating hours/day	Operating days/year	Electricity use (KWh)/year
[A]	Chilled storage	No. 1	5.0	70	16	365.0	20,440
		No. 2	5.0	70	16	135.0	7,560
[B]	Cold storage	No. 1	10.0	70	16	365.0	40,880
		No. 2	10.0	70	16	120.0	13,440
[C]	Blast freezer		20.0	80	20	158.0	50,560
[D]	Ice making machine	No. 1	30.0	80	24	186.0	107,136
		No. 2	30.0	80	24	57.0	32,832
[E]	Offices, etc.		20.0	80	12	260.0	49,920
	Total		130.0				322,768

2. Gouyave				Output (KW)	Load rate (%)	Operating hours/day	Operating days/year	Electricity use (KWh)/year
[F]	Ice making machine	No. 1 No. 2	P B					
		Subtotal		7.5	80	24	561.0	80,784
[G]	Cold storage	No. 1		7.5	70	16	365.0	30,660
		No. 2		7.5	70	16	120.0	10,820
[H]	Offices, etc.			2.0	80	12	260.0	4,992
	Total			39.5				126,516

3. Grenville				Output (KW)	Load rate (%)	Operating hours/day	Operating days/year	Electricity use (KWh)/year
[F]	Ice making machine	No. 1 No. 2	P B					
		Subtotal		7.5	80	24	184.0	26,496
[G]	Cold storage	No. 1		7.5	70	16	365.0	30,660
		No. 2		7.5	70	16	90.0	7,560
[H]	Offices, etc.			2.0	80	12	260.0	4,992
	Total			39.5				69,708

Electricity use (yearly) = (1) + (2) + (3) + 518,992 KWh

Unit price : EC$0.55 per 1 KWh

Basic charge : EC$2.0 per HP x 310 total HP

(Electricity capacity at each facility : Grand Mal = 200 HP, Gouyave = 55 HP, Grenville = 55 HP)

(1)	Electricity charges =	518,992 KWh x 0.55 =	285,446
(2)	Basic charge =	Total output 310 HP x 2.0 =	620
	Total		286,066

The details of operating hours and operating days for the cold storage, chilled storage and ice making machines at each facility are indicated below.

[A] Grand Mal : Chilled storage

When the quantity of fresh fish for export handled by the GCFL is calculated based on the results from 1992, the figures for each month are as shown in Table 3-10:

Table 3-10 Volume of chilled storage

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	
Quantity handled / month (tons)	8	23	40	53	34	0	0	-	-	38	11	4	Total days annual operation
Maximum stored quantity	1.1	3.1	4.0	5.3	3.4	0.1	0.2	0	0	5.2	1.5	0.5	
Chilled storage No. 1	■■	■■	■■	■■	■■	■■	■■	■■	■■	■■	■■	■■	365 days
Chilled storage No. 2		■	■■	■■	■■					■■			135 days

Note : Monthly volume is calculated for 30 days per month during the peak season (Mar. to May) and for 22 days per month during other months.

Each chilled storage room has a capacity of 2.9 tons. If the handled quantity for each month is handled in 22 days and if a maximum storage period of three days is secured, then for 4.5 months of the year operation of two chilled storage rooms will be necessary as the black squares in the table above in the operating conditions indicate.

■ Indicates operation for half a month (15 days) at an operation rate of 16 hours (16/24) per day.

[B] Grand Mal : Cold storage

When the quantity of frozen fish which is handled and the inventory at the end of each month for 1996 are calculated based on the results from 1992, the figures for each month are as shown in Table 3-11:

Table 3-11 Volume of frozen fish in cold storage

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	
Quantity handled / month (tons)	15	10	14	36	4	1	0	0	2	16	5	2	Total days annual operation
Maximum stored quantity	5	6	9	37	32	26	17	8	2	14	10	5	
Cold storage No. 1	■■	■■	■■	■■	■■	■■	■■	■■	■■	■■	■■	■■	365 days
Cold storage No. 2				■■	■■	■■	■■						120 days

Note : Monthly volume is calculated for 30 days per month during the peak season (Mar. to May) and for 22 days per month during other months.

The capacity of one cold storage room is 15 tons. It is estimated that the inventory of frozen fish will exceed 15 tons and will require the operation of two rooms in the four months indicated above. When the stock at the end of a month exceeds 30 tons cold storage at Gouyave and Grenville is used.

■ Indicates operation for half a month (15 days) at an operation rate of 16 hours (16/24) per day.

[C] Grand Mal : Blast freezer

From the above estimates, frozen fish will be placed in storage at a rate of about 26 tons/month in April; this comes to about one ton of freezing capability per day (with 20 hours of freezing). The quantity to be frozen in a year is 105 tons, with freezing work concentrating on the months of February to May. The quantity of fish which will be placed in storage is not always equal to the peak freezing capacity of one ton, however. Therefore, the criteria for calculation of the operating ratio will be 1.5 times the annual freezing quantity (105 x 1.5 = 158), so that the number of operating days per year will be set at 158 days.

[D] Grand Mal : Ice making machine

The demand for ice at Grand Mal is projected to be the following ratio for each weight unit of fresh fish for export.

Items	Ratio
1. Sales to fishing ships going out.	: 0.4
2. Fresh fish being landed and gathered.	: 1.5
3. In cold storage rooms (for cooling).	: 1.0
4. For shipping and packaging.	: 1.0
5. For general distribution and general customers in the surrounding area and capital district.	: 1.0
	$4.9 \approx 5$

If the quantity of fresh fish for export handled each month in [A] above is used with these ratios to calculate the demand for ice, the calculations will be as follows :

Table 3-12 Forecasted volume of fresh fish for export by month (1996)

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	
Tons of fresh fish per month	8	23	40	53	34	0	0	–	–	38	11	4	
Daily average (22 days)* - Tons	0.4	1.0	1.3	1.8	1.1	0.04	0.06	–	–	1.7	0.5	0.2	Total days annual operation
Max. stored quantity/day	2.0	5.0	6.5	9.0	5.5	0.2	0.3	–	–	8.5	2.5	1.0	
Ice-making mach. No. 1 (days)	12	30	30	30	30	1	2	–	–	30	15	6	186 days
Ice-making mach. No. 2 (days)			9	24	3			–		21			57 days

Note : Monthly volume is calculated for 30 days per month during the peak season (Mar. to May) and for 22 days per month during other months.

Table 3-12 shows that the simultaneous operation of two ice making machines is necessary for the months of March, April, May, and October (an average of four months a year). The total annual operating time of these two units is estimated to be at least 243 days a year (at 24 hours/day).

Electric power consumption is calculated on the basis of this estimate.

Note : Grand Mal handles 210 tons of fresh fish for export per year, and the demand for ice is about five times that or 1,050 tons.

The capacity of ice making machines is rated at 5 tons/day (24 hours). If this figure is used for a simplified calculation, then:

5 tons/day x 243 days = 1,215 tons of ice produced.

Ice sales = 210 x 1.4 ≈ 290 tons/year

[F] Gouyave : Ice-making machines

From Table 3-4, the quantity of fish landed in Gouyave and the projected GCFL purchases in 1996 will be: ① total landing quantity 613 tons, ② fish for export 125 tons, ③ domestic market fish 40 tons, for a total of 165 tons. The demand for ice will be from ④ sales to fishing vessels when they are going out, and ⑤ for storage before shipment to Grand Mal and for cooling during shipment. The ratio of each of these is set at 1, and the effective sales ratio is set at 70 percent for calculations. In addition, ⑥ the demand for ice for fish for the general market will be set at 20 percent for calculations.

Annual demand = (165 x 2) ÷ 0.7 + (613 - 165) x 0.2 = 471 + 90 = 561 tons/year

The ice making machines at Gouyave are one 2 tons/day (plate ice) unit and one 1 ton/day (block unit). Each of these units requires 7.5 kWh x 24 hours = 180 kWh to produce 1 ton of ice per day. Therefore, the annual operating time when converted to 7.5 kWh is : 561 (tons/day) x 180 kWh x 0.8 (load rate) = 80,784 kWh

Ice sales = 165 + (613-165) x 0.2 ≈ 250 tons/year

[G] Gouyave : Cold storage No. 1 and No. 2

21 m^3 x 2 rooms (storage temperature : -20 °C)

The cold storage in Gouyave was originally made for "coastal fishing development." Therefore, as cold storage for the GCFL which will mainly handle fresh fish for export, it is assumed that this cold storage will mostly be used as temporary storage for the fish landed at Gouyave until it is shipped by land to Grand Mal. In addition to the fish which will be handled for the GCFL, this facility will work together with the neighboring fisheries center attached to the Fisheries Division as a promotion center for coastal fishing in this area in order to contribute to the development of the regional fishing industry. The annual operating time was calculated under the assumption that one cold storage room will be operated continuously throughout the year, and that the other would be operated during the four busiest months.

[I] Grenville : Ice making machine

According to Table 3-4, the landed quantity of fish and the quantity bought by the GCFL in the Grenville area in 1996 is projected to be: ① total landed quantity 319 tons, ② fish for export 20 tons, ③ fish for domestic use 20 tons, for a total of 40 tons. The demand for ice will be from ④ mainly sales to fishing vessels when they go out and ⑤ for cooling during storage and shipment to Grand Mal. In the calculations, the ratio for each of these is set at 1, and the effective sales percentage is set at 70 percent. In addition, ⑥ the demand for ice in respect to the catch for the general market is set at 20 percent.

Amount necessary = (40 x 2) ÷ 0.7 + (388 - 40) x 0.2 = 114 + 70 = 184 tons/year

The ice making capacity at Grenville is one to two tons/day (plate ice) unit and one one-ton/day (block ice) unit. The amount of power necessary for each of these to produce one ton of ice per day is 7.5 kWh x 24 hours = 180 kWh.
Therefore, the annual operating time when converted to 7.5 kW is :

184 (tons/day) x 180 kWh x 0.8 (load ratio) = 26,496 kWh.
Ice sales = 40 + (388-40) x 0.2 ≈ 110 tons/year

[J] Grenville : Cold storage No. 1 and No. 2

Although the quantity of fish handled at Grenville for the GCFL is small at about 40 tons per year, one cold storage room will be operated throughout the year for the same reason as the above Grenville. In addition, in the calculations, it is assumed that the other will be operated for the three busiest months of the year.

[4] Water charges

Unit price : EC $14.38 per 1,000 gallons (EC $3.16/ton)

	Usage per day (tons)	Days used per year	Water charges (EC$: yearly)
1) Grand Mal	20	260.7	16,477
2) Gouyave	5	260.7	4,119
3) Grenville	5	260.7	4,119
Total			24,715

[5] Vehicle fuel expenses

	Distance	Round trips	Distance traveled (km/day)
1) Grand Mal ~ Airport	One-way 10 km	3	60
2) Grand Mal ~ Gouyave	One-way 15 km	2	60
3) Grand Mal ~ Grenville	One-way 23 km	2	92
Distance traveled per day (total)			212

Fuel consumption rate	:	5 km/liter
Fuel consumption per day	:	212 ÷ 5 km/liter = 42 liters/day
Annual operating days	:	365 x (6/7) = 313 days (operating six days a week)
Annual fuel consumption	:	313 x 42 liters/day = 13,146 liters/year
Fuel unit price	:	EC$5.6/gallon (1 gallon = 4,546 liters) EC$1.23/liter
Annual vehicle fuel expenses	:	13,146 liters/year x EC$1.23/liter = 16,170

[6] Personnel cost

1) Grand Mal

Full time	Position	No.	Annual salary (EC$)	Total annual salary (EC$)
	Executive Manager	1	45,000	45,000
	Plant Manager	1	45,000	45,000
	Chief Officer	1	30,000	30,000
	F. A. Officer	1	30,000	30,000
	Driver	2	10,000	20,000
	Workers/sales clark	6	8,000	48,000
Part time	10 people x 20 days x EC$30/day x 4 months			24,000
Subtotal				242,000

Note: Two part time workers will be working at Gouyave.

2) Gouyave

Full time	Position	No.	Annual salary (EC$)	Total annual salary (EC$)
	Manager	1	30,000	30,000
	Driver	1	10,000	10,000
Subtotal				40,000

3) Gouyave

Full time	Position	No.	Annual salary (EC$)	Total annual salary (EC$)
	Manager	1	30,000	30,000
	Driver	1	10,000	10,000
Subtotal				40,000

[7] Export box and packing material expenses

1) Export boxes :	Annual fish for export	200 tons (440,000 pounds)	
	Average fish weight	54 kg (120 pounds)	
	No. of boxes required yearly	200,000/54 ≈ 3,700 boxes	
	Unit price EC$45/box		
	Annual expense for export boxes	3,700 x EC$45 =	166,500
2) Packing material expense			10,000
Subtotal			176,500

[8] Maintenance expenses for equipment and machinery (including operating expenses for emergency generators)

Five percent of the estimated machine prices will be allocated as annual maintenance expenses.

	Estimated machine price (EC$)	Annual maintenance expenses (EC$)
1) Grand Mal	1,000,000	50,000
2) Gouyave	250,000	12,500
3) Grenville	250,000	12,500
Total		75,000

CHAPTER 4

BASIC DESIGN

CHAPTER 4 BASIC DESIGN

4-1 Basic design

4-1-1 Design policy

In regard to basic design, the existing conditions in Grenada must be thoroughly considered and the following items must also be considered, so that facilities of the optimum scale can be constructed with Grant Aid from the Government of Japan in this project.

(1) Designing an appropriate project scale

1) An appropriate forecast of demand must be made based on a survey of the existing conditions, before establishing the scale of facilities.

2) The contents of the facilities must be such that they can be constructed with the Grant Aid.

