

### 5-3 Social Evaluation

The coastal fisheries in Mauritius comprise mainly artisanal lagoon fishery, of which productivity is low and the income by fishermen is at a very low level. Under such circumstances, this project will bring a very bright social view where the techniques for shrimp culture industrialization are established, and a cooperative management business organized by fishermen themselves and taking job at shrimp culturing companies by fishermen are realized. As to the unit of shrimp culture farm to be realized approximately 10 ha area is considered to be appropriate and number of employees is estimated at approximately 15, with some fluctuation depending on the conditions. Accordingly for total area of 500 ha of shrimp farms, employment of totally 750 persons at 50 enterprises would be created. This will lead to securing of living bases for approx. 3,000 persons of 750 families a considerable contribution to the society. Since there are many unutilized lagoons in Mauritius, utilizing natural stones which are abundantly available and contemplating to enlarge culturing farms, will lead to the establishment of fisheries as a main stay of social economy in Mauritius.



**CHAPTER VI**

**CONCLUSION AND SUGGESTIONS**



## CHAPTER VI CONCLUSION AND SUGGESTIONS

### 6-1 Conclusion

The marine shrimp culture experimental station under the present project is to be a core of the shrimp culture industrialization development programme and the eventual purpose of the project is to develop the techniques of industrialized shrimp culture and to disseminate them. The targets of this programme are to develop the said techniques for Black Tiger Prawn by 1991, and to start production on a commercial basis in 1992; for marine shrimps, to develop their said techniques by 1993 and to start production on a commercial basis in 1994, and the projected volume of production of both shrimps for the year is 1240 tons and the farm area is 500 ha.

The original request of Mauritius focuses as its main object on the culture of "brackish" Black Tiger Prawn which needs freshwater, however, by analyzing the future prospect for development of shrimp culture in terms of "suitable field to culture", other shrimp species which are culturable in sole seawater are concluded to be taken up. As the above study of the future prospect has made clear the appropriateness of this project, a review on the kind and scale of needed facilities have been done taking into consideration the results of the site survey and other studies. The meaning of extending grant aid to this project by the Japanese Government is significant and its prompt implementation is required.

## 6-2 Suggestions

### 6-2-1 To Japanese Government

Considering the existing level of marine shrimp culture techniques in Mauritius, it is necessary to further develop the basic techniques, and at the same time early establishment of industrialization techniques is needed by conducting pilot tests. For this purpose the techniques already developed in the Southeast Asian countries are naturally to be introduced and also to be developed appropriately for use in Mauritius. In such case dispatch of the expert from Japan will further heighten the effectiveness of this project and make the progress of development faster. As a matter of fact an expert was dispatched from JICA for two years from 1983 to 1985, and played the pioneering role for shrimp culture in Mauritius. It is strongly recommended that such experts be dispatched again.

It is desired that two experts including one for seed production and the other for growing-out should be dispatched, and one of them should be a veteran who has much experience in executing technical development management, training and instruction comprehensively. Beside the dispatch of the expert, training of Mauritian aquaculture technical officers in Japan will accumulate the effectiveness of the project.

It is believed that the basis of marine shrimp culture in Mauritius will soon be established by this project and its promotion, and the industrialization begins to prosper within several years. However, the scale of facilities of this project is not large enough for demonstration but rather aims for the primary technical development. Accordingly, new construction plan will come up after several years for larger growing-out pond and hatchery with low construction and operation cost and adoptability for commercial project. Growing-out facilities of a large scale will be hopefully constructed by the Mauritian Government but as to large scale hatcheries, an opportunity will come up to consider financial assistance as well as technical assistance by Japanese Government because high technology is necessary for it. Its timing will be in the beginning of 1991.

6-2-2 To Mauritian Government

Management of this station will be under the organization of the Albion Fisheries Research Centre. However, since the main function of this station is field work on production rather than research, it is strongly desired to adopt a special working system by shifts for the operation of 24 hours a day and 7 days a week.

Mauritian Government shall construct a perfect protection fence around facilities in order to make assurance doubly sure; still maintenance of facilities and supervision of the products shall be carried out with full care of guarding.

Management, operation and maintenance of these facilities are requested to be secured fully by the Mauritian Government.

In the stage that the establishment of industrial techniques is prospected, demonstration ponds on a large scale will be desired to be constructed. These new facilities will not always be necessary to be constructed in the adjacent property to the Albion Fisheries Research Centre but rather in other potential site where freshwater intake is easy without pumping-up and where construction and operation cost is supposed to be very low. It should be constructed by Mauritian Government herself as a link in the chain of the Governmental policy.





## APPENDICES



APPENDIX

- App. 1 Minutes of Discussion on Basic Design Study for the Construction Project of the Marine Shrimp Culture Experimental Station
- App. 2 List of Members of Study Team
- App. 3 Itinerary of Study
- App. 4 List of Persons Concerning Basic Design Draft and Schedule
- App. 5 Natural Conditions on the Project Site
- App. 6 Infrastructure of the Planned Construction Site
- App. 7 Price Forecast of Cultured Shrimp
- App. 8 Estimate of Production Cost of Cultured Shrimp
- App. 9 List of Collected Reference

Minutes of Discussions

On

Basic Design Study

For

the Construction Project of the Marine Shrimp

Culture Experimental Station

In

Mauritius

Japan International Cooperation Agency (JICA), the Governmental Agency responsible for implementation of economic and technical cooperation programme of the Government of Japan, despatched the Basic Design Study Team on the Construction Project of the Marine Shrimp Culture Experimental Station in Mauritius.

The Team headed by Mr. Soichiro SHIRAHATA, National Research Institute of Aquaculture, Fisheries Agency, Ministry of Agriculture, Forestry and Fisheries, has conducted a field survey and held a series of discussions with Mauritius Government Officials concerned from November 23 to December 13, 1985.

Both Parties confirmed the results of the discussions attached herewith.

December 2, 1985

Port Louis.



.....  
Mr. Soichiro SHIRAHATA  
Leader  
JICA Study Team



.....  
Mr. R. Yat Sin  
Permanent Secretary,  
Ministry of Agriculture,  
Fisheries and Natural  
Resources

ATTACHMENT

1. The Project description is as follows:-

(1) Title of the Project.

The Construction Project of the Marine Shrimp Culture Experimental Station.

(2) Objective of the Project.

The Objective of the Project is to construct the Marine Shrimp Culture Experimental Station in order to get practical information necessary for the promotion of marine shrimp culture in Mauritius.

(3) Activities of the Station.

The following activities will be carried out in the Station.

(a) Research on and production of fry of marine shrimp and experimentation of growing-out of shrimp.

(b) Training in marine shrimp culture techniques.

(4) Location of the Project Site.

The Project site is located on the beach of Albion adjacent to the Albion Fisheries Research Centre as shown in ANNEX 1 subject to the result of the detailed study.

(5) Institutional Framework.

Ministry of Agriculture, Fisheries and Natural Resources of Mauritius is responsible for the execution of the Project. The Station shall belong to the Albion Fisheries Research Centre.

2. The Mauritius side has understood Japan's grant aid system explained by the Team, which includes a principle of using a Japanese consultant firm and a Japanese general contractor for the construction of the Station.

3. Major facilities and equipment requested to be provided by the Government of Japan are listed in ANNEX 2.

4. The Government of Mauritius will take necessary measures listed in ANNEX 3 on condition that the grant aid by the Government of Japan would be extended to the Project.

5. The result of the Basic Design Study shall be compiled in the Basic Design Study Report, which shall be submitted to the Government of Mauritius by the end of May, 1986.