3) Efforts must be made so that maintenance expenses for the facilities after their completion will be as small as possible.

(2) Design which thoroughly considers natural conditions

1) The weather, topography, geology, and marine condition must be thoroughly considered, and the design must reflect those considerations.

2) Considerations must be made, so that there is no adverse effect on the surrounding environment during construction and after completion.

(3) Structures and construction methods which match the local conditions

1) The structures and construction methods should be simple, and maintenance must be easy.

2) Materials which can be procured domestically or from surrounding nations must be given priority.

3) Considerations must be made to preserve the surrounding scenery.

4-1-2 Environmental conditions

Table 4-1 shows the design conditions which were established from the natural conditions which were surveyed and set for the basic design in this project. In regard to the weather, the basic figures are based upon the weather data from Point Salines

Airport which is located on the southern end of Grenada, about 8.5 km to the southwest of the project site. This airport is located 8.5 km to the southwest of the project site on Point Salines at the southernmost point of Grenada.

Table 4-1 Design conditions

			Project site	Remarks
Natural conditions	Max. wind velocity		60 m/second	Main wind direction : From east. Ave. annual velocity : 5.4 m/sec.
	Wave height		2.5 m/from west	
	Sea level	Tide level fluctuation	+0.24~0.66 m	Tide diff.: Max. 0.42 m Ave.: 0.24 meters, at highest tide
		Height increase caused by depression	+0.5 m	Once in 20 years (during hurricanes)
	Max. current speed		0.1 m/second	Coastal currents/tide currents
	Seismic intensity		0.14/0.05	Cycles : T=0.34/1.0 second
	Bottom material		Peat/sand (BH1)	The layer of sand on peat is shallow (50 cm or less), and there is little drifting sand from the coastal current.
	Rainfall		Annual ave.: 1554 mm	Rainfall strength : 100 mm/hour
	Temperature	Annual fluctuation (Monthly average)	Max. 32.2 °C Min. 20.6 °C	Ave. annual temp. : 26.8 °C
		Daily difference	5 ~ 6 °C (assumed)	
	Humidity (relative humidity)		Annual ave. : 81%	
Soil		Top layer	Middle layer	Bed
	Density	1.0 to 1.4 tons/m³	1.8 tons/m³	2.0 tons/m³
	Moisture content	60 ~ 190% wt	11 ~ 56% wt	—
	Soil/grading	Peat	Sand with silt	Rock/hardened sand (BH1) (BH3/4)
	Penetration data	1 ~ 3	5 ~ 30	50 or more
	Unconfined compression strength	1.1 ~ 1.2 tons/m³	(ø = 25°)	—
	Layer thickness	BH1 ~ 3 (MSL-5M) BH4	BH1 → 0 m BH3/4 → 3/5 m BH2 → 10 m	BH1/4 - MSL → 5/6 m BH3 - MSL → 10 m BH2 - MSL → 15 m

Each of the items in Table 4-1 will be described on the following clauses.

(1) Weather

1) Temperature

In general, both the annual and daily fluctuation are characteristic and show little difference; however, in the mountainous regions there is a decrease in temperature from elevation difference, and there is less affect from the ocean, so that the temperature difference is greater (see Table 4-2).

Table 4-2 Monthly temperature fluctuations (Pt. Salines Airport)

Month	Average maximum temperature (°C)	Average minimum temperature (°C)	Average temperature (°C)
Jan.	30.0	20.9	25.5
Feb.	30.4	20.6	25.5
Mar.	31.0	20.9	26.0
Apr.	31.3	22.4	26.9
May	31.8	23.6	27.7
Jun.	31.9	23.1	27.5
Jul.	31.4	22.6	27.0
Aug.	31.8	22.9	27.4
Sep.	32.2	23.0	27.6
Oct.	31.8	22.8	27.3
Nov.	31.5	22.8	27.2
Dec.	30.8	21.4	26.1
Annual average	31.3	22.3	26.8

2) Wind

Because of the affect of tradewinds, the wind blows mostly from the east all year long (see Table 4-3). Fluctuations in Atlantic high pressure which are located near Bermuda, however, cause slight changes, so that the prevailing winds blow from the eastnortheast during the winter and east-southeast during the summer.

Table 4-3 Wind direction frequency (Pt. Salines Airport)

Wind direction	Frequency (%)
0° - 50°	3
51° - 90°	45
91° - 130°	46
131° - 180°	4
181° - 230°	< 1
231° - 270°	< 1
271° - 310°	< 1
311° - 359°	< 1

The wind velocity is also very steady, except on the rare occasions when a low pressure approaches. The only tendency for wind velocity is slightly weaker in the summer than in the winter. There are distinct differences in wind velocity during the day: the wind is strongest around noon (about 6.7 m/second) and the weakest during the night (about 4.0 m/second). Compared with the airport where the data was taken, the project site is protected by mountains on the east, so that winds from the east are even weaker.

Table 4-4 Monthly average wind velocity (at Pt. Salines Airport)

Month	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual average
Wind velocity (m/second)	6.1	5.8	5.9	6.5	6.5	6.7	5.4	5.2	4.7	4.6	4.9	4.9	5.1

Once or twice a year, a low pressure storm will move north on the east side of the island, and a strong west wind will blow at this time. Because the project site is located on a bay open to the west, it will be exposed to wind and waves blowing from that direction, so that precautions are necessary.

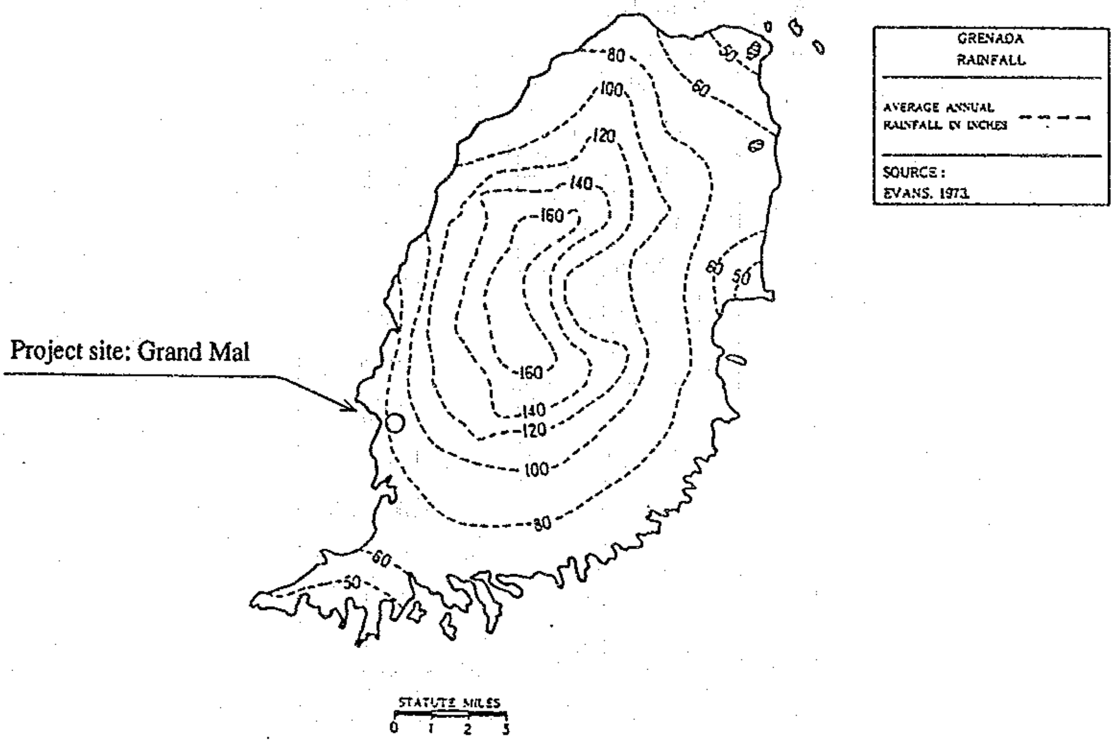
3) Hurricanes and low pressure

Most hurricanes and low pressure develop between June and December. It is said that those hurricanes and low pressure which might affect Grenada and which would cause west winds at the project site are most frequent between October and December.

4) Rain

In Grenada the tradewinds hit the mountains, climb, and create tradewind clouds which bring rainfall. Because of this there is a big difference in rainfall in the mountains and coastal areas. At Grand Etang which has some of the heaviest rainfall, annual rainfall can exceed 4,000 mm. In the southwest cape area where rainfall is the lowest, it is only around 1,000 mm.

Fig. 4-1 Rainfall distribution on Grenada Island *(Unit: Inches/year)*



Rainfall trends can be divided into the dry season (December through May) and the rainy season (June through November). This division is caused by the movement of the Inter-tropical Convergence Zone. In other words, a boundary area (low pressure) is sandwiched between two high pressure systems which also sandwich the equator, and these systems move north and south as if being pulled by the sun. Therefore, a little after the sun moves north, the rainy season starts in June in Grenada, and when the sun moves south (December), the rainy season ends. It is said, however, that this division is not as clear in recent years.

Table 4-5 Rainfall by month (Pt. Salines Airport)

	Month	Rainfall (mm)
	December	95.0
	January	40.9
	February	31.7
	March	31.8
	April	19.5
	May	30.6
	June	142.0
	July	172.5
	August	125.7
	September	142.0
	October	107.8
	November	179.7
	Annual rainfall	1,119.2

The location where the data in Table 4-5 was monitored has the least amount of rainfall according to rainfall distribution diagrams. Therefore, this rainfall cannot be applied to the projected site. Estimating from the rainfall distribution, the annual rainfall at the project site in Grand Mal is probably around 1,554 mm. In addition, because rainfall of 132 mm/hour has been reported in the mountains (Grenada Environment Profile), it must be assumed that the project site might experience rainfall of about 100 mm/hour.

5) Humidity

Because the climate is oceanic, Grenada is very humid throughout the year (see Table 4-6).

Table 4-6 Monthly relative humidity (Pt. Salines Airport)

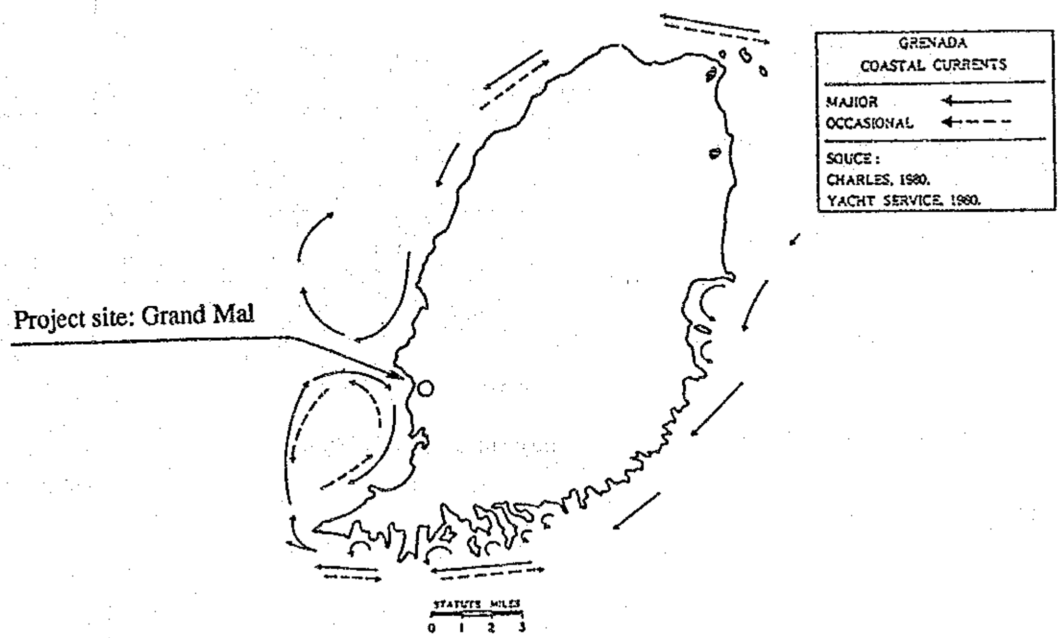
Month	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual average
Humidity (%)	78.0	77.5	75.5	77.0	79.5	83.5	81.5	80.5	81.5	78.5	81.5	78.0	78.0

(2) Marine conditions

1) Current speed

In the waters around Grenada, the prevailing current is a westerly current from the Atlantic towards the Caribbean Sea. The currents which go around the southern and northern capes of Grenada turn south and north, and create the coastal currents on the west coast near the project site.

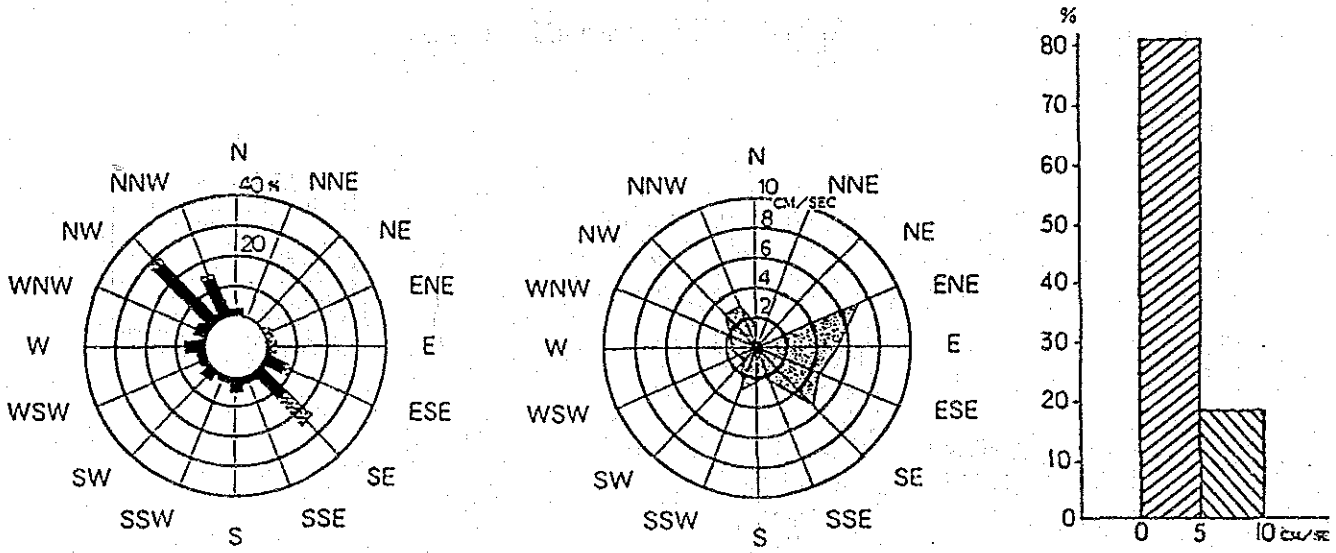
Fig. 4-2 Currents around Grenada



On the south side of the island off Pt. Salines, there is a western current which has a speed of about 2 knots. (Refer to the diagram.) Because the project site is located at the deepest point in Grand Mal Bay, it is not affected by this current. From the observations made in our study and from the fact that the currents run on a half-day cycle which is synchronous with the changes in the tides (there is a southeast current when the tide is coming in, and a northwest current when the tide is going out), it is clear that the current is affected by the tides. In addition, because the fluctuations caused by tides in this area are very small, it is estimated that the speed of the currents in front of the project site are about 10 cm/second at maximum.

In our survey an Andler current and speed meter was used to analyze the frequency of current speeds, the convergence between currents, shape of tidal currents, etc. (Reference: Tide and Current Survey Records)

Fig. 4-3 Current situation and probability diagrams for the project site



Current direction probability diagram

ST. GRANDMAL -1.4m

September 28 - 29, 1993

Average current speed diagram

Probability of different current speeds

2) Sea level fluctuations

One of the features of the Caribbean Sea, including the waters around the project site, is that there is very little fluctuation in the sea level. Fluctuation during the spring tides is only about 24 cm, and even when the fluctuations are greatest during the winter and summer solstices, the fluctuation is only about 60 cm. (Port Authority data and marine charts) We installed a tide meter at the project site in our survey and found that sea level changed in half day cycles. We confirmed that the fluctuation was only about 20 cm during the spring tide. From the data from our survey, we analyzed harmonic constants, etc. (Table 4-7.)

Fig. 4-4 Tide fluctuation records (at the Project site)

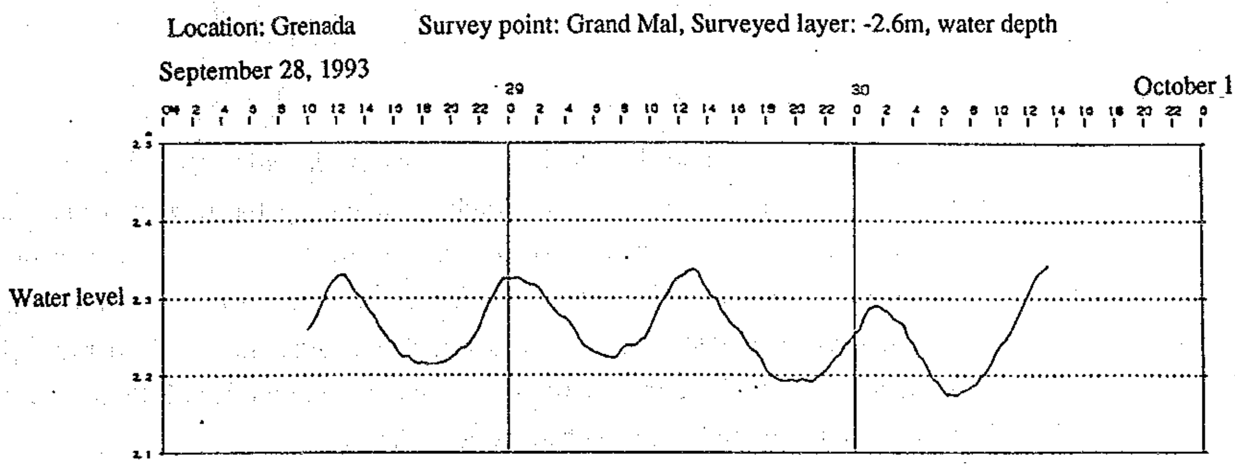


Table 4-7 Results of analyzing of tides and currents for 24 hours

Location: Grenada Grand Mal

Position: West: 61° 45' 6" North: 12° 4' 36"

Survey date: September 28 to 29, 1993

Instrument used: Tide gauge

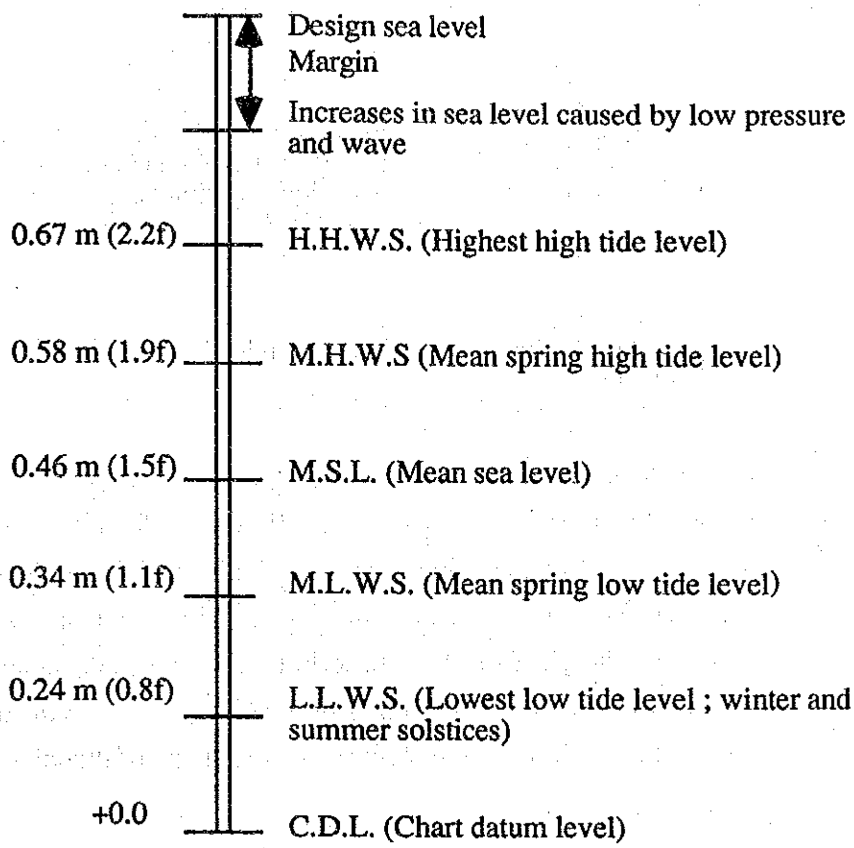
Tidal component	Tidal constant: Amplitude cm	Tidal constant: Phase lag
M_2	3.7	40
S_2	1.9	69
K_2	1.2	69
N_2		
K_1	5.2	240
O_1	4.6	230
P_1	1.8	240
Q_1		
M_4		
MS_4		
A_0	226.8	

Increases in the sea level caused by low pressure is estimated by the intensity of the low pressure, the speed at which the center of the low pressure move. Because there is no data whatsoever concerning these, however, it must be assumed that the generally accepted rise in sea level of one centimeter for a one hectopascal decrease in the atmospheric pressure is occurred. Also, because the eye of a hurricane has never been in the vicinity of the project site, increases in the sea level were estimated at 0.5 m.

In item 3) we estimated the height of waves, and they were estimated to be about 2.0 m under normal conditions. During hurricanes, because most hurricanes pass over the eastern side of the island in a northerly direction, the project site will have winds from the west, so that the maximum height of waves at such times is estimated to be about 2.5 m.

The tide, low pressure and wave height data have been summarized in the tide chart as shown in Fig. 4-5. Because the mean sea level reference (MSL reference) is used in Grenada for benchmark elevations, etc., MSL was also used as the reference surface for this design. This is used in representing ground heights and shore protection heights.

Fig. 4-5 Imray-Iolaire Marine Chart, B-32, Carriacou to Grenada)



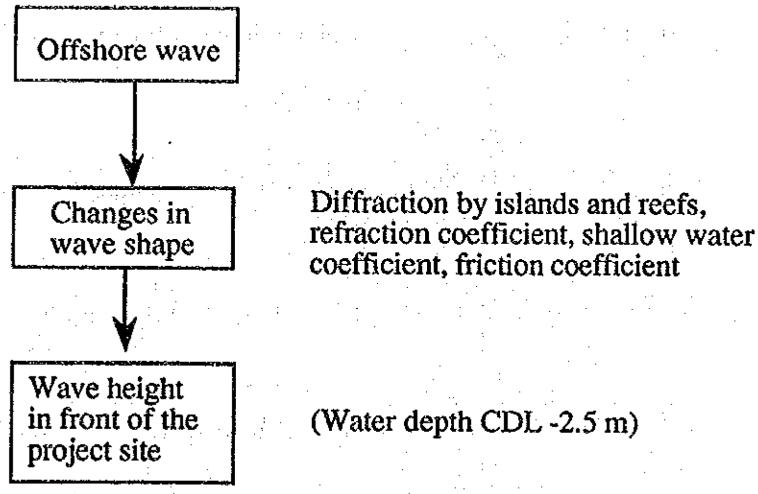
3) Waves and Swells

[Normal conditions]

In regard to offshore waves in this area (10 to 15 degrees north/60 to 65 degrees west), the figures observed by Germany (18,678 observations over 21 years) and estimated values have been adopted (see Table 4-8). (DWS = Deutcher Wetterdienst Seewetter Amt/1990)

Table 4-8 Offshore Wave Heights Appearing Once Every X Years   Ho (m)

Chances of repeating	NE	E	SE	S	SW	W	NW	N
One year	3.8	4.1	2.8	1.6	0.8	0.7	1.0	2.4
10 years	4.9	5.2	3.5	2.8	3.3	1.8	2.6	3.8
20 years	5.2	5.5	3.8	3.2	3.8	2.2	3.1	4.2
50 years	5.6	6.0	4.0	3.8	4.5	2.5	3.7	4.8



In regard to waves caused by the prevailing wind, (east to northeast) they will be higher in the northeast and easterly directions. In the case of this site, however, this direction is sheltered by the island itself. Therefore, waves from the west (SW, W, NW), to which the site is open, will be considered. The maximum wave height from this direction which appears once every twenty years (3.7 m/southwest-T, = 7 sec) is reduced to Ho' = 2.0 m in front of this site which has a depth of -2.5 m, because of the shape of the island, etc.

[Abnormal conditions]

According to the Meteorology Division (MET), during the 103 years from 1886 to 1989, there were 37 instances (once every 2.8 years) of tropical storms with maximum winds of 35 knots (18 m/sec) or greater. Of these, there were eight hurricanes that had maximum winds which exceeded 63 knots (32 m/sec) and which came within 75 nautical miles of the main island (once every 13 years). There have been only two hurricanes which hit the main island (once every 52 years), and the last was Hurricane Janet in 1955.

In this region, hurricanes usually pass north of Grenada, that is located at latitudes less than 10 degrees, high waves caused by hurricanes are in the direction of the west. These waves will hit the project site as long period swell.

Because wave height data from Hurricane Janet (which hit the main island in 1955) is not available, the data from Hurricane Allen which hit Florida in 1980 was used to estimate wave heights caused by hurricanes from the west (NW, W). (Shore Protection Manual; Washington; 1984)

(Allen) :	Maximum significant wave height	:	Hs=9.6 m
	Maximum significant wave period	:	Ts=12 sec.
	Radius of maximum wind velocity	:	R=15 nautical miles

From this data, the maximum wave height would be H_s = 6.7 m/4.5 m for an approach distance of r - 30'/75'. From the approach probability above, it is estimated that the maximum wave height (offshore waves) during the approach of a once-every-20-years hurricane would be H_0 = 4.9 m. Based on this, if refraction and shallow water effects for ordinary conditions are considered, then the wave height in front of the project site which has a water depth (h) of -2.5 m would be H_0 = (2.7 m/W, 3.4 m/NW). Because waves which exceed h/2 will be broken waves, however, even when a once-every-20-years hurricane approaches a maximum wave height of H_0 = 2.5 m is assumed with an enough safety.

[Effects of special sea bed topography]

In front of the project site there is a natural trench (100 m in width, 15 m in width) at 200 m offshore which is used by the tankers which supply the fuel to farm. In order to determine whether or not this special seabed topography would amplify waves, we used the Gōda method to analyze waves. Because the reflection in the topography in front of this site is large, we found that this trench would not cause waves to be amplified greater than the offshore wave height (H_0') which we used earlier.

4) Sea bottom movement

The sea bottom of the project site area is made up of sand, seaweed, cobblestone, and old reef. It is currently very stable, with no affect from drift sand. Because the main currents are from tides, the current speed is very slow, and even at spring tides it is only about 10 cm per second. In other words, the conditions are such that any movement in the sea bottom is very rare. When there are waves and swells from the west, however, currents may be caused by waves, and these could cause drift sands and erosion on the beach.