ANNEX 1

Project Site

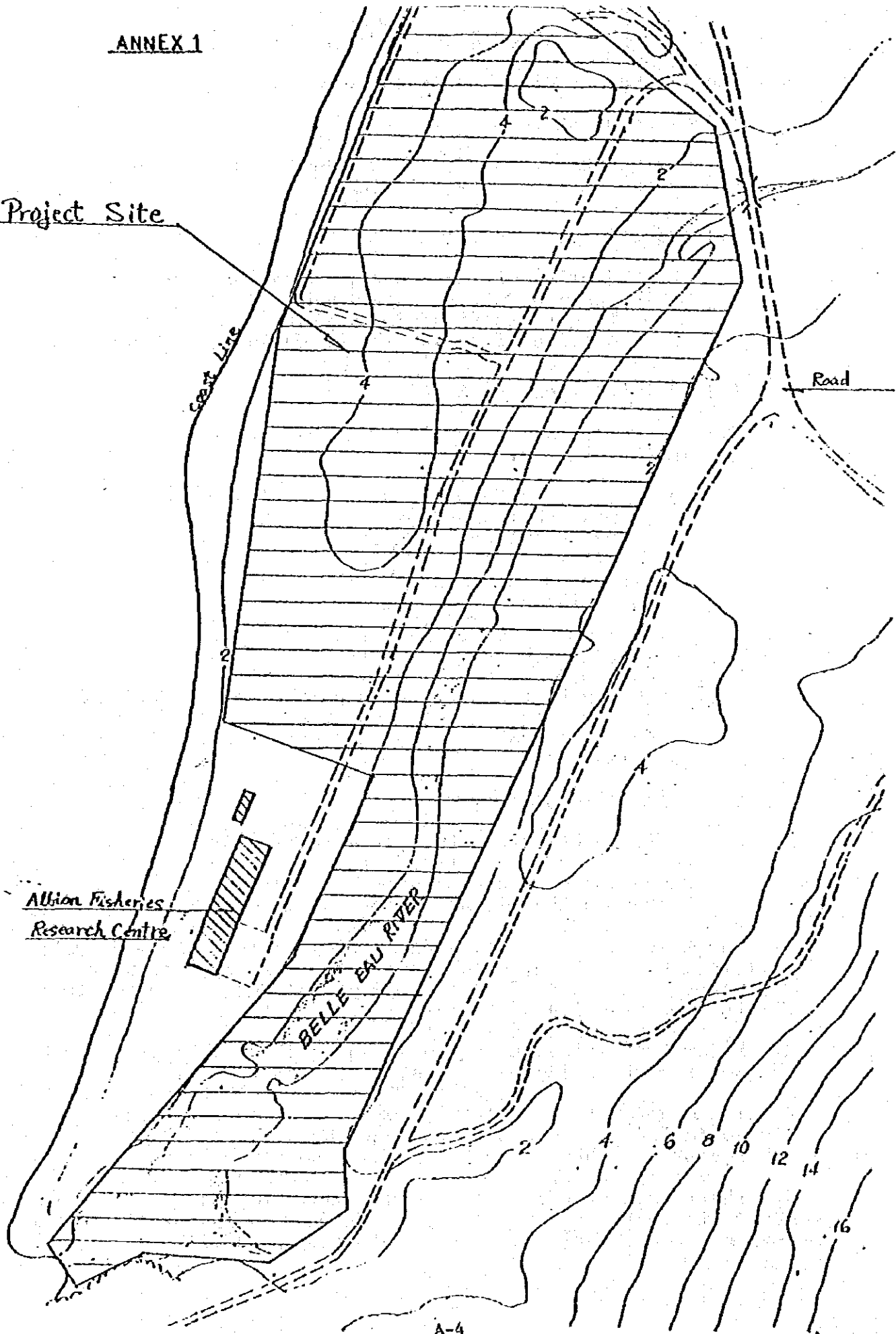
East Line

Road

Albion Fisheries  
Research Centre

BELLE BAU RIVER

A-4



## ANNEX 2

### I. List of Facilities

#### 1. Research Building

- (1) Chief technician room
- (2) Technician office room
- (3) Visitor and trainee room
- (4) Watchman room
- (5) Dry laboratory
- (6) Wet laboratory
- (7) Plankton pure culture room
- (8) Overlook inspection room
- (9) Miscellaneous

#### 2. Hatchery Complex

- (1) Complex building structure
- (2) Maturation tank
- (3) Phytoplankton culture tank
- (4) Zooplankton culture tank
- (5) Hatching and early stage larval tank
- (6) Post larval tank
- (7) Fry gathering pit and system
- (8) Aeration system incl. compressor
- (9) Water supply system incl. pump and pipe
- (10) Agitator with motor
- (11) Electric power system incl. lighting and generator
- (12) Filtering system and elevated reservoir tank
- (13) Drain system
- (14) Storage
- (15) Miscellaneous

#### 3. Growing-out Practice Complex

- (1) Seawater supply system
  - (i) Introduction pipe and suction pit system
  - (ii) Pump station
  - (iii) Pump and diesel engine
  - (iv) Spillway
- (2) Freshwater supply system
  - (i) Dam type reservoir with emergency spillway
  - (ii) Pump station with pump and diesel engine
  - (iii) Well system
  - (iv) Spillway
- (3) Water mixing pond
- (4) Water supply channel and discharge channel
- (5) Experimental pond
- (6) Pilot and demonstration pond
  - (i) Breeder rearing pond
  - (ii) Nursery pond
  - (iii) Growing-out pond

- (7) Experimental barachois
- (8) Electric power system for paddle wheel and lighting
- (9) Dry storage
- (10) Cold storage
- (11) Operational working shop
- (12) Miscellaneous

## II. List of Major Equipment and Materials

### 1. Equipment for Research and Training Sector

- (1) Laboratory equipment
- (2) Field operation equipment
- (3) 4WD vehicle
- (4) Miscellaneous

### 2. Equipment for Hatchery Sector

- (1) Mobile tank for plankton culture and experimental rearing of larva
- (2) Artemia hatching tank
- (3) Refrigerator
- (4) Net screen box for hatching tank and plankton tank
- (5) Net for spawning operation and rearing larva operation
- (6) Fry transfer container
- (7) Oxygen cylinder
- (8) Truck
- (9) Miscellaneous

### 3. Equipment for Growing-out Sector

- (1) Tide gauge
- (2) Paddle wheel
- (3) Vertical pump
- (4) Flat boat with outboard engine
- (5) Harvesting gear such as setnet, drag net, cast net, etc.
- (6) Harvesting equipment such as net frame box, scoop net, etc.
- (7) Feed spreader
- (8) Feed container
- (9) Live shrimp transfer container
- (10) Chilled water container
- (11) Forklift
- (12) Truck
- (13) Remote control searchlight system
- (14) Wireless phone
- (15) Miscellaneous

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ANNEX 3

Major undertakings to be taken by the Government of Mauritius.

1. To secure a plot of land.
2. To clear and level the site.
3. To construct the gate and fence in and around the site.
4. To provide facilities such as distribution of electricity, water supply, drainage, gas supply and telephone lines up to the Project site.
5. To ensure prompt unloading and customs clearance for the goods imported by the contracted Japanese firms for the Project.
6. To exempt Japanese nationals from customs duties, internal taxes and other fiscal levies which may be imposed in Mauritius, with respect to the supply of the products and services under the Grant.
7. To accord Japanese nationals whose services may be required in connection with the supply of the products and the services under the Grant such facilities as may be necessary for their entry into Mauritius and stay therein for the performance of their work.
8. To maintain and use properly and effectively the facilities constructed and equipment purchased under the Grant.
9. To bear all the expenses other than those to be borne by the Grant, necessary for construction of the facilities as well as for the transportation and the installation of the equipment.

MINUTES OF DISCUSSIONS

ON

THE CONSTRUCTION PROJECT OF MARINE SHRIMP CULTURE

EXPERIMENTAL STATION

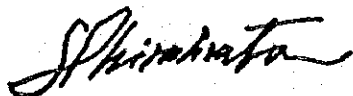
IN MAURITIUS

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In response to the request of the Government of Mauritius for grant assistance for the construction project of Marine Shrimp Culture Experimental Station (hereinafter referred to as "The Project"), the Government of Japan decided to conduct a basic design study on the Project and entrusted the study to the Japan International Cooperation Agency (JICA). JICA sent to Mauritius the team headed by Mr. Soichiro Shirahata, National Research Institute of Aquaculture, Fisheries Agency, Ministry of Agriculture, Forestry and Fisheries from November 20 to December 14, 1985.

As a result of the study, JICA prepared a draft report and despatched a mission to explain and discuss it with the Mauritius Government officials concerned from March 1 to March 15, 1986. Both parties had a series of discussions on the Report and agreed to recommend to their respective Governments that the major points of understanding reached between them, attached herewith, should be examined towards the realization of the Project.

March 11, 1986  
Port Louis.



(Soichiro Shirahata)  
Leader  
JICA Mission

A-8



(R. Yat Sin)  
Permanent Secretary,  
Ministry of Agriculture,  
Fisheries and Natural  
Resources

ATTACHMENT

1. The Report principally satisfies the Mauritius side and appropriate alterations in design agreed during the discussions will be incorporated in the Final Report.
2. The Mauritius side understood Japan's grant aid system and the necessary measures to be taken by the Mauritius side as shown in ANNEX 3 of Minutes of Discussions on the Project signed on December 2, 1985, on condition that the grant aid by the Government of Japan would be extended to the Project.
3. The Mauritius side ensures that facilities of the Project constructed under the Grant Aid be maintained and used properly and effectively for the execution of the Project.
4. The Final Report (10 copies in English) will be submitted to the Mauritius side by the end of May, 1986.

*Jin*

*[Signature]*

App. 2 List of Members of Study Team

(1) Basic Design Study

Team Leader	Soichiro Shirahata	National Research Institute of Aqua- culture, Fisheries Agency
Project Coordinator	Shigeto Hase	Grant Aid Division Ministry of Foreign Affairs
Aquaculture Development Planner	Mitsutake Miyamura	Taiyo Gyogyo K.K.
Seed Production Spe- cialist	Takemi Ichimura	"
Architect	Tadatsugu Otsuyama	"
Civil Engineer	Kozo Matsumura	"

(2) Explaining Basic Design Draft

Team Leader	Soichiro Shirahata	National Research Institute of Aqua- culture, Fisheries Agency
Project Coordinator	Takeshi Komori	Japan International Cooperation Agency
Aquaculture Development Planner	Mitsutake Miyamura	Taiyo Gyogyo K.K.
Architect	Tadatsugu Otsuyama	"

App. 3 Itinerary of Study

(1) Basic Design Study

Day

1	Nov. 20	1985	Wed.	Lv. Tokyo 21:00
4	23		Sat.	Ar. Mauritius 14:30
5	24		Sun.	Meeting 09:00 - 12:00 Team, Dr. Enomoto, Tsuchiya
6	25		Mon.	Courtesy Call, Minister and Vice-Minister of Agriculture, Fisheries and Natural Resources. Conference with the Fisheries Division visit to the Albion Fisheries Research Centre. Arrangement with DDS Irrigation on a boring survey.
7	26		Tue.	Land Survey, Tamarin District, Salt Field, Barachois, La Ferme Freshwater Aquaculture Station Aeroview Survey from a helicopter Preliminary Survey of Site Arrangement with Mr. Takano, secretary of the Japanese Embassy in Madagascar Team Meeting.
8	27		Wed.	Land Survey, East and Northern Coast Preparation of Site Measurement
9	28		Thu.	Arrangement with Mr. Namjan, Ministry of Works Official on collection of data and information of Construction Regulations and Standards, visit to the Land Used Project Division of the Ministry of Agricul- ture, Fisheries of Natural Resources for the above objectives. Visit to the Central Water Authority to collect freshwater source data and information Visit to the Ministry of Housing to get Land Register Chart Drafting Minutes, Team Meeting.