(3) Earthquakes

"Earthquake load" (CUBIC PART 2/Sec. 3) is a standard for buildings but not for the jetty, wharf and other civil engineering structures. The concept of earthquake load can be applied to civil engineering and construction facilities, so that in this project they will be applied. (Recommendations for the design of concrete sea structures/FIP, Oct. 1973. This material is based on the U.S.A UBC which is the base for CUBIC.)

These standards are a modified seismic intensity method which considers the inherent period of structures, and the horizontal earthquake load (V) in relation to the weight of a structure (W) is calculated from the following equation:

$V = K' \times W$

Modified seismic intensity= $K' = ZCISK$

Z : Regional coefficient with a maximum value of 0.75. (North of St. Lucia)
Minimum 0 to 0.25 (Inside Guiana), 0.5 at Grenada.

I : Importance coefficient for buildings. 1.5 for buildings and similar structures. 1.2 for structures where people gather ; 1.0 for other structures. In regard to civil engineering structures, there is not much danger to human lives, so that 1.0 is used.

C : An attenuation coefficient for earthquakes which considers the inherent period (T) of buildings; maximum 0.12 (=) $1/15\sqrt{T}$

S : This is a bed coefficient and is related to C.
Maximum $CS \leq 0.14$

Seismic intensity K : In regard to gravity type structures a maximum of 2.0.
Generally 0.8 to 2.0.

As a result of the above, the modified seismic intensity corresponding to the natural period (T) of structures are as follows:

T (natural period)	K' (modified seismic intensity)	Remarks
0.3 sec	0.140	k=2.0
1.0 sec	0.070	
5.0 sec	0.035	

Because long period, large scale, tough (steel) structures are not being considered in this project, we believe that a maximum of K' = 0.14 for design seismic intensity is appropriate.

(4) Geology

The Lesser Antilles, including Grenada, are a group of islands shaped in a bow which were formed by volcanic activity. This volcanic activity is a result of the islands location on a plate boundary, in which the South American continental plate is being forced under the Caribbean Plate. The basis for Grenada Island was created during the volcanic activity during the Tertiary Oligocene (about 25 million years ago), and it took its current form during the volcanic activity in northern Grenada during the Miocene era (about two million years ago). Excluding a small part of the north, igneous rock covers most of the island; and it is believed that the bed of the project site is composed of volcanic rock including basalt and other igneous rock. (Point of St. Eloi)

It seems that the project site used to be a lagoon at the back of Grand Mal Bay, and the center of the site only has an elevation of 0.8 m and is marshy. As a result, the surface layer is about five meters of peat, so that it is very soft. In standard penetration tests the results ranged from an N value of 1 to 3. Because filled-up foundation buildings and a parking lot is scheduled for construction on this part of the site, the optimum type of foundation soil improvements and foundation structure must be carried out must be selected carefully.

The medium layer is silt and fine sand, and this layer continues to a depth of about 12 m. This layer is also lacking in hardness with an N value of only 3 to 29. Therefore, it is not strong enough to be a supporting layer.

Beyond a depth of 12 m, the soil is made up of silt and medium grain sand, so that the hardness is better. This layer continues to about 16 m. (BH-2) At BH-1, the bed was reached at 5.5 m, but at the center of the site BH-2, the bed was not reached even at a depth of 16 m. The bed is highest towards the north, and it becomes lower going to the south. At the center of the site the bed is believed to be at a depth of about 20 m.

The geology in the sea indicates a soft peat and sand layer to about five to nine meters below the sea bed. Below that, however, is a very hard layer made up of sand and gravel. The N value of this layer is over 50, so that it is more than sufficient as a supporting layer. (BH-3 and BH-4)

The samples which were acquired from boring were put through physical laboratory testing. The results of those tests and a diagram of the boring sample are included in the Appendices.

(5) Other

The land at the project site is covered with weeds and shrub trees. Cattle and goats were allowed to graze on the site, and there is no special growth which must be protected. There is no coral at the bottom of the sea in front of the project site, and there are only a few small fish. Therefore, there is little chance that the construction of this complex will cause environmental damage or affect resources. To the north of the site, however, there are active reefs with coral and other marine biology. The seawater in this area is very clean, so that during construction and after completion of the site, efforts must be made to prevent pollution of this beautiful natural environment.

4-1-3 Structural design standards

(1) Design codes

Because Grenada does not have any technological codes, technological codes which are internationally accepted have been adopted.

In general, BS standards and ASTM standards are used in Grenada for steel and concrete materials. In this project, we have adopted the following standards which are equivalent to or better than these standards.

1) Fishing Port and Harbor Structure Standard Design Code: Japan Fishing Port Association
2) Technical Standards for Port & Harbor Facilities in Japan (1980): The Overseas Coastal Area Development Institute of Japan
3) Road Pavement Guidelines: Japan Road Association
4) Soil testing methods: Japan Soil Engineering Society
5) Concrete Standard Code: Japan Civil Engineering Society
6) Japan Industrial Standards (JIS): Japan Standards Association
7) CUBIC: Caribbean Unified Building Code

(2) Design load

In regard to design load, the load of materials was determined as shown in Table 4-9 from soil tests. For land fill is recommended to use soil from the mountains. If soil from rock quarries is used, the soil might contain gravel and stone, so that particles greater than 50 mm in diameter must be sifted out.

Table 4-9 Load of Materials (after compacting)

Type	Density (ton/m³)		Internal friction angle	Remarks
	In the air	In water		
Submarine soil	1.90	1.00	40°	When only sand 1.6 ~ 0.85 ton/m³
Land fill (medium compact sand)	1.80	1.00	35°	Mountain soil
Backfilling material (light weight)	2.10 (1.40)	1.24 (0.80)	35°	Sand (2 mm or less) under 15%
Live load	1 tons/m² (jetty, bank protection), 2 tons/m² (buildings)			

4-1-4 Design criteria for facilities and equipment

(1) Overall facilities

Because Grenada does not have any construction code which must be met, BS (British Standards) have been adopted as the standards for structural calculations and technological matters. Authorization for construction must be obtained by filing the required papers with the Planning Division and receiving their authorization. Examinations are conducted once a month, and the papers from the previous month are examined. Therefore, an examination period of one and a half months must be included in the construction process.

(2) Water supply and drainage

Water supply and drainage is under the control of the National Water Supply and Sewage Company (NAWASA). The water source is Bendom Dam (a small 2-meter dam). Surface water is gathered at this dam, and is fed to various locations through three foot diameter pipes. At Grand Mal, there are six inch water pipes located two feet below roads. The water supply is sufficient during the rainy season, but during the dry season water pressure is reduced. During the evening hours when water use is the highest, there is a lack of water in areas other than the St. George's area. Therefore, the NAWASA instructs hotels and other heavy users of water, such as this project, to install water tanks which can hold a three days supply of water. The water quality meets WHO standards.

In consideration of oceanic pollution, the Government of Grenada is strengthening its guidance concerning water drainage for large scale projects. In some cases, hotels are installing their own seepage tanks. In the case of the facilities in this project, the installation of a septic tank with a BOD of 20 ppm or less has been mandated. Urban sewage is discharged 200 m offshore through submarine drainage pipes. There are open air sewage channels in the area around the project site, so that the use of these channels to drain waste water from the project site is planned.

(3) Electricity

Electricity is supplied to Grenada Island by Grenada Electric Service Ltd. Six diesel generators provide a maximum capacity of 10 to 12 million kVA. The northern main line which passes close to the planned site can supply four-line, three phase 400 volts and single phase 240 volts. The Ministry of Agriculture, which is the main party of the project, will submit a request for supplying the project site with electricity, and in three to six months after the request a transformer will be installed. There are four or five power failures a month in the area of the project site, each failure lasting from several hours up to half a day, so that an emergency generator will be required for the project site.

(4) Disaster prevention

There are no disaster prevention laws. After the complex is completed, an inspection will be held by the Fire Department, and they will give instruction on the location of fire extinguishers. Although hurricanes and tropical storms which are unique to tropical areas are rare at the northern 15 degree latitude where Grenada is located, the entire complex should have sufficient strength and water drainage facilities.

(5) Surrounding environment

Although the length of the access road from the main road (which goes from St. George's to Gouyave) is short, there are residences nearby, there are sharp turns, and the inclination is steep. The access road must be improved, including the paving, by the Government of Grenada. In addition, this access road must pass through the existing asphalt plant before it reaches the project site, so that the transfer of this plant or improvements on the site must be made by the Government of Grenada.

The surrounding waters are under the jurisdiction of the Harbors Division (??). Directions for maritime safety and prevention of pollution are being given by the Division. There are especially strict directions which prohibit the passing of fishing boats over hoses used to pump petroleum from tankers to land, and the Division has given instructions to locate the port facilities of this project as far away from the mooring buoy as possible. In addition, the use of fire with construction equipment when building the facilities is also prohibited.

4-2 Examination of facility standards

4-2-1 Storage and ice making facilities

(1) General design conditions

The following design conditions have been set for the design of the ice making, freezing and cold storage facilities which are to be installed.

1) External temperature	:	30°C
2) External humidity	:	70%
3) Water supply temperature	:	25°C
4) Power supply	:	AC 400 V, 50 Hz, 3 phase
		AC 230 V, 50 Hz, single phase

(2) Chilled storage (0°C, storage of fresh tuna for export): 51 m^3/room x two rooms

In regard to the calculations for the storage capacity of the chilled storage rooms for fresh tuna, the calculation methods will differ from those for normal chilled storage, although the packing method will have some effect. This is because the size of tuna is large, they are difficult to handle, and they must not be deformed or damaged. Because of these factors, it must be remembered that only a small quantity of tuna can be stored when compared with the capacity of the chilled storage room.

The capacity was calculated after considering the following conditions.

- The maximum number of fresh tuna for export handled per day during the busiest time of year.

The characteristic of Grenada in which the catch fluctuates greatly from season to season and the management policy of GCFL which will be in charge of the complex to sell fresh fish for export which can command a relatively high price were the basis for the calculations. Based on the purchase and sales plans for 1996, chilled storage has been designed to allow it to store the maximum quantity handled during the busiest period. If the monthly export quantity for 1996 is calculated from the figures from 1992, then they are as shown in Table 4-10.

(The ratios of the monthly purchase quantities, export quantities, and domestic sales quantities were about the same in 1991, so that the monthly percentages from 1992 have been adopted. Refer to Table 3-7.)

Table 4-10 Quantity of fish for export handled per month (estimates for 1996)

Unit: Tons/month

Month	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Percentage	(4)	(11)	(19)	(25)	(16)	(0)	(0)	(–)	(–)	(18)	(5)	(2)
Q'ty for export 210 tons/year	8	23	40	53	34	0	0	–	–	38	11	4

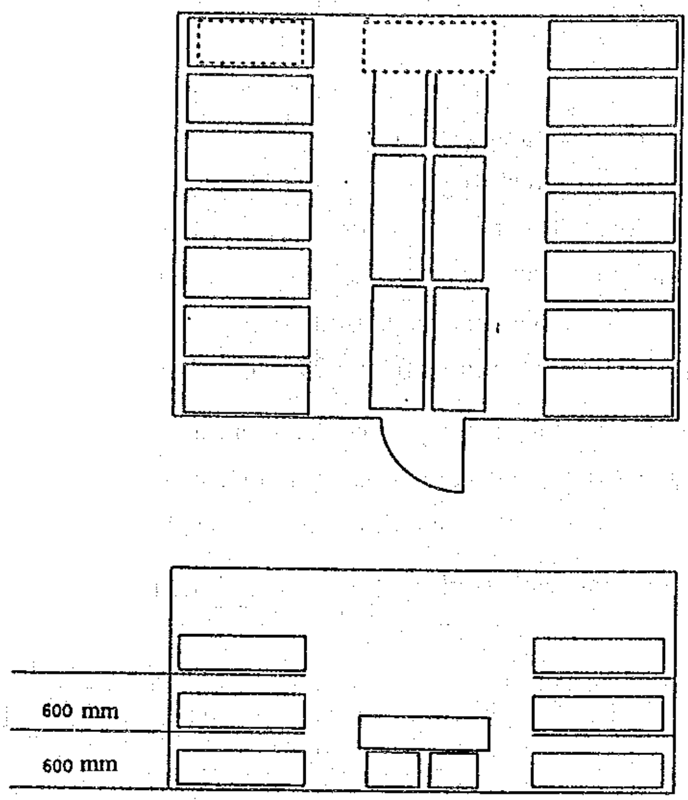
Note: The quantity of fish for export handled in April is 53 tons/month. This comes to:
53 / 30 days = 1.80 tons per day

- From the above, the quantity handled per day during the busiest months is 1.8 tons.
- There is a three day wait for air transport, so that a maximum storage capacity for 5.4 tons is required.
- The average size of a fresh tuna is about 54 kg. The main dimensions are 1.2 m long by an average diameter of 35 cm. If such tuna are stored most efficiently in cold storage, the following type of storage is necessary. Because of the heavy weight, three tiered storage is the maximum; one room should be capable of holding 2.9 tons, two rooms will hold 5.8 tons of storage (see Fig. 4-6).

[Per room]

First and third tiers :	14 tuna x 3 tiers = 54 kg x 14 tuna x 3 tiers =	2,268 kg
Center :	6 tuna x two tiers = 54 kg x 6 tuna x 2 tiers =	648 kg
		2,912 kg
	2 rooms : Total capacity	5,824 kg

Fig. 4-6 Fresh Fish Storage Procedures in Chilled Storage



(3) Cold storage (-20 °C, general fish for domestic sales) : 51 m³/room x 2 rooms

- GCFL has set the quantity to be handled in 1996 at 100 tons.
- The distribution of frozen fish is totally different from that for fresh tuna; most of the fish will be sold on the domestic market.
- In the case of frozen fish, once the fish are frozen, they can be stored at about -20 °C for up to three or four months and maintain quality.
- Based on sales results to date, the purpose is to be able to cope with stable domestic demand. Frozen fish caught during the busiest periods (especially April to May) will be kept in storage until June to September, then sold.
- From the following estimates of inventory, the maximum storage capacity during the busiest period should be 30 tons.

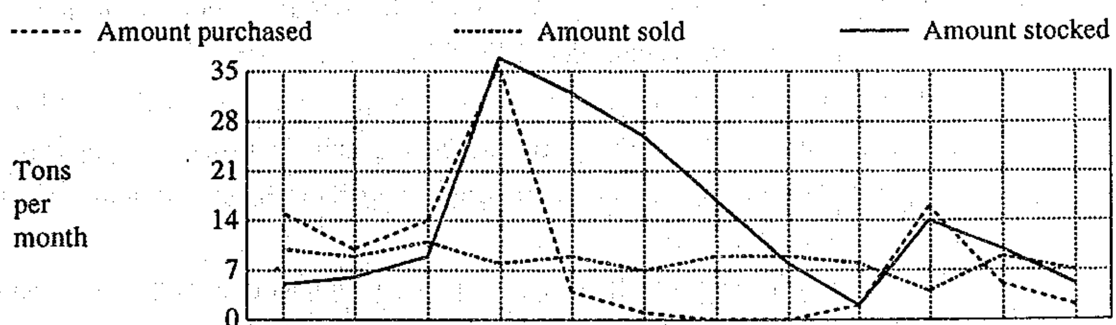
Table 4-11 Estimates of Monthly Purchases

Month	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
		← Peak season →				← Off peak season →						
Busiest period (%)	(14)	(10)	(13)	(34)	(4)	(1)	(0)	(0)	(2)	(15)	(5)	(2)
Low catch 105 tons/yr	15	10	14	36	4	1	0	0	2	16	5	2
Percentage (%)	(10)	(9)	(11)	(8)	(9)	(7)	(9)	(9)	(8)	(4)	(9)	(7)
Sales q'ty 100 tons/yr	10	9	11	8	9	7	9	9	8	4	9	7
Month end inventory	5	6	9	37	32	26	17	8	2	14	10	5

Note: The ratios of the monthly purchase quantities and domestic sales quantities were about the same in 1991, so that the monthly percentages from 1992 have been adopted. Refer to Table 3-6.

Plotting the above Table 4-11 Estimates of Monthly Purchases, sales and amount of fish stocked for domestic sales (1996) on a graph yields the following (Fig. 4-7):

Fig. 4-7 Estimated total domestic sales of fish (1996)



	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Amount purchased	15	10	14	36	4	1	0	0	2	16	5	2
Amount sold	10	9	11	8	9	7	9	9	8	4	9	7
Amount stocked	5	6	9	37	32	26	17	8	2	14	10	5

The storage capacity for prefabricated cold storage is set at one ton: per 2.5 m^3 (coefficient: 0.4) in Japan by the Warehouse Act. In the case of GCFL, however, because the fish to be handled ranges from large pelagic fish exceeding one meter in length and relatively small demersal fish, the weight which can actually be stored will probably be under 0.4 tons. In this project, we have considered cargo handling passages, installation spaces for unit coolers, and space for cold air circulation, so the following equation is used:

	Width		Depth		Height		
Storage room volume	5.1 m	x	4.2 m	x	2.4 m	=	51.40 m^3
Unit cooler volume (Reduction)	1.0 m	x	0.8 m	x	0.6 m	=	-0.48 m^3
Passage volume (Reduction)	1.0 m	x	3.2 m	x	2.4 m	=	-7.68 m^3
			Effective cold storage volume			=	43.24 m^3

Per cold storage room:	Storage weight =	0.6 x 43.24 x 0.6 =	15.57 tons
2 cold storage rooms:	Total storage weight =	15.57 tons x 2 =	31.14 tons

Therefore, for the period from the second half of March to the first half of August when the stored capacity is expected to exceed 15 tons, operation of two cold storage rooms will be necessary. Only one room will have to be operated the remaining months. This will allow coping with fluctuations in the quantity handled, so that efficient operation is possible. Also, by using this period to inspect and maintain equipment, and clean the chilled storage rooms, it will be possible to conduct thorough maintenance of the facilities.

(4) Blast freezer: 1 ton/day (freezing for 20 hours), one unit

- The concept of 'freezing' in Grenada differs from that in Japan in which 'freezing' is conducted rapidly at very low temperatures in order to maintain quality. Slow freezing is considered "freezing" in Grenada.
- In Grenada fish are not eaten raw as they are in Japan, so that this method of freezing is sufficient for the quality of frozen fish. Therefore, the regular and simple unit cooler method will be adopted, and the blast and semi-air blast methods will not be used.
- The freezer will be designed so that large fish such as tuna and marlin can be hung down from the ceiling and small fish can be frozen in racks.
- Because the domestic sales of fish is 100 tons per year and the production (catch) of fish during the busiest time of year is an average of one ton per day, we have determined that a capacity of 1 ton per day (20 hour operation) is appropriate.

(When converted to 54 kg tuna, this comes to 20 tuna per 20 hours.)

(5) Ice making machines : 5 tons/day x 2 units (flake ice)

In the Grenada fishing industry, the use of ice to maintain the freshness of fish which has been caught and in distribution is yet to catch on sufficiently. The education currently being conducted by GCFL and the Fisheries Division is expected to increase demand for ice, however. As the free market system for the catch on the market, it is expected that freshness will have a big effect on the price of fish, so that the installation and operation of ice making machines is expected to play an important role.

There are three types of ice which are used in the fishing industry: ① block ice, ② plate ice, and ③ flake ice. Each has its advantages and disadvantages, and the type of ice which is used depends on the use. In the case of ① block and ② plate ice, large blocks of ice are crushed, so that the size of the crushed ice is relatively large. This provides the advantage of not melting for long periods; however, the disadvantage is that the size of the ice is not uniform, and because some of the edges are sharp the fish may be damaged. In the case of flake ice, the size of the ice is very small, making it easier to melt than block ice; and if stored at temperatures below freezing it forms into big blocks. Conversely, there is no worry about it deforming or damaging fish.

In the case of fresh fish (especially tuna), lowering the temperature of the fish to maintain freshness, and not deforming or damaging the surface are important factors in maintaining the commercial value. Therefore, after consultation with Grenada and because of the reasons above, we have determined that the introduction of flack ice making machines is best for this project.

According to GCFL plans, when the quantity of fresh fish handled is set at 1, the use of ice and its ratio will be as follows:

a) Supplying to fishing vessels : 1

b) Precooling of fresh fish (quick cooling after processing) : 1.5

c) Keeping fresh fish cold (used in chilled storage) : 1

d) Export of fresh fish (ice packing) : 1

e) Distribution/general demand : 1

The scale of ice making at the project site will be based on the above ratios, and the quantity of fish to be handled at Grand Mal. The quantity of tuna for export to be purchased by GCFL in 1996 is projected at 210 tons. The quantity of ice to be used by fishing vessels at Grand Mal is projected at 60 tons for landed fish for export and 30 tons for landed fish for domestic sales, so that the total is 90 tons out of a total of 210 tons or 40 percent. Therefore, the planned amount of ice used in comparison to the quantity of fish handled comes to the estimated ratio shown below. In addition, the landed quantity of fish at Grand Mal in 1992 was 413 tons per year and the estimate for 1996 is 502 tons per year. Therefore, if the 90 tons to be purchased by GCFL is subtracted, then 412 tons per year will be landed. If the use of ice is raised to the 50 percent that is used for fish for export, then the use of ice for landed fish for the domestic market would create demand of about 206 tons of ice. After considering the conditions above, the annual demand for ice will be as follows:

Fishing vessels (when putting out to sea)	:	0.4
Pre-cooling (before cooling)	:	1.5
Keeping cool (during storage in chilled storage)	:	1.0
Shipment and packing	:	1.0
Other distribution and general use	:	1.0
Total		4.9 ≑ 5

From the above calculations, the following formula yields the required ice making capacity:

210 tons/year x 5 tons/day = 1,050 tons/year.

- Furthermore, from the 53 tons/month of fresh fish handled during the busiest months, a quantity of 53 x 5 = 265 tons/month of ice is required. If the ice making machines are operated continuously during the busiest months at 30 days/month, the monthly maximum ice making capacity is set at 10 tons/day x 30 days = 300 tons. If non-operation during the other months, down-time because for inspections and maintenance, and repairs for unexpected malfunctions and overhauls are considered, then two 5 ton/day units are considered best.
- Because ice storage is usually located directly below the ice making machines, their capacity is limited. In the plan, the ice making machines will be located directly above ice storage, so that ice will fall down from its own weight into storage. The capacity of ice storage will be equal to three to four days of production of ice when the ice making machines are operated 24 hours a day. This will allow coping with fluctuations in demand for ice. From the above conditions and calculations, the specifications of the various equipment have been set as follows:

1) Chilled storage facilities

Chilled storage capacity	:	About 102 m^3 (two rooms)
Chilled storage storing capacity in tons	:	About 5.8 tons (two rooms)
Chilled storage temperature	:	0°C

2) Cold storage facilities

Cold storage capacity	:	About 102 m^3 (two rooms)
Cold storage storing capacity in tons	:	About 32 tons (two rooms)
Cold storage temperature	:	-20°C

3) Freezing facilities

Freezing method	:	Unit cooler (cold air circulation)
Freezing temperature	:	-25 °C (final freezing room temperature)
Freezing capacity in tons	:	1 ton/day (20 hours)
Fish to be frozen	:	Yellowfin tuna, demersal fish, and other

4) Ice making facilities

Daily ice making capacity	:	10 tons/day (5 tons/day x 2 units)
Type of ice	:	Flake ice
Ice storage capacity	:	About 40 tons (20 tons/room x 2 facilities)

4-2-2 Number of fishing ships using the facilities

This landing jetty will be made mainly for the seven tuna fishing vessels which were introduced with the previous Grant Aid. The shape of the jetty will be an I-shape. Two fishing vessels will be able to moor on the right side of the end of the I, and two fishing vessels will be able to moor on the left, so that four vessels will be able to moor at one time. When more fishing vessels of the same scale are constructed and introduced in the future, they will mainly moor at the piers in Gouyave and Grenville. The 23 small fishing vessels which are located in Grand Mal to the south of the project site and some small fishing vessels from other villages will also use the new jetty to land fish at this complex. Therefore, the construction and scale of the landing jetty will also consider such small fishing vessels.

(1) Dimensions of fishing vessels using the complex

	Large fishing vessels	Small fishing vessels
Total length :	14.0 m	6.0 m
Width :	4.50 m	1.5 m
Draft :	1.80 m	0.5 m

(2) Number of ships using the complex

Large fishing vessels : 7

Small fishing vessels : 40

The number of fishing vessels which will use the facilities is based on the current number of fishing vessels currently operating in the Grand Mal area. In the future, when all the facilities for the landing of the catch, loading of ice before heading out, loading of bait (GCFL is also planning the storage and sales of flying fish which is the bait used for long line tuna fishing), fueling, and watering are in place, all of these fishing preparations will be conducted at the same time and efficiently. This will increase the chances that more fishing vessels will use Grand Mal, so that the design must consider such an increase.

4-2-3 Quality control and related facilities

Between sixty to seventy percent of the fish handled at Grand Mal will be fresh tuna for export. Because the fishermen do not have sufficient knowledge in regard to quality control for such fresh fish and because inland transportation will be required in the distribution process, it is expected that freshness will deteriorate. The equipment necessary to inspect the freshness and quality of the fish handled will be introduced. This equipment will be installed in the quality inspection room located next to the conference room at Grand Mal.

Currently, there are no GCFL employees who are quality inspection specialists, however, there are a few marine biologists working for the Fisheries Division. These marine biologists will have to train quality control employees. There are also plans to hold technician training courses in Japan, so that the quality inspection department will be improved.

(1) Physical and chemical inspection equipment

	Inspection items	Required equipment	
pH value		pH meter	1 unit
Harmful substances	Mercury accumulation	Mercury analyzer	1 unit

(2) Disinfection inspection equipment

	Inspection items	Required equipment	
Bacteria	Live bacteria count E. Coli	Incubator	1 unit
		Autoclave	1 unit
		Hot air sterilizer	1 unit
		Colony counter	1 unit
Parasites	Fluke, etc.	Stereo microscope	1 unit
		Document	1 unit

(3) Physical inspection equipment

Inspection items	Required equipment	
Fish body center temperature (large fresh fish and frozen fish)	Thermister	3 units
	Augur	4 units

(4) General inspection equipment: 1 set

4-3 Basic plan

4-3-1 Landscape plan

The land necessary for the project site is a square piece of land measuring 40.3 m on a side. This land will be surrounded by a road with a width of eight meters. When the circulatory road is included one side of the square will be 59 m. The height of this land has been calculated according to the Port and Harbor Structure Standard Design Law based on the natural conditions of the site and with consideration given to the height of the land of neighboring structures. The calculated height was set at 2.5 m above the mean sea level. (See Table 4-12.)

In executing this project, the land soil shall be improved and the site will have to be prepared. The method used for improving the soil will be the preload method. Although this method is not as good at improving the land soil as other methods, as Table 4-12 shows.

Because the shearing strength (Cv) of the peat surface layer at the project site is about 1.0 ton/m2, it is estimated that the height limit to banking is 1.5 m. Therefore, it has been determined that it would be dangerous to increase the site base from height of 0.8 m to the required ground height of 2.5 m at one time. Therefore, it will be necessary to execute banking construction with the following process while monitoring the effect of soil improvement.