<u>Day</u>			
10	Nov. 29, 1985	Fri.	Discussion with the Chief of the Fisheries Division on Minutes, present of draft minutes Visit to the Forest Division of the Ministry to collect data and information on legal management of rivers Team Meeting to discuss site survey and positioning of seawater collection system.
11	30	Sat.	Draft of lay-out of the facilities Site survey, Set of standard lines, Staking, level measurement
12	Dec. 1	Sun.	Arrangement of data collected
13	2	Mon.	Visit to Livestock Feed Ltd. Site and standard lines survey, level measurement water quality survey, attendance of reception sponsored by the Japanese Government and the Mission. Exchange initialed minutes.
14	3	Tue.	Team leader and Mr. Hase leave for Madagascar, arrangement of a boring contract, site survey, cross-section topographic survey, water quality survey.
15	4	Wed.	Arrangement with the Fisheries Division on data and information collection, site survey, cross-section topographic survey, seabottom geological survey, water quality survey, and preparation of boring survey (DSS Irrigation)
16	5	Thu.	Earth quality survey by boring and ditching, Belle Eau River Survey, water quality survey Arrangement with L.C. Lam Thnon Miue, a Agricultural Chemistry Div. official to collect agricultural chemicals information at the Fisheries Div. Office.
17	6	Fri.	Visit to the Agriculture Extension Service to collect agricultural chemicals information, visit to Concrete Pipe of Products Ltd., Premixed Concrete Ltd., Long Till Ltd. and general construction to study the prices of construction materials
18	7	Sat.	Complete boring survey, measurement of Belle Eau River, water quality survey, measurement of the facilities especially tanks of the Albion Fisheries Research Centre.
19	8	Sun.	Arrangement of data collected

Day

20	9	Mon.	Visit to cold storage companies: New Cold Storage Co., Ltd., Fisheries Cooperative Cold Storage, Happy World Storage, and Panagora Marketing Co., Ltd. Visit to construction companies to study prices: Randabel & Son Ltd., United Basalt Ltd., and Building & Engineering, Water Quality Survey
21	10	Tue.	Collection of data and information lacked, confirmation of standard line measurement and level measurement. Collection of the prices of construction materials, collection and catch of breeder shrimp for study.
22	11	Wed.	Land survey of Southern Coast Visit to Plastic Pipes & Production for price study. Visit to the Ministry of Works, to collect cost information of construction works ordered by the Government
23	12	Thu.	Receive additional data and information from the Fisheries Div. Visit to the Electric Power Corporation to collect electric works information, Receive the results of the boring survey.
24	13	Fri.	Courtesy call to the Minister and Vice- Minister of the Agriculture, Fisheries and Natural Resources Greeting to Fisheries division officials concerned.  Lv. Mauritius 21:00 MK#746
25	14	Sat.	Ar. Tokyo 21:15

(2) Explaining Basic Design Draft

<u>Day</u>					
1	March	1	1986	Sat.	Lv. Tokyo
2		2		Sun.	Ar. Pari
3		3		Mon.	Lv. Pari
4		4		Tue.	Ar. Antananarivo, Madagascal Visit to Embassy of Japan Ar. Mauritius
5		5		Wed.	Meeting with Vice-Minister of Agriculture, Fisheries and Natural Resources on Basic Design Draft. Conference with the Fisheries Division on Basic Design Draft.
6		6		Thu.	Visit to the Albion Fisheries Research Centre and Site. Conference with Technical officers on Construction plan and operation plan of the Project. Visit to coastal area.
7		7		Fri.	Conference with the Fisheries Division. Visit to Trou Paufaron fishing port facilities.
8		8		Sat.	Inner discussion on the draft report. Visit to the fishing ground of adult shrimp
9		9		Sun.	Arrangement of data collected.
10		10		Mon.	Conference with the Fisheries Division. Courtesy call to Ministry of External Affairs and Ministry of Economic Planning and Development. Discussion on draft Minutes.
11		11		Tue.	Signed Minutes. Meeting with the Minister of Agriculture, Fisheries and Natural Resources. Courtesy call to the Honorary Consul- general of Mauritius.
12		12		Wed.	Attended XVIII Anniversary of Mauritius Independence Day Lv. Mauritius
13		13		Thu.	Ar. Zurich Lv. Zurich Ar. Amsterdam
14		14		Fri.	Lv. Amsterdam
15		15		Sat.	Ar. Tokyo



App. 4 List of Persons Concerning Basic Design Study

Hon. N. Déerpalsingh	Minister of Agriculture, Fisheries & Natural Resources
Mr. R. Yat Sin	Permanent Secretary, Ministry of A.F. & N.R.
Mr. S.C. Seéballuck	Principal Assistant Secretary, Ministry of A.F. & N.R.
Mr. M. Munbodh	Acting Divisional Scientific Officer (AFRC)
Mr. I. Jehangeer	Scientific Officer (AFRC)
Mr. Vo. Chineah	" ( " )
Mr. G. Dewakar	" ( " )
Mr. G. Dhaneshwar	" (Freshwater Aquaculture Station)
Mrs. R. Veerapen	Administrative Officer, Fisheries Division
Mr. Cyril Nicolas	Permanent Secretary, Ministry of External Affairs
Mr. R. Bheenick	Director, Ministry of Economic Planning and Development
Mr. C.A. Hare	Honorary Consul General for Japan in Mauritius
Mr. Y. Takano	Conseiller, Ambassade du Japon, Tananrive
Dr. Y. Enomoto	JICA Expert (Marine Biologist)
Mr. Nishioka	JICA Expert (Civil Engineer)
Mr. Namjan	Ministry of Works
Mr. Lam Thuon Mine	Agricultural Chemistry Division, Divisional Scientific Officer
Mr. J.C. Appapoulay	Agriculture Extension Service, Senior Technical Officer
Mr. J. Li Kan Tin	Happy World Storage
Mr. M. Ng Man Sun	New Cold Storage Co., Ltd., Sales Manager
Mr. L.M.C. Jullienne	Panagora Marketing Co., Ltd., Processing Manager
Mr. P. de Maroussem	Owner of Grazing Ground in Wamlar
Mr. J.P. Hardy	Livestock Feed Ltd., Manager
Mr. J. Fanchette	" , Nutritionist

Other Governmental Officers of Ministry of Housing, Ministry of Works, Land Use & Project Division, Forest Division, Central Water Authority, etc.

Other persons of private companies such as Concrete Pipe & Product, Ltd., Premix Concrete Ltd., Long Till Ltd., General Construction, Randabel & Son Ltd., United Basalt Ltd., Building & Engineering, Plastic Pipes & Production, etc.

## App. 5 Natural Conditions of the Project Site

### (1) Topographic Condition

Topographic map of the project site is shown in Fig.-2.

The project site adjoined Indian Ocean in the west side and the Belle Eau River in the east side is flat land developed like a sand spit.

The result of topographic survey presented in Fig.-3 shows that the site is almost flat and that the average ground level and the undulation are  $\pm 4.0^m$  and  $\pm 0.5^m$  respectively.

### (2) Soil Condition

Soil investigation during the field survey

Boring work and excavation work were conducted by a local boring firm under the supervision of the team.

#### a) Investigation method

The rotary boring method was adopted for this investigation and also the trial pit method was adopted for observation of soil stratum. For the boring, standard penetration tests were carried out, and samples were taken by means of thin-wall samplers.

Physical tests were conducted at the University of Mauritius.

#### b) Boring location

Four different locations on the land and one location in the sea were determined, as shown in Fig. 3.

#### c) Investigation results

Fig.-4 illustrates the boring logs with the N values at two boring locations and trial pit logs. It was cleared from this investigation on the land that the site is composed of coral sand moderately compacted.

From the results of trial pit excavated  $3^m$  depth from the ground surface, it was judged that ground water level lower than  $+1.0^m$ .

At the sea boring location, sub-surface materials are composed of three layers.

◦ First layer            -0.9 - -2.9

Coarse sand layer

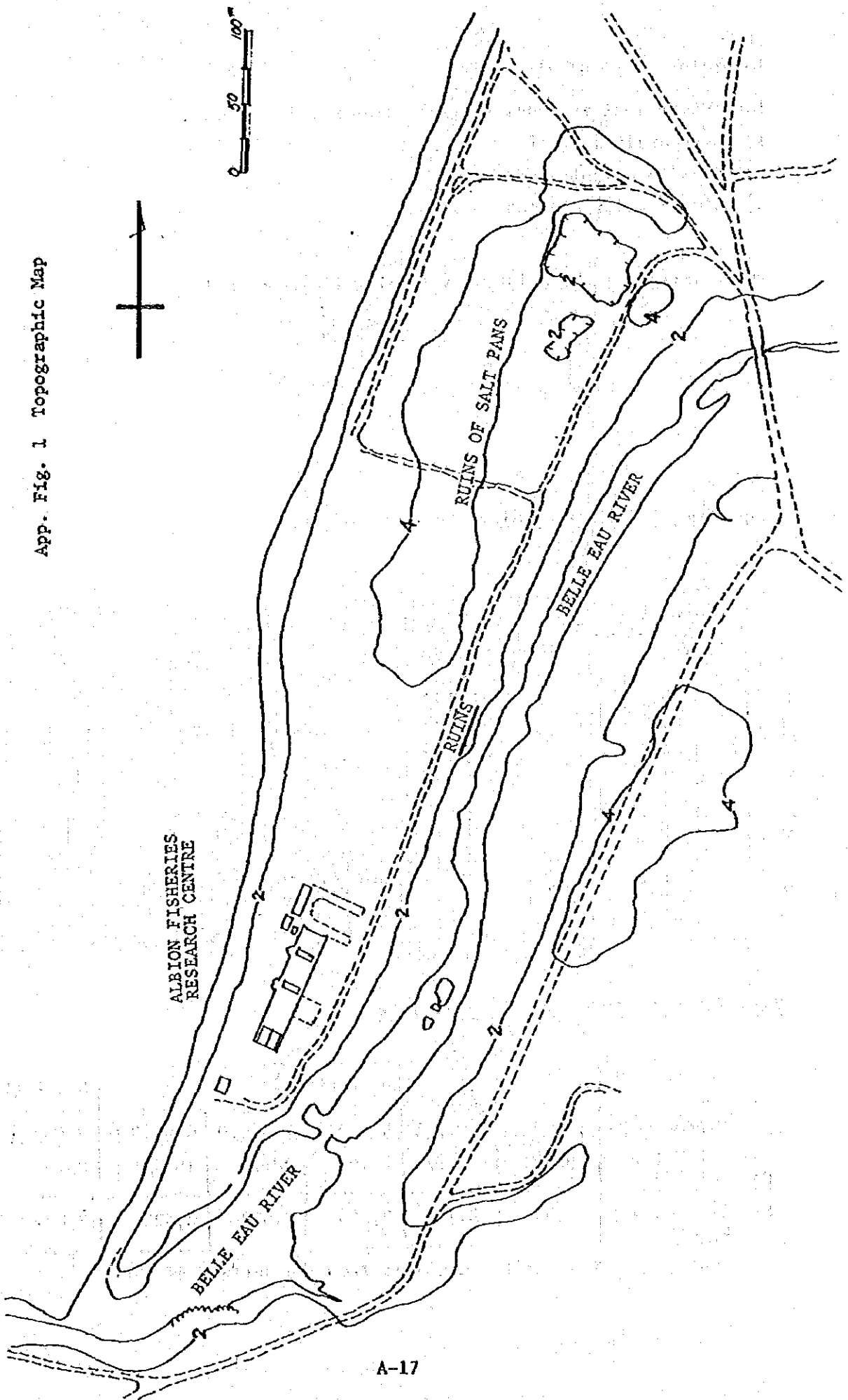
◦ Second layer        -2.9 - -5.9

Dense brown clay having N value 30

◦ Third layer         -5.9 -

Moderately weathered basalt

App. Fig. 1 Topographic Map



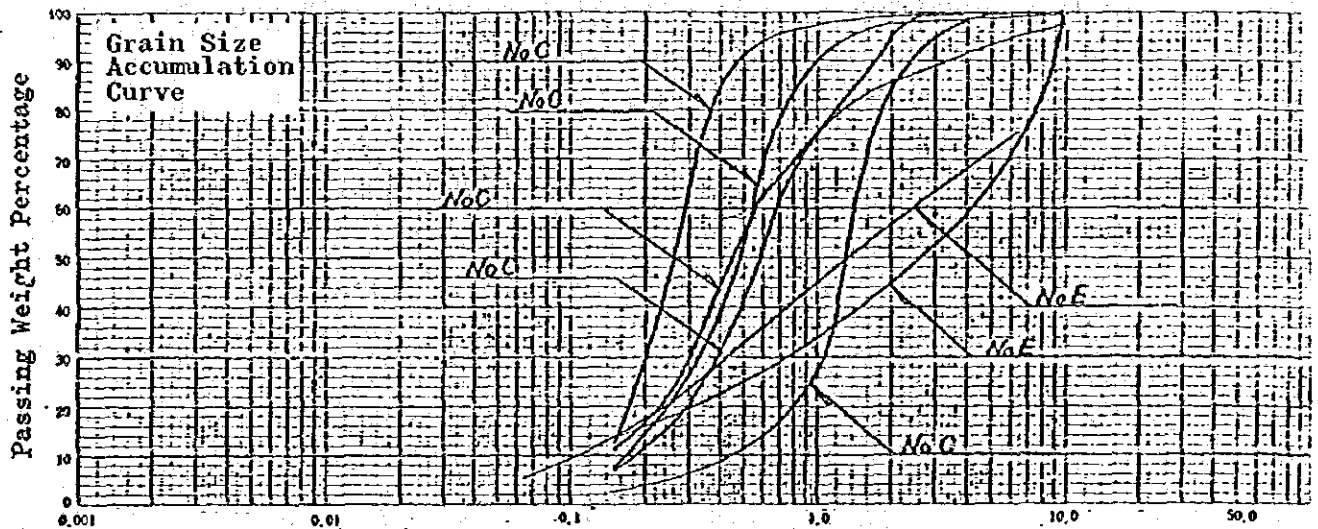
**Laboratory Test Result**

Laboratory Test includes the following physical tests.

- 1) Sieve analysis test
- 2) Specific weight
- 3) Natural water content

The results are shown in the following figure & Table.

App. Fig. 2 Result of Sieve Analysis Test

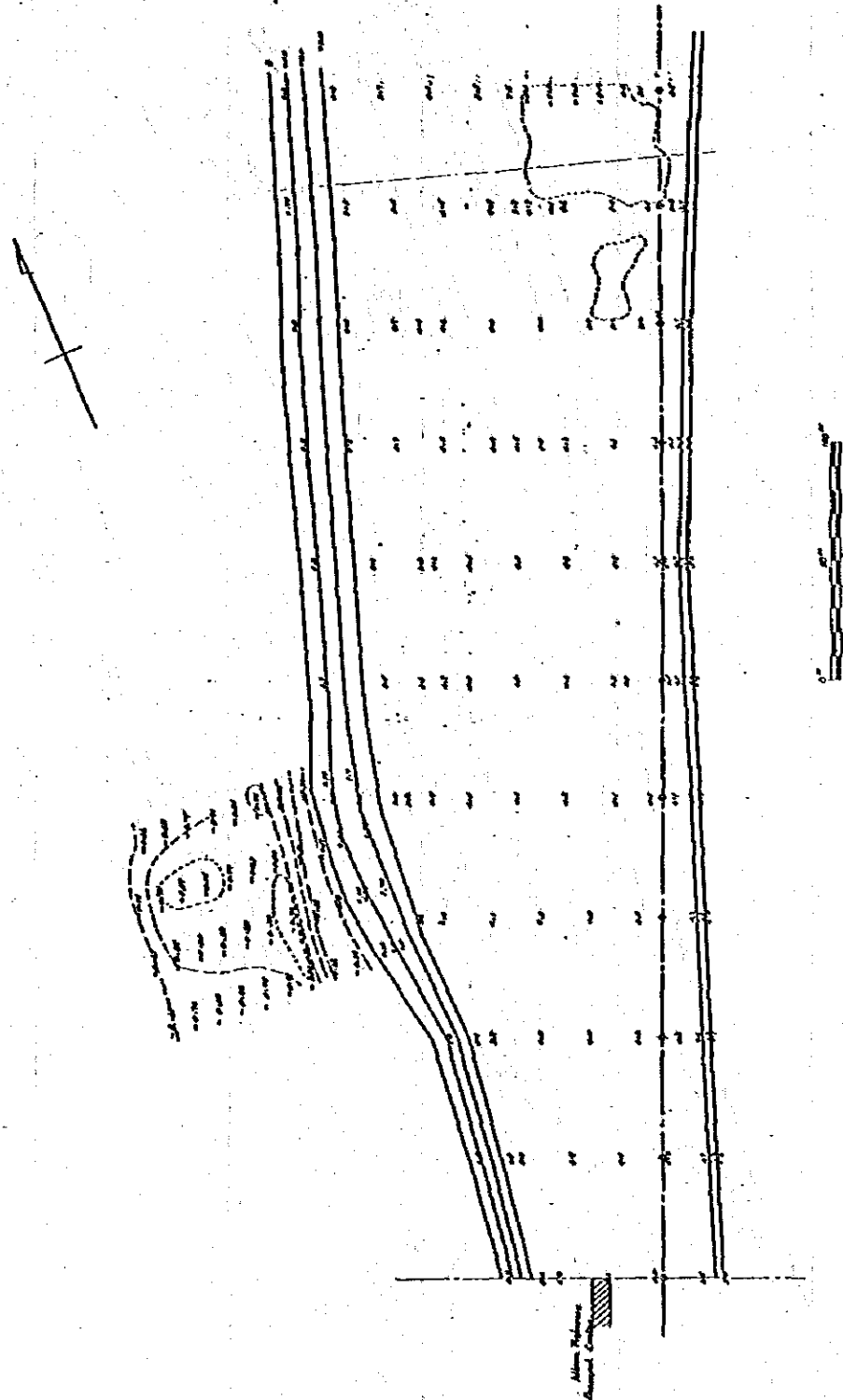


App. Table 1 Result of Physical Test

Station	No. C (Land)					No. E (Sea)
	1.5-2.0	2.0-2.5	4.5-5.0	7.5-8.0	9.0-10.0	2.0-2.5
Natural Water Content (%)	9.10%	19.9%	17.6%	22.7%	10.5%	23.4%
Specific Weight kg/m <sup>3</sup>	2,532	2,713	2,806	2,572	2,525	2,624

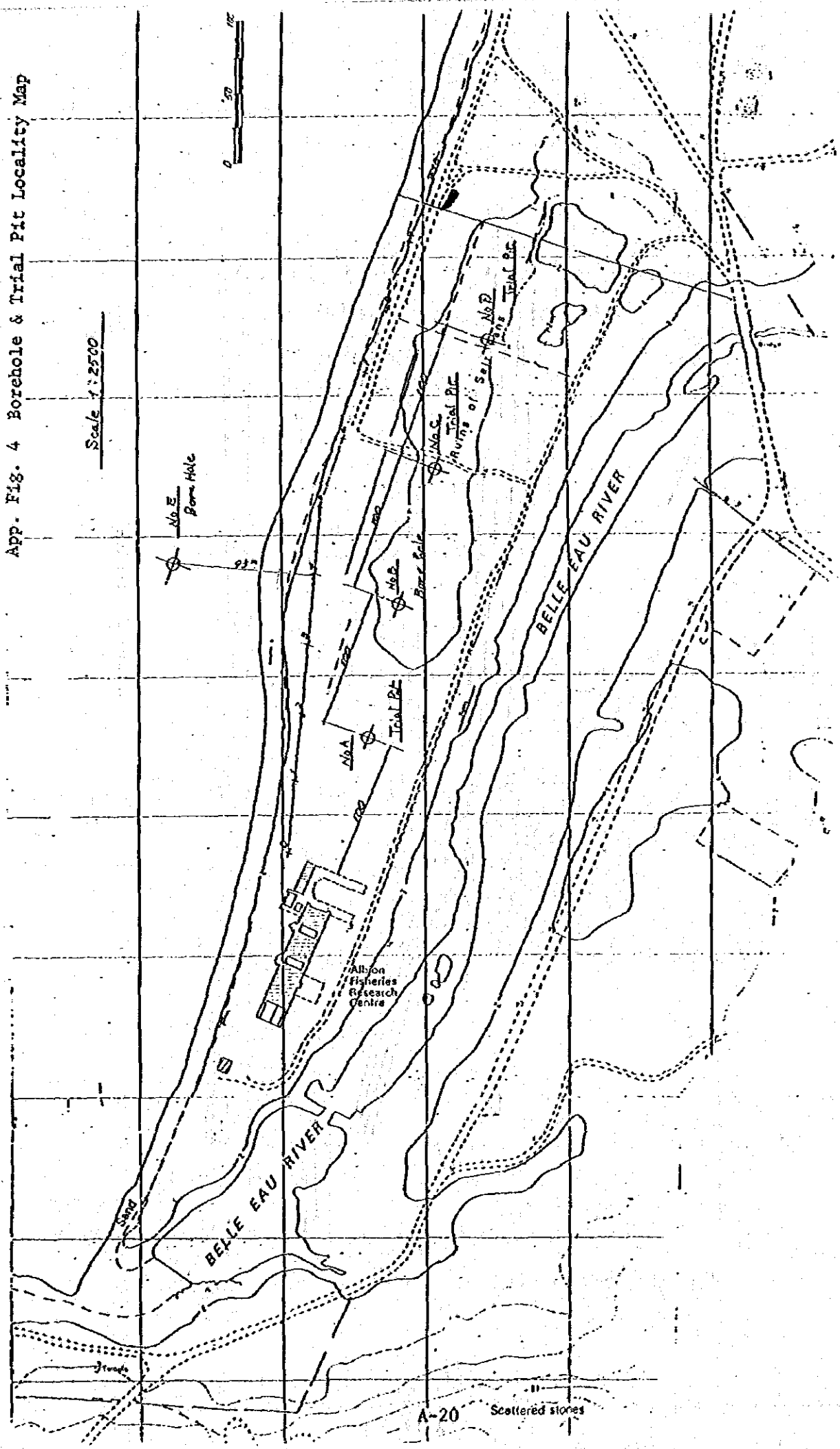
Note: Depth indicates distance from the surface of earth