(1) Counter weight banking (height 1.5 m) with a maximum width of 20 m will be placed on the external circumference of the site in order to prevent horizontal displacement of the peat layer and damage from rising.

(2) Before the covering banking is put in place, a grid of drainage gullies measuring 1.5 m in depth and 0.5 m in width which reach to a depth of 50 cm from the surface of the peat layer will be digged at intervals of 2.5 to 3.0 m. These gullies will be filled with sand of good drainage properties, and this sand will be built up to a thickness of 20 cm to cover the entire covering banking. This will promote consolidation drainage from the peat layer.

(3) After work on the covering banking is completed, any sinking of the bank surface will be monitored until consolidation settlement is complete. (Approximately one month.)
(4) After consolidation settlement is complete, only the site area (a square with 45 m sides) will be built up to a ground height of 2.5 to 3.5 m. (If there is no horizontal displacement or other problems, then the ground will be built up to 3.5 m, otherwise it will be built up to 2.5 m.)
(5) Any settlement of the surface height of the built up area will be monitored, and adjustments will be made. After consolidation settlement is complete, any banking which exceeds the ground height of 2.5 m will be removed. This will complete preparation of the site. (Approximately four months.)
(6) Both the covering banking and site banking will have a surface inclination (5 percent) from the center out so that water will be drained naturally. This will prevent water from probing on the banking.
(7) The external circumference of the banking will have a 1:1 gradient. The seaward side of the banking will be protected with a stone shore protection surface, and the landward side will be partially protected by stone, and the rest will have vegetation planted to protect the banking from crumbling.

Quarry waste from the red quarry located near the site will be sufficient as banking material. It will be necessary, however, to remove any rocks which are over 10 cm in diameter. Even if this site preparation is carried out, it is assumed that only half of the top 5 m of the peat layer will be consolidated and the lower portion will not be stronger. Therefore, countermeasures which compensate long term consolidation settlement (maximum 50 cm) because of the large load, including the banking load, are necessary.

Table 4-12 Selection of the ground height

(1) Ground height of adjacent area	Asphalt plant : + 1.5 m Machine base at north side : + 2.5 m School site at south side : + 3.3 m (bench Mark) . Texco / private houses at east side : + 2.0 m or more
(2) Selection of the sea wall upper surface height	Full tide (HHWL) = CD + 0.66 m = MSL + 0.21 Rise in water level due to low pressure Δh = 0.5 m MSL - CD + 0.45 m Maximum wave height outside bank Hmax = 2.5 m The location of the bank protection is α - 0.6 /1.5 (port standard) because the shore line/water depth = Ho' and the sea bed slope = 1/47 Sea wall upper surface height = designed tide level + α x Ho' = (0.21 m + 0.5 m) + 0.6 x 2.0 = 1.91m. Therefore, 2 m was selected
(3) Site ground height	It was decided to be 2.5 m by adding the drain slope (5%) of the landing place (10 m in width) to the sea wall upper surface height

4-3-2 Civil engineering facilities design

The main civil engineering facilities design required for this project are as follows:

(1) Entrance road and drainage channel culverts
(2) Circumference road
(3) Covering banking and bank-slope protection
(4) Shore protection construction
(5) Landing jetty
(6) Fencing and sodding
(7) Methods for improving the ground at the site.

These are considered below.

1) Entrance road and drainage channel culverts

The entrance road and drainage channel culverts which will start from the entrance of the existing asphalt plant will be a paved road with a width of ten meters in order to match the existing access road. This ten meters includes six meters for two lanes, one meter on each side for the road shoulder, and one meter on each side for protective area.

The existing drainage gully is an open channel. At the section where the entrance road will cross the gully, a steel reinforced concrete culvert will be made at the site in order to provide sufficient drainage during normal rainfalls.

2) Circumference road

The circumference road located on the site will be the same construction and dimensions as the entrance road; however, it will only be drained by its inclination to the outside.

3) Covering banking and protective cover construction

Because the project site has a weak peat layer surface, it is difficult to build up the site to the necessary ground height of 2.5 m at one time. Therefore, the site will be prepared by using the preload method in two stages including covering banking and site banking as we described earlier.

Gravity type retaining walls will not be used to protect the slope of the covering banking and site banking. Instead sides with a gradient of 1:1 to 1:2 will be used. The length of 20 m on the seaward side will be exposed to waves, so that they will be protected with the same armor stone as that for shore protection. The landward side which is not exposed to waves will have vegetation planted on it.

4) Shore protection construction

The seaward side of the prepared site will be exposed to wind, waves and swells, so that it will have to be protected in order to prevent the banking from collapsing. Although the use of gravity type shore protection is possible, when the fact that the entire site is located on weak ground, this method would require the use of a pile foundation, and this would make it costly. Although technologically the use of sheet pile shore protection is perfect for preventing horizontal movement of the peat layer, this method is also expensive. Because of these factors, a shore protection method which can cope with the long term consolidation settlement (maximum 50 cm) of the prepared site and which is cost effective for shore protection is the mound construction (gradient 1/2 to 1/1) covered with stone facing. The average weights of the stone necessary for shore protection is based on the "Fishing Harbor and Port Structure Standard Design Law" according to the specific gravity of the stone. These factors were considered together with the wave height for the installation location, allowing for shallow water deformations for waves from each direction (shown in Table 4-13), to come up with the average weights of stone necessary in Table 4-14.

Table 4-13 Maximum Wave Height at the Shore Protection Construction Site (meters)

Water depth (h) m	0	-0.5	-1.0	-2.5
Design 3.8 m/SW	0.8	1.2	1.6	2.5
Offshore waves 4.9 m/NW, W	1.0	1.3	1.7	2.5

Table 4-14 Weight of Rocks Necessary for Shore Protection Construction (tons)

Water depth	Slope gradient cot α			
(h) m	1.00	1.50	2.00	3.00
0	0.20	0.13	0.10	0.07
-0.5	0.44	0.29	0.22	0.15
-1.0	0.99	0.66	0.55	0.33

Specific gravity of rock = 2.14
KD = 5 for damage ratio 1 to 5 percent
[According to the Hudson formula]

Table 4-15 Study of Jetty Layout Shape

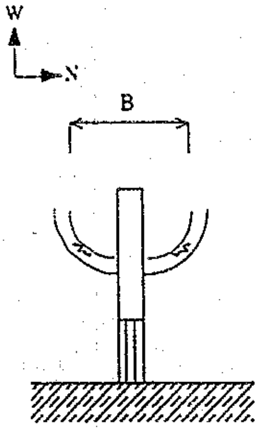
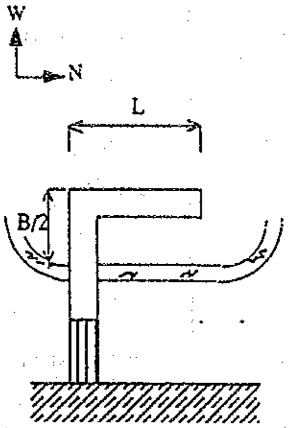
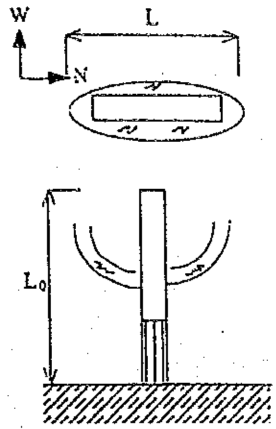
Shape			
Elements	Straight type Dredging on both side. (Width 50 m)	L type Dredging on one side of the end.	Jetty and breakwater $L / L_0 > 1$
Features	No protection against western swells.	By installing a curtain wall on the L-section, some breakwater effect (about 30 percent) can be expected. Mooring length under normal conditions is increased.	Diffraction will provide about a 50 percent breakwater effect against long cycle swells.
Construction cost index	100	200 (80 per mooring length unit)	150

Table 4-16 Selection of a Weak Ground Improvement Method
(Peat layer: 5 meters)

	Replacement method	Consolidation method	Mixed reinforcement
Type	Sand compaction, etc.	Preload + (covering banking) Well point Sand/paper drain	Quick lime/cement, etc.
Required construction equipment	Crane, special casing, jack of hammer.	Special construction equipment required for methods except the preload method.	Crane, special mixer.
Improvement effectiveness (shearing strength)	Three times or less for all layer thickness.	In the preload method, two times or less for one-half of the layer thickness. For the other methods, two times or less for all the layer thickness.	Four times or less for all the layer thickness.
Construction period		(Excluding the preload method)	
(Machine procurement)	Four months	Three months	Four months
(Actual construction time)	Two months	Preload method : Four months Others : Three months	One month
(Total)	Six months	Preload method : Four months Others : Six months	Five months
Construction cost index	100	Preload method : 50 Others : 90	150

5) Landing jetty and access way construction

The large fishing vessels which will moor at this jetty have a maximum draft of 1.3 m. When the affect of swells, etc. are considered, an additional 0.5 m should be added, so that the depth at the jetty should be 2.0 m.

The submarine soil is weak peat near the shore (BH/3), but about 100 m offshore this layer no longer exists. When this submarine soil surface is considered, dredging and making the jetty shorter in order to acquire the necessary depth is not effective, because it is very likely that the dredged area will be filled up naturally. Therefore, the jetty should be made 90 m in length in order to secure the required water depth of 2.5 m (40 m for large fishing vessels), even though this method is expensive. The landward side of the jetty which has a depth of 1.0 to 2.0 m (length 50 m) will be constructed for use by small fishing vessels and as a delivery area.

This jetty and the circumference road on the site will be connected with a 20 m long road with a pile foundation. In order to prevent any effects from sinking, this road will be constructed of the same concrete pavement as the jetty.

Although an L-shaped jetty or the use of a breakwater are also possible, we have decided to use a simple straight jetty. This is because from November to January there are two to three large swells a month from the west which make it impossible for even large tankers to moor and conduct work. We believe it best to avoid the use of the jetty by fishing vessels when such swells develop.

The height of the jetty has been set based on the dry height of the fishing vessels which will use the jetty. The portion of the jetty to be used by large fishing vessels will have a height of 1.5 m higher than the average tide, and the portion used by small fishing vessels will have a height 1.0 m higher than the average tide. Both of these heights are lower than the maximum wave height of 2.5 m which occurs during swells and abnormal conditions, so that it is expected that the jetty will be exposed to strong waves. Therefore, both the jetty and the platform will have slits in the floor boards, in order to alleviate the force of waves.

6) Fencing and sodding

In order to maintain the safety of the facilities at the site, a fence and gate will be located around the site. Gates will be located at the landward delivery side and at the jetty. The perimeter fence will be built along the circumference road, and will be about two meters high. In order to alleviate the effect of salt in the air, the fence and gates should be galvanized, so that they are not expensive to maintain.

Vegetation shall be planted on the covering banking and slope of the site where there is no stone facing, in order to prevent erosion. The type of vegetation to be used should be quick rooting and adaptable to a seaside environment.

7) Methods for improving the ground at the site.

Because the fisheries complex will be supported by a pile foundation there will be no subsiding. In regard to the perimeter road and parking space, earth will be built up on the original ground, so that there is likely to be subsidence over a long period because of the nature of the ground. In this case, stress will be placed on the buildings' piping, etc., so that there is a danger of damage to the buildings. Improvements will be made in this design to reduce residual subsidence after completion of the facilities, so that maintenance after the completion of the facilities will be easier. After further consideration, the ground will be improved through the consolidation construction method as shown in Table 4-16.

4-3-3 Basic policy for facilities design

The following points have been established as the basic policy for facilities design after considering the contents of the project.

(1) In regard to complex scale, based on the survey of the present conditions, a scale which is appropriate for the quantity of fish handled and the management policy for 1996 and thereafter.

(2) Because this complex will handle foodstuffs, the facilities must be kept clean for a long period, be easy to clean, and be durable. In addition, the materials used and the construction methods should be planned so that maintenance expenses after construction is completed can be kept to a minimum.

(3) Because the ground at the site is weak, plans must be made so that the basic structures, prepared ground, and peripheral roads will maintain their stability for a long period.

(4) Because the project site is exposed to sea winds, high waves and other harsh natural conditions, the structure and materials must be able to withstand these conditions.

(5) Plans must be made to use local materials and materials from neighboring countries wherever possible.

4-3-4 Layout plan

The following points must be considered in the layout plan.

(1) The location of the access road, the position of existing marine facilities, the weak ground and other conditions must be comprehensively considered in the layout plans, so that the total construction costs, including the construction costs to be born by the Government of Grenada, are kept down.

(2) The layout and periphery plans for the main facilities and the peripheral facilities must assume that there will be uneven settling of the weak ground.

(3) The plans must be made to make the distance from the jetty entrance to the main facilities as short as possible.

(4) Because this complex is a distribution facility, plans must be made to facilitate delivery and handling.

(5) The height of facilities, including the height of the banking, must be such that the drainage from the septic tank is the optimum height for the existing drainage channel.

With the above as the policy for the layout plans, the layout and periphery plans must be made so that the overall construction scale is as small as possible.

4-3-5 Architectural design

(1) Floor plan

The main function of this complex is the cleaning and processing of the catch. In addition, there will be auxiliary facilities such as ice making facilities, cold and chilled storage, and maintenance and management facilities.