App. Fig. 3 Result of Site Survey

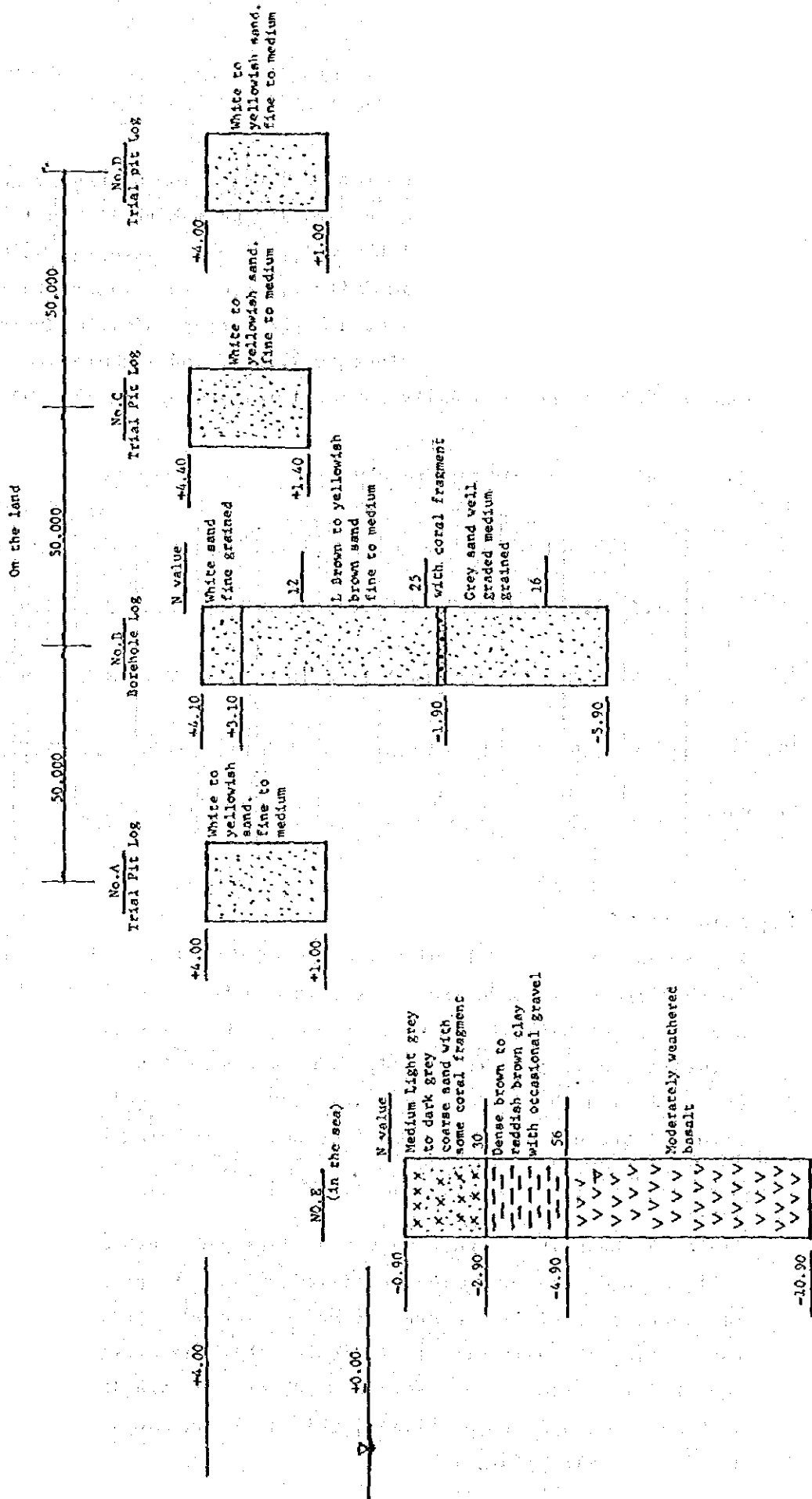


App. Fig. 4 Borehole & Trial Pit Locality Map

Scale 1:2500



App. Fig. 5 Boring Log



(Scale Vert : 1/100)

### 3) Meteorological Condition

#### (1) Temperature

Table-11 shows, the annual temperature fluctuation at Medine located on 5km south from Albion. In summer, the mean highest and lowest temperature are 30.5°C and 21.6°C respectively, averaging 26°C during these months. The mean daily range of temperature in summer is about 9°C. In winter, the mean highest temperature is 26.8°C, while the mean lowest temperature is 17.6°C, and the average temperature is 22°C. The mean daily range of temperature is also 9°C.

App. Table 2 Monthly and Yearly Means of Temperature

1951-1975	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Yearly mean
Mean Maximum (Tx)	31.1	31.2	30.8	30.0	28.5	26.4	25.8	25.5	26.6	27.8	29.5	30.5	28.6
Mean Minimum (Tn)	22.8	22.5	22.3	20.9	19.1	17.4	16.9	17.1	17.1	18.0	19.8	21.3	19.6
Mean = $\frac{T_x + T_n}{2}$	26.9	26.9	26.5	25.5	23.8	21.9	21.3	21.3	21.9	22.9	24.7	25.9	24.1
Mean Daily Range $T_D = T_x - T_n$	8.3	8.7	8.5	9.1	9.4	9.0	8.9	8.4	9.5	9.8	9.7	9.2	9.0

#### (2) Rainfall

Fig-5 shows the rainfall distribution of Mauritius Island. As shown in the Figure, Western side of the island including Albion is dry area compared with other area. Table-12 shows the average monthly rainfall over a 30-year period, as measured at Albion, it is relatively dry in Albion throughout the year, although seasonal variations in rainfall are conspicuous, with less than 50mm being registered during May and November, and over 100mm during the months of December through April.

Table-13 shows the average number of days per month during which rainfall reached or exceeded the specified value. In preparing this table, the average rainfall measured at Medine for 30 years. As shown in this table, the data clearly indicates that the average number of days when rainfall reaches or exceeds 0.1mm and 5mm are 181.6 days and 35.6 days per year respectively, this area as many number of rainy days but little rainfall.



App. Table 3 Selected Rainfall Stations in Mauritius  
Annual Normals in Millimetres, (1951 - 80)

Station No. & Name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
12740 Albion	120	139	143	73	39	25	18	15	13	15	25	102	727

App. Table 4 Average Number of days per month on which Rainfall reached or exceeded the values specified in the first column (Millimetres)

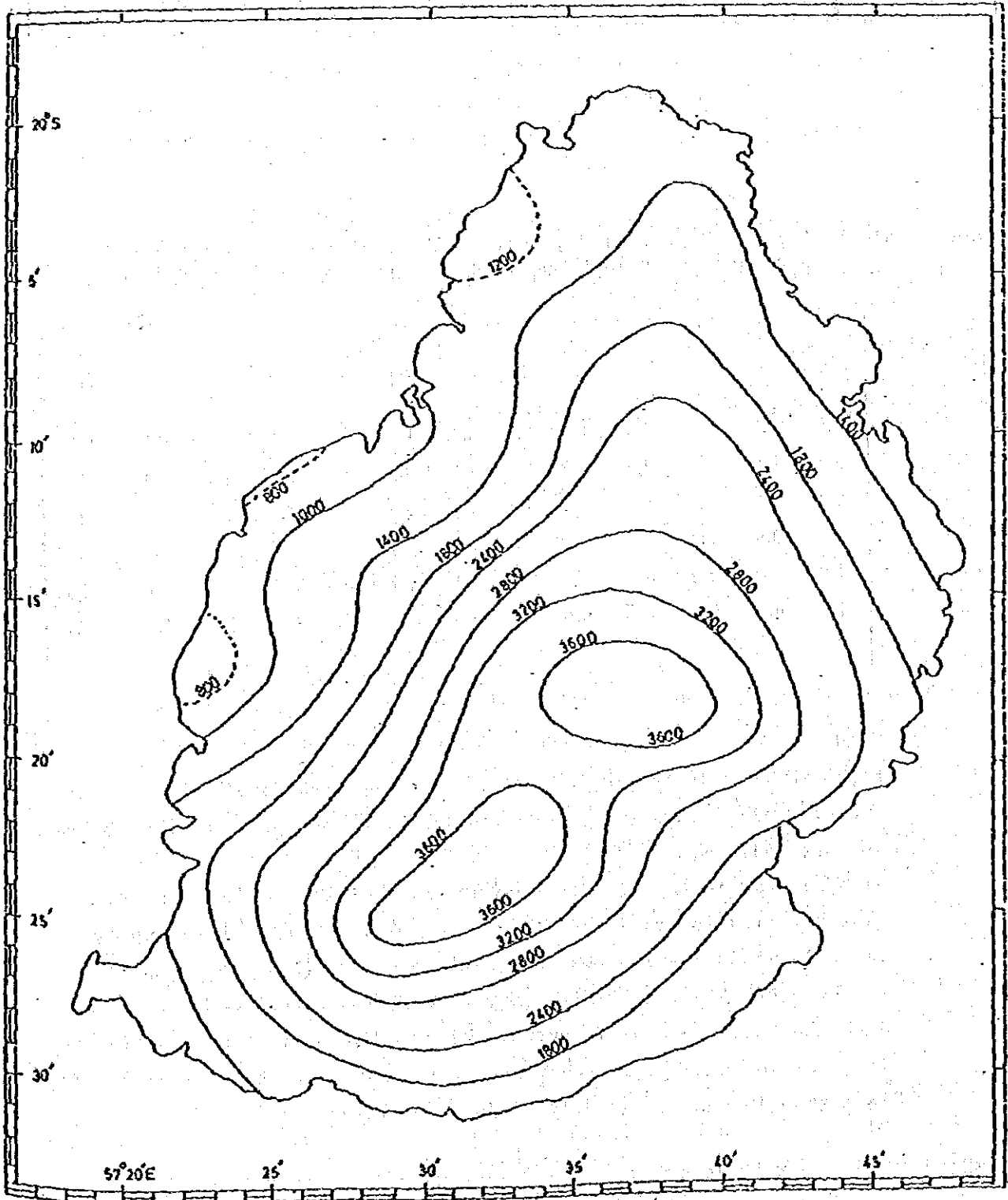
MONTH RAINFALL (mm)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
	0.1	10.5	10.5	10.7	8.2	5.7	6.0	5.1	4.3	3.5	4.3	4.1	8.7
1.0	9.3	9.9	10.3	7.8	4.7	4.7	3.5	3.3	2.1	3.4	3.7	8.1	70.8
5.0	5.1	5.5	6.0	4.3	2.3	1.7	1.1	0.9	0.7	1.1	1.9	5.0	35.6
10.0	3.7	3.9	3.7	2.8	1.3	0.9	0.4	0.4	0.3	0.5	0.7	3.1	21.7
25.0	1.9	2.0	1.3	0.9	0.3	0.3	0.1	0.2	0.2	0.1	0.5	1.7	10.1
50.0	1.1	0.1	0.4	0.3	0.0	0.1	0.0	0.0	0.0	0.0	0.1	0.7	2.8

### (3) Wind

Fig-6 shows monthly wind roses based on the records of normal winds and classified into two categories less than and greater than 18 knots in Fort William.

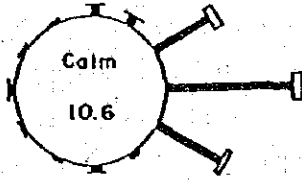
With regards to the distribution of winds of less than 18 knots, easterly winds prevail throughout the year. On a seasonal basis, easterly winds are the most frequent in summer (November - April). On the other hand, in winter (May - October), winds from the E30°S direction are the most frequent. Winds of greater than 18 knots are frequent in January, February and July. As in the case of winds of less than 18 knots, easterly winds also prevail.

App. Fig. 6 Rainfall Normals 1951 - 1980

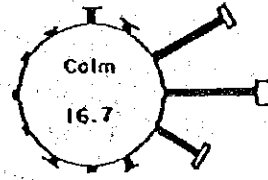


App. Fig. 7-1 Windroses

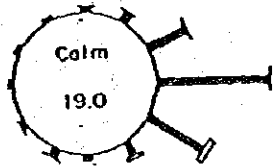
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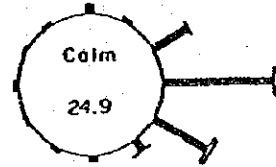
FEB.



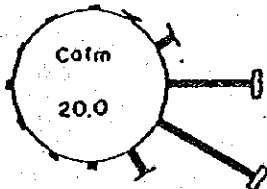
MAR.



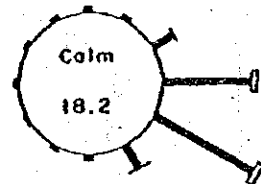
APR.



MAY



JUN.



**LEGEND**

0    20    50 (%)

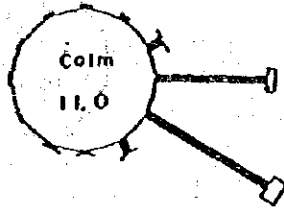
a    b

a: Freq. of wind less than 18kts  
b: Freq. of wind over 18kts

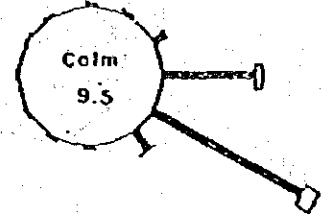
Windroses (Fort William)

App. Fig. 7-2 Windroses

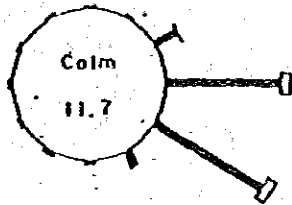
JUL.



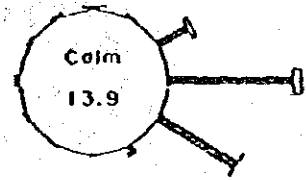
AUG.



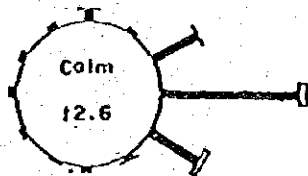
SEP.



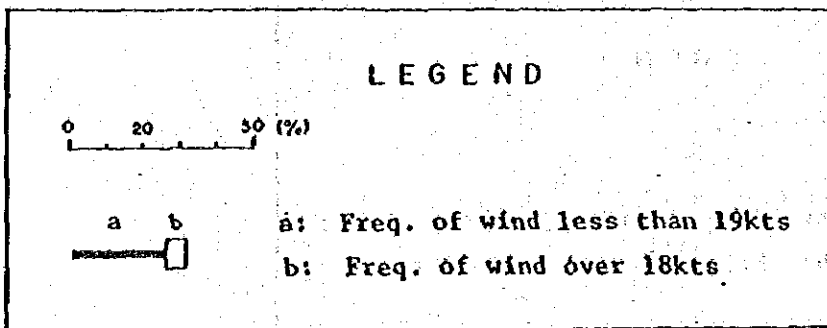
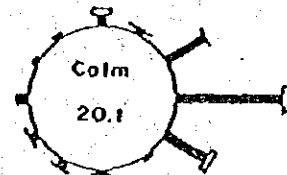
OCT.



NOV.



DEC.



Windroses (Fort William)

#### 4) Cyclone

The Mauritius Island is often attacked by cyclones during summer season. App. Table-6 shows the records of cyclones having a maximum wind velocity of 48 kmph (30mph) or greater, as measured at Pamplémousses, 10 km to the northeast of Port Louis. Among these cyclones, the largest were Carol (1960) and Jenny (1962), which had wind velocities reaching 130 kmph.

From these wind observation data of cyclone, the relations of return period years and highest gust probable are estimated as shown in App. Table 5.

Rainfall in some recent cyclones are shown in App. Table 6. Even at Medine located in the dry area, large rainfall was brought by cyclones. Among the records of rainfall in cyclones, rainfall in Hycinthe reached 680mm to be equal to the average annual rainfall at Medine.

App. Table 5 Return-Period Years and Highest Gust

Return Period Years	100	50	14	5
Hourly wind (Kmph)	125	112	90	72
Highest gust probable (Kmph)	230	200	160	130

App. Table 6 Occurrence of Cyclone

YEAR	Date	Kmph	YEAR	Date	Kmph
1876	February 19	91	1931	March 5	82
	February 26	66	1932	April 10	55
1877	February 10	77	1934	January 29	65
1878	January 15	54	1935	February 28	40
1879	February 26	75	1939	March 20	51
	March 21	95		December 16	72
1881	January 21	59	1940	March 21	51
1883	December 7	53	1943	March 27	61
1888	January 5	40	1944	February 8	56
1892	February 12	56		April 10	50
	April 29	122	1945	January 16	95
1894	January 13	48		February 2	79
	February 22	73		April 7	62
1896	February 20	60	1946	February 1	65
1897	December 5	84	1954	January 12	56
1899	March 6	51	1955	February 27	48
1901	January 12	85	1960	January 20	79
1902	February 5	92		February 20	130
	February 9	64	1961	December 25	72
1904	March 21	52	1962	February 20	129
1905	January 23	58	1964	January 20	98
1906	December 29	57		February 28	53
1908	March 1	71	1966	January 7	69
1910	January 11	57		March 24	64
1911	February 6	52	1967	January 4	61
	March 29	57	1970	February 20	55
1916	May 26	67		March 29	74
1921	March 11	68	1972	February 12	63
1922	February 10	54		March 4	55
1924	January 3	66		November 30	56
1925	December 12	60	1975	February 6	86
1926	April 19	66	1978	January 21	61
1927	January 20	60	1979	December 23	108
1929	February 9	55	1983	December 25	74

App. Table 7 Rainfall (mm) in some recent cyclones (1958-1981)