1) Scale of processing facilities

There are no similar facilities in Grenada which might be used as reference points. The required area for these facilities was estimated from the handling of tuna and demersal fish which will be the main catch handled, the space necessary for workers handling the fish, the quantities handled, etc.

a) In the processing process, workers will be located on both sides of a 90 cm wide by 5.4 m long work bench. Therefore, passages are necessary on both sides, so that the overall work area required will be a span of about 5 m.

b) In the cleaning process, two to three lines similar to that described above will be installed depending on the quantities handled, so that an area with a span of 15 m and without any columns will be allocated in order to facilitate locating work benches.

c) All equipment necessary for the processing and cleaning processes will be movable, so that work can be made as efficient as possible according to fluctuations in the catch.

2) Scale of ice making machines, and cold and chilled storage facilities

Because this space requires the installation of ice making machines and cold storage equipment which are not custom made (using 90 cm square panels), and because there must be room for the installation work of these units, these facilities will be made up of a 6 m by 6 m grid.

3) Scale of management facilities

Personnel will be allocated according to the personnel makeup of the management department and the content of their work. The space required will be calculated from area calculation criteria.

	Work content	Calculation criteria	No. of people	Required space
Office	Office work be multiple clerks	4.5 ~ 7.0 m^2/person	2	9.0 ~ 14.0 m^2
	Section manager class	6.0 ~ 9.0		
	Department manager class	9.0 ~ 20.0	1	9.0 ~ 20.0
	Director, president class	15.0 ~ 25.0	1	15.0 ~ 25.0
	Secretary	≥10.0		
Conference room		1.5 ~ 5.0	10	15.0 ~ 50.0
Total			14	48.0 ~ 109.0 m^2

The GCFL organization has 12 people at the headquarters. Of these, there are four management and office personnel. The other eight are workers and drivers. Because workers will usually be at the processing plant, there are only four people who are in the management department. The conference room will be used for GCFL board of directors' meetings, and meetings with the Fisheries Division, so that places for about ten people are necessary. Considerations should be made, so that seminars for fishermen can be held in the conference room or the processing plant, depending on the number of people attending.

(2) Vertical plan

The main items in the cross section planning of this complex are the ease of work in the processing plant and storage of equipment and facilities.

The delivery entrance and shipment exit of the processing plant should be 800 mm above the road surface in order to facilitate moving fish from the plant to trucks and vice versa. At the same time, the roof overhang should be made large, so that the fish will not be exposed to strong sunlight at this time. The floor of the processing plant should be inclined sufficiently so that water drains and it is easy to keep clean. Because the processing plant is located in the center of the complex, the cross section plans should make sure that natural light and natural ventilation are sufficient, so that work is comfortable. Of the various facilities, the installation area of ice storage and ice making machines should have a minimum inside height of 4,300 mm including work space. In regard to cold storage, the ceiling height should be at least 3,300 mm high. The equipment storage section, the warehouse and the office management section should be raised 100 mm, so that water from the processing plant does not flow into them. The floor of the lavatory for fishermen should be raised 100 mm above the road surface.

Ceilings will basically be the backside of roofs. In rooms such as the offices where air conditioning will be used, however, a double ceiling should be installed in order to reduce the load on air conditioning.

(3) Material plan

In considering the above, the natural conditions and the usage conditions of the facilities must be considered, so that the following items should be included in the plans:

- The project site is a coastal area which is affected by salt.
- The climate at the site is hot and humid during the day time all year around.
- Because foodstuffs are to be handled, considerations must be made for hygiene. (Select materials which are difficult to stain and easy to clean.)
- Be sure to consider long term use, and select durable materials which will not deteriorate or break.

1) Roofs

In Grenada a wide range of materials are used for roofing depending on the use and scale: roof tiles; asphalt shingles; slate; galvanized steel; etc. Because this project includes both land roofs and inclined roofs, urethane waterproofing construction will be used.

2) Outer walls

In regard to outer walls, excluding the plank walls used in houses, mortar walls finished with paint are generally used. Although resin based spray finishes are also available, basically mortar and paint walls will be used because of ease of maintenance.

3) Interior

In regard to floor finish, different finishes will be used according to the use.

- From the point of view of hygiene, the processing plant floor will be cleaned with brushes every day, so that non-slip ceramic tiles which are being used at the current facilities will be used.
- The floors of the ice storage room, cold storage rooms, equipment storage rooms, machine room and work room will be mortar finished with hardener.
- The management department floor will be finished with wood.
- Inner walls will be basically mortar finished with paint.
- Only the ceilings in the offices, conference room and work rooms will be plywood finished with paint. The other buildings will have the roof slabs finished with paint.

4-3-6 Mechanical work plan

(1) Water supply

Water is already being supplied to the existing asphalt plant from the water main by a 150 mm diameter water pipe. This will be extended for the project site. According to the water bureau (NAWASA), the water supply pressure in the area of the project site is low. In the dry period, the water supply capacity is not sufficient for large volume use in a short time. Therefore, a water tank will be installed under the buildings to store water. Because water at high pressure is necessary for the cleaning work in the processing factory, water will be raised with a pump from the water storage tank to an elevated tank ten meters above the processing plant level, so that water pressure will be maintained. Water usage at this complex will be about 20 tons a day, including the water used for the ice making machines and the processing plant. Because NAWASA has requested that the complex maintains a three day supply of water during the dry season, the water tank will be 60 tons in capacity.

The cleaning hose faucets in the processing plant will be embedded in the floor, so that they can be used even when the work benches are moved.

(2) Drainage

Three types of drainage will be considered: sewage; miscellaneous waste water, including water used for cleaning in the processing plant; and rain water. Sewage will be handled according to the instructions from NAWASA: after being placed in the septic tank, it will be discharged into the existing drainage channel which is located to the north of the site. The drainage standard for the septic tank is BOD 20 ppm or less.

In regard to miscellaneous waste water, gratings in the drains in the floors of the plant will catch any gills, scales, entrails, etc., then the water will be discharged directly to the drainage channel.

In regard to rain water, the rain ducts on the roofs will be designed, so that as much rain water as possible will be drained directly into the drainage channel. Because the piping under the circumference road may be damaged due to uneven sinking, however, the flexible pipe method or the road surface connection method (vertical flexible pipes) will be used. The circumference road will have a drainage inclination toward the covering banking, and any rain that falls in this area will be drained naturally.

(3) Sanitary

Because the number of people using the lavatories is small, lavatories will be divided into those for men and women. The lavatories will be allocated as follows by job type:

	For men	For women
For office workers	One urinal	
	One toilet	One toilet
For workers	Two urinal	
	Two toilet	Two toilet
For fishermen	One urinal	
	One toilet	One toilet

(4) Air conditioning

The office, conference room, inspection room and work room in the management department will be air conditioned. Each room will be controlled individually. External units will be located under the eaves.

(5) Ventilation

Because Grenada is hot throughout the year, the entire complex will be designed so that there is sufficient ventilation. Because there is a wind from the east year around at the project site, ventilating blocks or ventilating opening will be used, so that the natural wind can blow from east to west. Machine ventilation will only be used in the laboratory and work shop which may use volatile oils.

4-3-7 Electrical work plan

(1) Power supply

Because the main electrical line is located along the national road to the east and distance would be great if the incoming line was installed along the access road, a request will be made to the electric power company to install the incoming line from the national road along the border with Texaco. The high tension panel will be located in the workshop. Receiving equipment will include 150 KW for power and 30 KW for other uses.

(2) Power line

Ice making, cold storage and chilled storage equipment will require high power lines. The switchboards will be located in each of the rooms in order to facilitate secondary wiring.

(3) Generator

In order to cope with power failures, emergency power generators will be installed to run the ice making machine and two cold storage facilities, which are indispensable for the complex, to continue operating. Two 40 KW generators will be installed, and they will be connected for emergency use. In addition, the minimum illumination equipment required for work at night will also be connected to these generators.

(4) Light and power outlets

Fluorescent lighting will be used as general illumination in the processing plant and office in order to increase work efficiency. The cold storage and chilled storage facilities will use waterproof fluorescent lights. In order to facilitate landing work at night, the street lights will be located around the complex and the jetty will be illuminated (halogen lights).

All outlets, except for those in the office and the work room, will be waterproof, and outlets will be located on columns and walls so that transportable processing equipment can be used wherever necessary.

(5) Radio

Radio equipment will be expanded so that contact can be made with fishermen while they are working, landing times can be confirmed, receiving preparations can be made, and that work in general will be smoother. The radio equipment will be located in the office.

(6) Telephone

The work for incoming lines and for installation of telephones is to be done by the Government of Grenada. Therefore, after the installation locations are confirmed, the necessary conduits, etc. will be installed.

(7) Other

Lightning rods will be installed.

Television antenna and fire alarm equipment will not be installed.

4-3-8 Equipment plan

(1) Basic policy

The following items will be the basic policy for the equipment and material plans based on the contents of the project.

1) Equipment in models and in specifications which fit the jobs, meet the needs of the complex and which are appropriate for the technological level of the users will be introduced and installed, so that the functions of this complex and the purpose of this project are achieved.
2) In considering the procurement of expendables and replacement parts, an appropriate quantity will be introduced, so that there are no problems with the maintenance of machinery.
3) In considering normal resupply by the operating organization, simple material, such as fish boxes, etc., will be procured from the United States, Canada and neighboring countries.

(2) Fisheries distribution equipment

1) Insulated vehicles

In order to transport fish from the regional facilities at Gouyave and Grenville to the central Grand Mal complex, and to transport fish to the airport from Grand Mal, insulated vehicles are necessary. Considering the fluctuations in quantities transported because of the difference in catch between the busiest and slowest periods of the year, and functionality and economy, we believe that two vehicles should be allocated: a large insulated truck; and a smaller pickup type truck.

Large insulated truck: Maximum load 2 tons -- 1 unit
Pickup type insulated truck: Maximum load 1 ton -- 1 unit

2) Truck with crane

When this complex is completed, most of the large fresh tuna for export will be handled at Grand Mal. These fresh tuna must be handled quickly to maintain freshness, and they must be handled so that they are not deformed or damaged.
The size of tuna ranges from 1.2 to 1.5 m in length, and each weighs an average of 54 kg. In order to land these tuna at the jetty and to transport them from the jetty to the processing plant, a truck with a crane will be allocated.

Maximum load: 1 ton
Crane lifting capacity: 350 kg -- 2 units

3) Forklifts

In order to smoothly handle the fish boxes gathered from the various local facilities and the large fish and fish boxes in the processing plant, forklifts will be introduced and allocated. These are especially necessary to handle the tuna for export which have been packed in boxes. Each of these boxes weighs about 100 kilograms, so that moving them to the trucks and loading them is hard work for even two workers. Introduction of forklifts should make this work easier.

Lifting capacity: 1.5 ton 1 unit

4) Fish boxes

In order to transport the fish purchased at Gouyave and Grenville, and in order to smoothly execute the selection and storage work of fish landed at Grand Mal, fish boxes are necessary. In order cope with different sizes of fish and different uses, three types of fish boxes are necessary: types A (insulated with lids), B and C.

Type A: For transporting large fish, and gathering and transporting small fish.

Length 1,168 mm x width 508 mm x height 724 mm (external dimensions)

Gouyave	2 units	
Grenville	2 units	
Grand Mal	6 units	Total : 10 units

Type B: For storage of large fish, and division and storage of small and medium sized fish.

Length 1,048 mm x width 311 mm x height 337 mm

Gouyave	4 units	
Grenville	4 units	
Grand Mal	20 units	Total : 28 units

Type C : For division of small and medium sized fish, and storage of residue.

Length 1,359 mm x width 711 mm x height 635 mm

Gouyave	2 units	
Grenville	2 units	
Grand Mal	20 units	Total : 24 units

5) Carts

These carts are used to transport large fish and the above fish boxes with the complex. They will be made of stainless steel which is corrosion resistant.

Flat shaped carts

Length 900 cm x width 600 mm

Gouyave	2 units	
Grenville	2 units	
Grand Mal	4 units	Total : 8 units

Box shaped for transporting ice

Length 1,880 cm x width 813 mm x height 640 mm

Gouyave	2 units	
Grenville	2 units	
Grand Mal	4 units	Total : 8 units

(3) Material for processing

The facilities at Gouyave and Grenville do not have fish processing facilities, so that if the fish are not processed on board the fishing vessels, then this work will be conducted at the processing plant at Grand Mal. The work is as follows:

After both fish for export and for domestic consumption are delivered, they are weighed. After their entrails are removed, their heads, gills, scales, etc. are removed, then the fish are washed.

Then,

- Small fish for domestic consumption are partially processed, then frozen and stored; or
- Large fish for domestic consumption are frozen whole, then stored. Depending on the quantity to be shipped, they are cut with band saws after being taken out of storage, then they are packed with the vacuum packing machine and shipped out (some of these are returned to chilled storage). In order to conduct this work, the following equipment is required.

1) Cleaning tables (tabletop : Teflon)

Size : Length 2,400 mm x width 1,200 mm x height 600 mm : 8 units

2) Packing benches (tabletop : Teflon)

Size : Length 2,400 mm x width 900 mm x height 750 mm : 8 units

3) Work benches (stainless steel)

Size : Length 1,800 mm x width 1,200 mm x height 800 mm : 2

4) Scales (with a table)

Ranges

0 to 500 kg : 3

0 to 20 kg : 2

0 to 1 kg : 2

5) Band saw

For cutting large frozen fish : 1 unit

6) Vacuum packing machine

For vacuum packing fillets, frozen tuna and blocks of marlin in vinyl : 1 unit

(4) Quality inspection equipment : 1 set

(5) Equipment for the workroom (workshop) : 1 set

4-4 Implementation plan

4-4-1 Implementation policy

(1) Construction policy

The construction plans for this project will be based on the following policy:

1) Local manpower and material will be utilized as much as possible.
2) Protection of the surrounding environment will be considered.
3) Close communications with the local parties will be maintained in order to prevent trouble.
4) The culture and traditions of the other country will be respected.