Year	Cyclone	Dates	Medine (West)	St. Antoine	Peeps.	FUEL	Plat- sance	Vacoas	H.D.A. (Roka)
1958		Mar 17-19	202	396	313	486	393	312	608
		Apr 6- 9	121	110	153	115	123	330	290
1959		Mar 4- 5	174	104	88	121	165	202	207
1960	Alix	Jan 16-20	245	305	171	278	336	615	415
	Carol	Feb 25-29	340	368	324	357	320	508	277
1961	Beryl	Dec 20-25	407	429	487	623	381	746	-
1962	Flora	Jan 24-29	102	196	197	109	110	130	238
	Jenny	Feb 27-28	100	142	132	75	97	187	169
	Lucie	Mar 19-22	44	88	113	306	35	146	247
1964	Danielle	Jan 17-20	296	443	413	356	350	795	766
	Gisele	Feb 25-28	70	34	57	39	61	228	256
1966	Denise	Jan 5- 7	186	218	159	223	143	377	390
1967	Gilberte	Jan 11-14	174	161	216	263	121	451	-
1970	Héraine	Jan 23-24	108	118	71	95	230	256	124
	Louise	Mar 27-30	56	128	73	180	119	247	168
1971	Helga	Feb 4- 8	131	163	139	176	141	526	407
1972	Dolly	Feb 6- 8	111	165	164	197	194	177	241
	Eugenie	Feb 11-13	66	92	73	23	27	182	100
1973	Lydie	Mar 6- 8	108	131	170	221	223	326	343
1975	Gervaise	Feb 5- 7	273	213	243	305	260	533	471
1978	Fleur	Jan 18-21	81	72	73	149	64	279	195
1979	Celine II	Feb 5- 7	76	48	50	140	34	143	136
	Claudette	Dec 21-23	163	170	204	178	125	295	330
1980	Hyacinthe	Jan 16-27	680	776	868	939	1011	1030	1353
	Laure	Mar 12	63	104	176	132	76	177	99
1981	Johanne	Mar 1- 6	79	186	188	260	164	120	180
	Lisa	Apr 8-14	63	184	141	189	149	398	285

(5) Oceanographic Condition

1) Tide levels

Observation of tide levels are not carried out in Albion. The general tide levels at Port Louis are as follows:

M.H.W.L. : +2 ft (0.61m)

M.S.L. : +1.2ft (0.37m)

L.W.L. : +0.00 (Chart Datum from Admiralty Charts)

2) Tidal currents

During site survey, the direction of bow of small fishing boats mooring by one point in sea of the project site area to be constant whole days has been observed. From the result of this observation, it was judged that SSE current paralleled to shoreline of the project site prevailed.

3) Waves

As can be seen from the wind statistics, the prevailing easterly trade winds become land breezes in Albion. In addition, any influence from ocean waves is blocked by the reefs situated on front area of the project site.

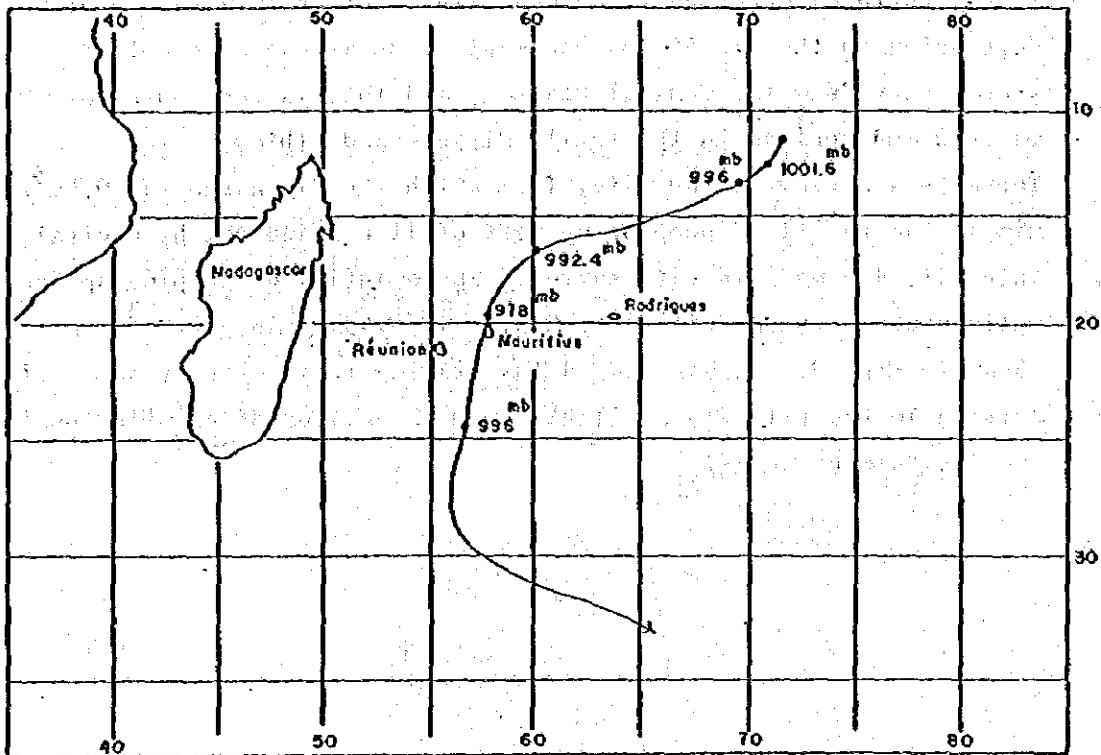
However, many of the cyclones developing in the South Indian Ocean pass near Mauritius, so it is necessary to think about the waves caused by cyclones. The waves caused by Cyclone Gervaise, one of the most severe cyclone to be considered to Port Louis Harbour, had been estimated by computer. The wave height and the path of Gervaise are shown in App. Table 8 and App. Fig.-8 respectively.

App. Table 8 Wave at Attack of Cyclone Gervaise (Estimated)

Direction	Period	Hight
NW	10 sec	5.0 m
WNW	10 sec	5.4 m



App. Fig. 8 Track of Cyclone Grervaise



(6) Hydrological Condition

1) River

The project site is situated in the mouth of the Belle Eau River which is the nearest freshwater resources. The drainage area of this river is 15.7 sq miles and the source is up to near Phoenix. The water of this river is used for irrigation taken from irrigation weir situated 0.6km up of the site. However the discharge at the bridge near the site was  $0.5 - 0.6\text{m}^3/\text{min}$  during fine days, and  $2.0\text{m}^3/\text{min}$  after rainfall.

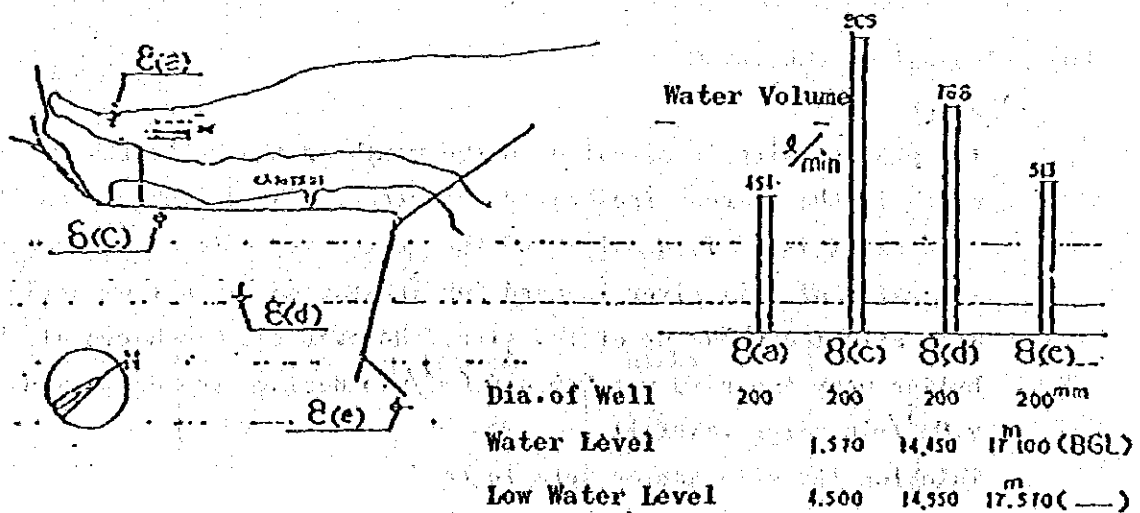
Thinking the site survey term to be dry season, it is available that the quantity of intake from the river is  $0.5\text{m}^3/\text{min}$  in dry season and  $2.0\text{m}^3/\text{min}$  in rainy season.

## 2) Groundwater

To the north of Corps de Garde Mountain, another lava flow over a depression in the rim of the basement rocks allows movement of groundwater from the Central Plateau, and this is the source of the marshes and springs in the Petite Riviere and Albion.