(2) The scope of construction in this project is as follows:

1) Securing of the project site, and improving and preparing the grounds.
2) Vegetation and perimeter fence construction on the project site.
3) Construction of landing, processing, storage and ice making facilities.
4) Procurement of landing, transporting and processing equipment and facilities, and fishing vessel maintenance equipment.
5) Providing of personnel to supervise the execution and construction of the above.
6) Executing of the necessary procedures and acquiring the necessary authorization for the execution of the above.

(3) Items for which the Government of Japan and the Government of Grenada are responsible

The items for which the two governments are responsible are as follows:

[1. Items for which the government of Grenada is responsible, and exemption measures.]

1) Securing of the projected construction site and land to store construction equipment and materials, and removal of obstructions on the project site, including waterways.
2) Providing of a rock quarry for the supply of gravel for construction, and providing of a block construction yard.
3) Partial undertaking of the ground improvement works and maintaining the circumferential roads and the one for access.
4) Procedures for the exemption of tariffs and import charges which would be applicable to the equipment and material used in this project.
5) Procedures for the exemption of all taxes and other charges for which the Japanese would be applicable in Grenada when providing the construction equipment and materials, and their services.
6) Exemption of project execution authorization which related Japanese parties would require, and the acquisition and granting of other rights.
7) Effective maintenance, management and operation of the facilities which are constructed with the Grant Aid.
8) Construction and procurement of additional equipment necessary for the operation of the facilities.

[2. Items for which the government of Japan is responsible.]

1) Procurement of all equipment and manpower necessary for construction.
2) Execution of marine and land transport of imported equipment and machines necessary for construction, and payment for export insurance.
3) Assistance for project execution and bidding work, and consultant services for construction supervision.

4-4-2 Matters important to execution of the Project

The level of construction companies and the level of construction technology in Grenada cannot be said to be high, because of the lack of large scale construction projects in recent years. Private contractors only have the scale and technological level to build private residences and similar structures. There are few contractors which have experience in large scale construction, including pile construction. In addition, the technology in concrete construction and reinforced steel cocrete, and construction standards which control the quality of those are not stable.

Because of the above circumstances, it is necessary to confirm the following precautions in construction.

(1) A local construction company which can supervise the quality, processes and budget of large scale pile construction and concrete construction must be selected carefully.
(2) The main contractor must create an organization and make the construction plans after thoroughly considering the manpower and efficiency of the local construction company.
(3) Because pile construction and precast concrete construction will have to depend on imports from surrounding countries, the transporting of heavy equipment for construction and materials, quality control and process control will have to be conducted smoothly.
(4) In regard to concrete construction which will be conducted at the site, methods to install a concrete plant at the project site should also be considered.
(5) The construction methods for underground piping and other equipment which may be affected by uneven settling of the ground must be considered and executed.
(6) In order to prevent delays in the construction process due to the rainy season, the overall construction process and the content of work during the preparation period must be carefully discussed with the parties in Grenada.
(7) During construction, efforts must be made to maintain order and prevent theft at the construction site.
(8) Because the construction site is near private residences, safety management and management of cleanliness must be thorough.

4-4-3 Plan for supervision of construction work

After the signing of the design management contract with the government of Grenada, consultants will conduct surveys and hold final meetings with the local government. Then, they will make detailed design blueprints, structural calculations, quantity calculations, construction specifications, and other material required for bidding in Japan. After the material required for bidding is completed, plan authorization procedures, bid qualification examinations, and bid evaluations will be conducted. Then, a main contractor will be selected following the appropriate procedures.

After contracting for construction, the consultants will check the construction blueprints submitted by the contractor in Japan. Next, they will supervise factory production of fabricated materials, check materials to be exported for quality, conduct witnessed inspections, and inspect the loading of materials on ships.

When construction in Grenada starts, a supervising engineer will be dispatched. This engineer will adjust acceptance by the contractor, supervise construction, conduct quality control tests, witness completion tests, and write supervisory reports.

4-4-4 Procurement of equipment and materials

The construction materials required for this construction project are: sand, formwork material, protective masonry, cement, bricks, and steel (reinforcing steel bars, shaped steel), and architectural materials (blocks, bricks, paint, glass, steel fittings, wood fittings, hygienic ceramics, piping, etc.). Of these materials, sand, formwork material, protective masonry, blocks and bricks can be procured in Grenada. The other materials will have to be imported from the United States and other neighboring countries. Because similar public construction projects (shore protection construction, construction of government buildings, etc.) are being conducted in Grenada, and related construction is scheduled to be continuous in the future, there should be no problem with procuring the necessary construction materials.

In regard to heavy construction machines and methods of transporting them, the types and quantity of machines which can be procured locally are limited, so that they will have to be shipped from surrounding countries.

4-4-5 Implementation schedule

The period required for the civil engineering and building construction in this project—including construction to improve and prepare the site—is estimated at 21 months. Therefore, this project will be divided into two phases.

Project implementation chart is as shown in Table 4-17.

	Implementation design	Construction & equipment procurement	Total
Phase I : Civil engineering works	4 months	11 months	15 months
Phase II : Building construction	4 months	10 months	14 months

4-4-6 Estimated project expenses

A breakdown of expenses born by both Japan and Grenada based on respective share of responsibility can be estimated based on the conditions below:

(1) Expenses borne by Japan side

(2) Expenses borne by Grenada side

① Planting and drainage ditch construction cost : EC$ 40,000

② Asphalt plant demolition and mobilization cost : EC$ 106,500

③ Partial ground improvement cost : EC$300,000

④ Access road improvement cost : EC$100,000

(3) Calculation conditions

Time of calculation : February 1994

Construction period : As indicated in the implementation process table

4-5 Effects on the environment and countermeasures

Grenada is putting an emphasis on tourism which can utilize its beautiful natural environment and marine products, and the ocean is an especially important tourism resource.

This project involves facilities which are to be the center for the promotion of fisheries and those who depend on marine resources for their livelihoods. Therefore, it shall be located near the sea. As a result, careful considerations must be made during the planning and construction stages, so that the neighboring waters which are an important natural resource are not destroyed.

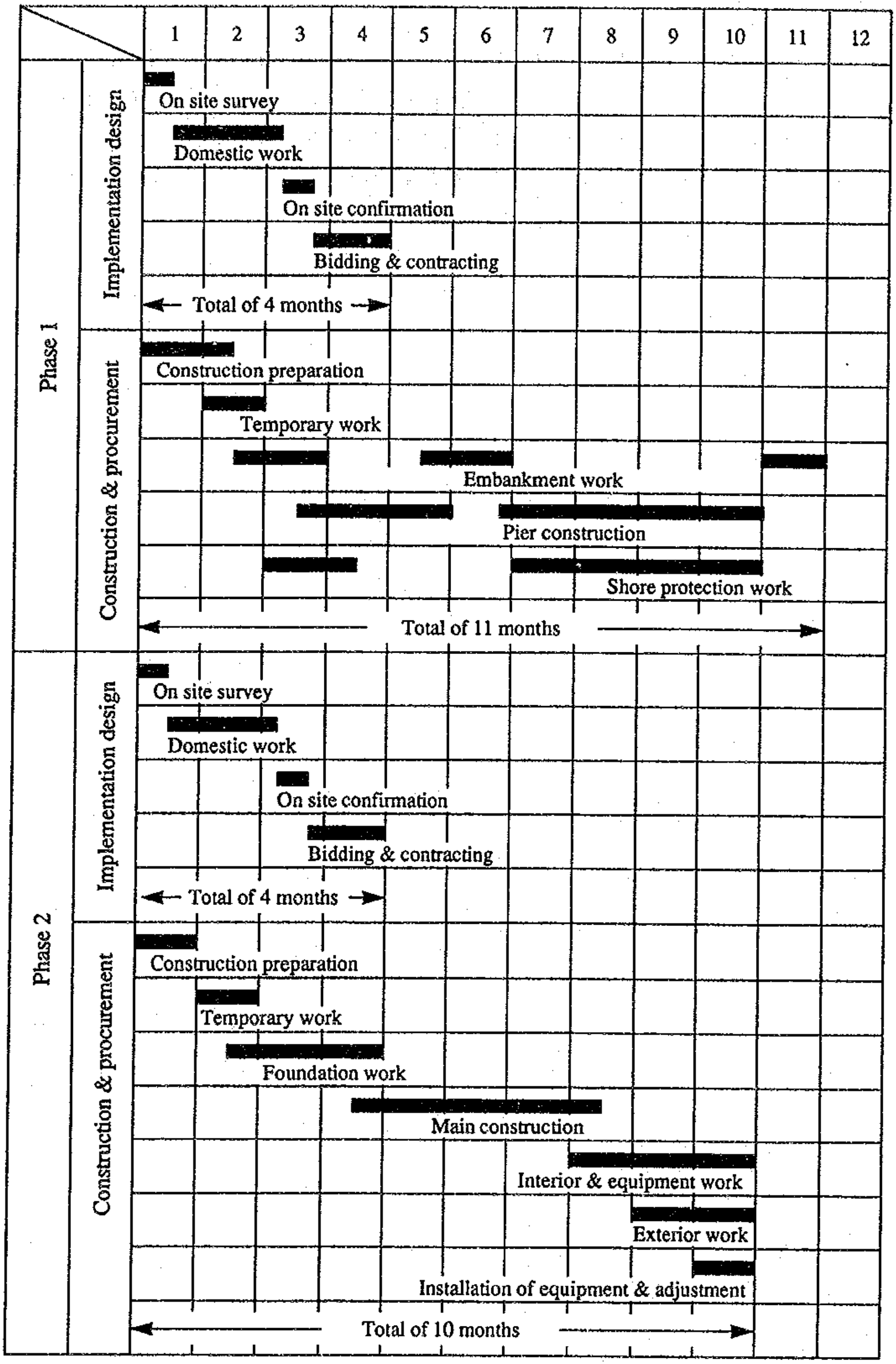
The marine facilities will require a pier and sea walls, so that a survey on the water depth and currents to a distance of 100 meters from the shore was conducted. As a result of the survey, we decided on the use of piles to construct the pier so that it would not disrupt the currents. The position and length of the pier have been determined after studying the present sea bottom. This includes the depth of water necessary for fishing vessels to moor. The design is such that no dredging will be necessary. There is little marine life such as coral and seaweed in the neighboring waters, nor are there any fish living in them. Therefore, we have determined that there will be little affect on the biological environment from pile construction.

Shore protection construction will not differ from the current shoreline to any great extent. Initially, gravel will be laid to prevent pollution of the waters by silt from earth used in construction behind the sea walls. In addition, temporary works will be made during construction to prevent silt from polluting the sea during the rainy season.

Because residences of fishermen and farmers are located around the access road to the project site, there is a possibility of traffic accidents involving the residents. In order to prevent such accidents the following measures will be taken: guards will be located at intersections and other important locations; leftover supplies and the like will be cleaned on a daily basis; the frequency and times when construction vehicles will be entering and exiting the site will be notified to the residents; etc. Also, in order to prevent inadvertent accidents on the project site involving nearby residents, gates and fences will be installed around the construction site so that unauthorized personnel cannot enter, and thorough safety precautions will be taken during construction.

The planned buildings will be built along a coastline which is relatively rich in vegetation. As a result, the roofs of the buildings will be very obvious from nearby residences and the road. Therefore, the plans call for the roofs to be painted green, so that sunlight will not be reflected too strongly from them, and so that the buildings will blend into the surrounding environment.

Table 4-17 Project Implementation Chart



CHAPTER 5

EFFECTS OF THE PROJECT AND CONCLUSION

CHAPTER 5 EFFECTS OF THE PROJECT AND CONCLUSION

5-1 Benefits of project implementation

Status quo and problems	Countermeasures in Project	Effects of Project
After promoting the development of small and coastal fisheries, the government of Grenada has promoted commercial fisheries. This was in an attempt to increase the catch and thereby improve the living standards of fishermen, and to expand the domestic and export markets. The following problems exist in the capital of St. George's, however, and they are limiting the nurturing and promotion of commercial fisheries. 1) Existing processing and storage facilities are growing old and they are limited in capacity. As a result, efficient production activities cannot be carried out. 2) Because the existing landing facilities are separated from the processing, storage and ice making facilities, there are obstacles to the carrying of ice on fishing vessels, landing of catches, and keep the freshness of catches. This is preventing the improvement of profitability. 3) The facilities required for the expansion, instruction and promotion of commercial fisheries are lacking. Therefore, there are unused marine resources and catches are not being used effectively. In addition, the processing of catches is bad, so that losses due to poor quality are high.	A fisheries complex in Grand Mal, near the capital, is to be constructed with the following functions, so that it can gather catches landed in regional areas, act as a distribution core for the domestic market and airport, and act as a landing base for commercial fisheries. 1) Landing of catches, and the safe and efficient docking of fishing vessels. 2) Acceptance of catch, and processing, storage, and sales of catches. 3) Distribution of marine products. 4) Support for fisheries activities. 5) Improvement in the quality of marine products.	Creating a commercial fisheries complex near the capital of St. George's will contribute to an increase in the catch and promote the fisheries industry. In addition, it will stabilize and improve the living standards of fishermen, and domestic demand and exports will expand. 1) By constructing processing and storage facilities near the jetty, landing of large fish, such as tuna, and delivery work will be conducted more smoothly. This will make it easier to maintain the freshness of catches. Furthermore, by constructing processing and storage facilities of an appropriate scale, distribution functions will be improved, thereby expanding domestic demand and promoting exports. 2) Because ice making facilities will be expanded and efficient sales will be possible, it will be possible to support the improvement in the quality of catches. This will contribute greatly to the effective use of resources (by eliminating waste).