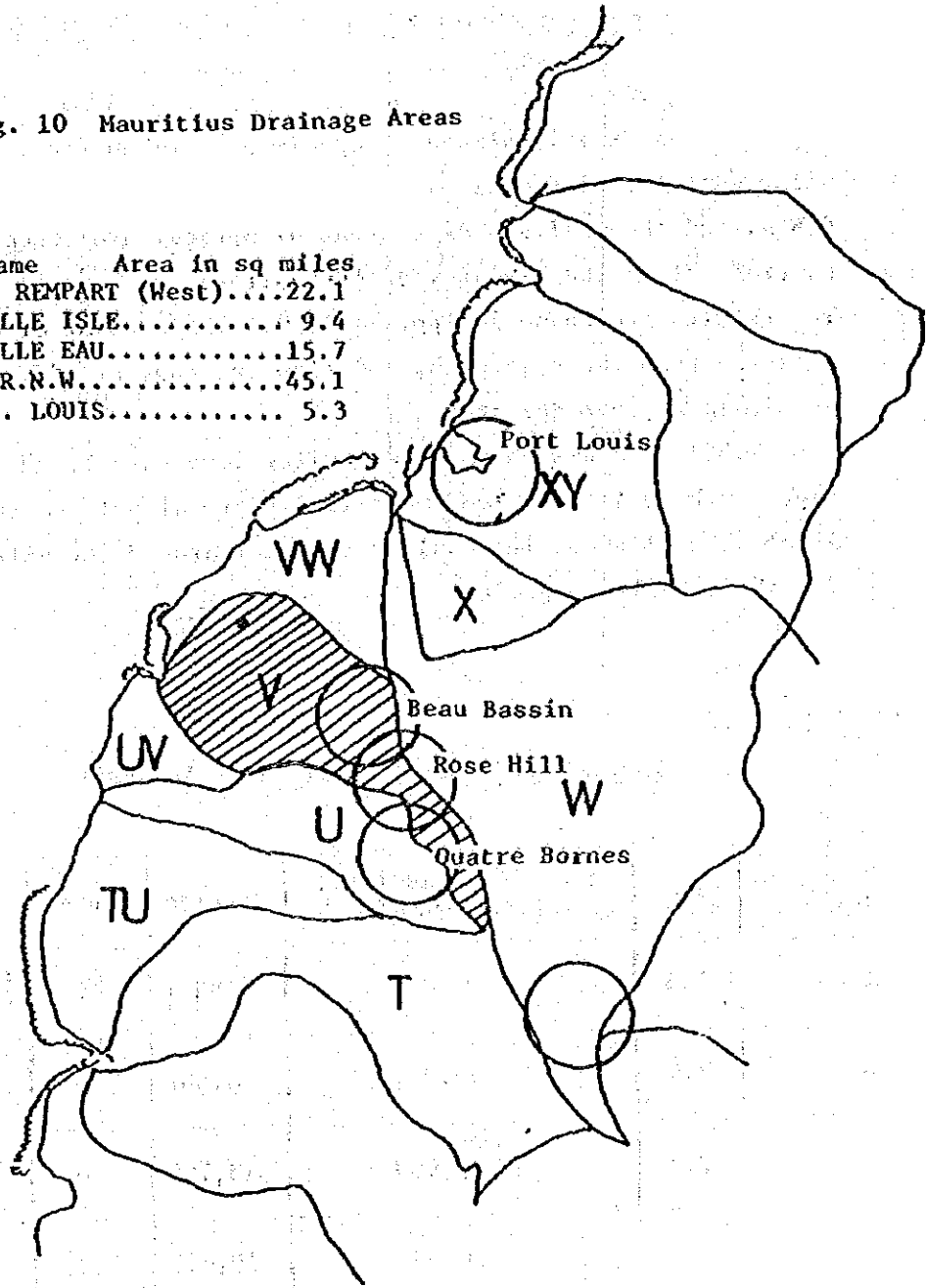
There is a spring in the site, from which the discharge was  $0.4\text{m}^3/\text{min}$  in the result of pumping up test of it carried out by Central Water Authority during this site survey. The quantity of pumping up from wells around Albion drilled by C.W.A. is  $0.45\text{m}^3/\text{min}$  -  $0.9\text{m}^3/\text{min}$  as shown in Fig.-9. It was judged that taking freshwater by some wells drilled in the site was available from the reason of existing spring and the data of wells.

App. Fig. 9 Quality of Pumping up from Wells around Albion



App. Fig. 10 Mauritius Drainage Areas

Name	Area in sq miles
T DU REMPART (West).....	22.1
U BELLE ISLE.....	9.4
V BELLE EAU.....	15.7
W G.R.N.W.....	45.1
X ST. LOUIS.....	5.3



### 3) Quality of water

Fig.-10 shows the locations of specimen be taken for the analysis of water quality. The analysis was carried out in the laboratory of C.W.A. and the analysis of content of agricultural chemicals was carried out in the Ministry of Agriculture.

The results are shown in App. Table 9. The content of copper was not detected from the specimens, and also the content of agricultural chemicals was not detected.

App. Table 10 shows the mean sea-water temperature, PH and Salinity of each month in Albion. PH and Salinity are almost constant through a year. As above mentioned, the quality of water around the site is suitable for shrimp culture project.

App. Table 9 Results of Water Analysis

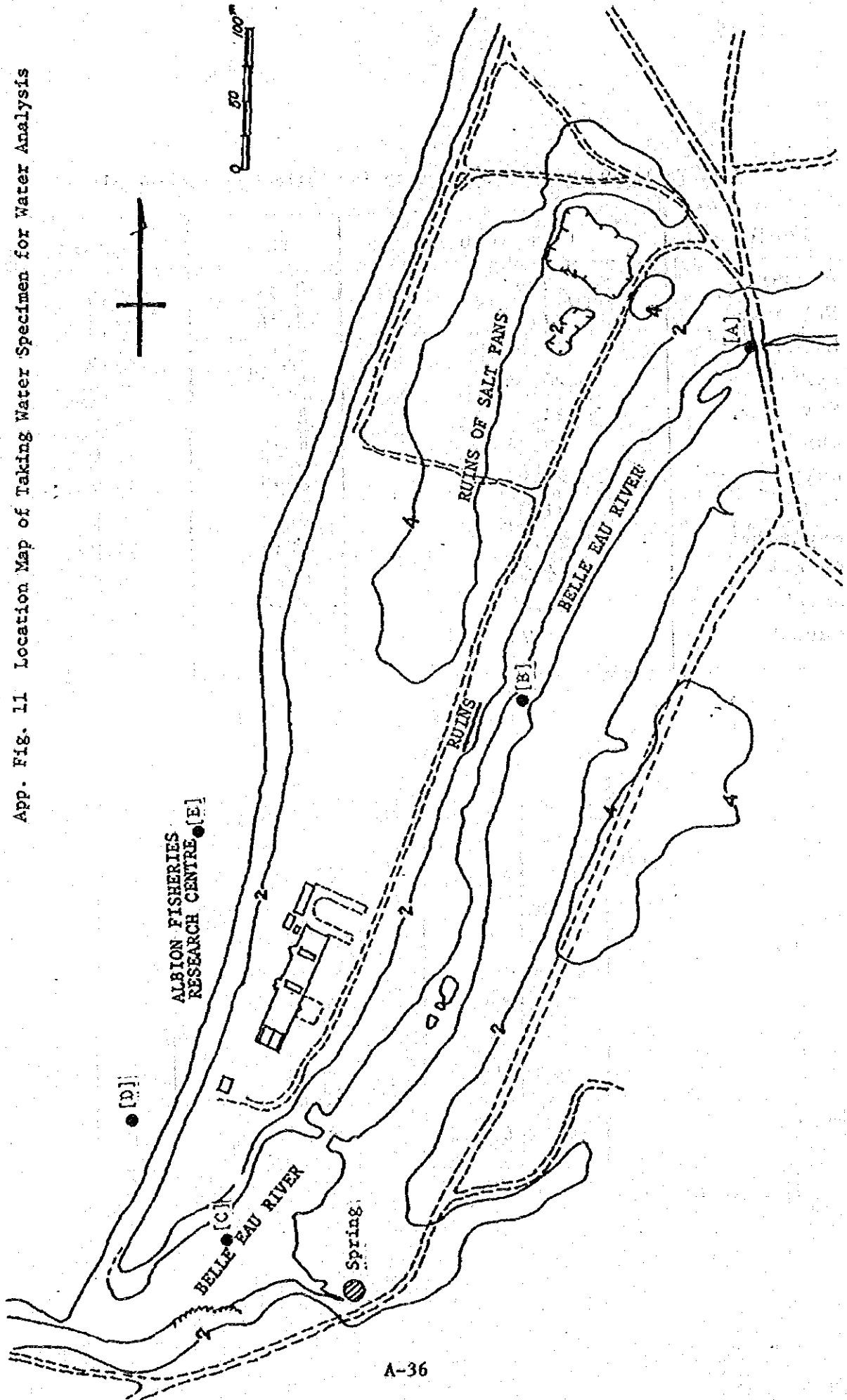
Point	Item	PH	Electric Conductivity 26°C (micromhos/cm <sup>3</sup> )	Chloride	Copper	Remarks
A		7.3	800	85.1	0	Depth Sampling Layer 50cm 25cm
B		7.4	35,000	8,501	0	" 1.3cm " M.L.
C		7.4	35,000	13,755	0	" 1.5cm " M.L.
D (Sea)		8.0	70,000	19,427	0	" 0.9cm " M.L.
E (Sea)		8.0	70,000	19,852	0	" 1.2cm " M.L.

M.L. Middle Layer

App. Table 10 Oceanographic Data for Collection Station Albion

Month	Mean Temperature	PH	Salinity ‰
January	27.5	8.13	35.5
February	27.7	8.16	34.6
March	26.25	8.4	35.5
April	26.35	8.38	35.75
May	23.9	8.2	36.5
June	22.46	8.25	36.0
July	21.9	8.27	35.7
August	21.8	8.27	36.5
September	22.9	8.16	34.22
October	24.01	8.21	35.11
November	26.08	8.10	35.0
December	28.7	8.31	36.0

App. Fig. 11 Location Map of Taking Water Specimen for Water Analysis



## App. 6 Infrastructure of the Planned Construction Site

### 1) Roads

A paved road leading to the Albion Fisheries Research Centre, already constructed, lies next to the planned site. This road will be used as an access road to the site. The paved road is built of a substructure, consisting of 20cm-thick basalt rock covering the surface soil and macadam paved road with a 3/4"-thick asphalt. It therefore requires reinforcement to accommodate heavy-weight vehicles used in the present project.

### 2) Power Supply

The Central Electricity Board supplies power by 200V or 400V, 50Hz. The power supplied to the Research Center is transformed by a 50KVA transformer. For the present project, transformers shall be added to receive 4-line power supply. An emergency generator shall be provided to supply power during a power failure.

### 3) Service Water

The city water coming into the Research Centre shall be branched into the intake pit and elevated reservoir, from where water shall be supplied to the facilities of the present project using the force of gravity.

### 4) Sewage System

In Mauritius, sewage and waste water is treated by septic tanks and absorption pits. The local regulations shall also apply to the current project. The waste water of the culturing pond shall be drained into the sea.

### 5) Gas

There is no city gas supply to the project site.

App. 7 | Price Forecast of Cultured Shrimp

1. International Quotation of Indian White Shrimp (headless)

The international trade price quoted of the products (headless) of Indian White Shrimp caught from the natural sea (1982-1984) and forecast price in 1990 are as follows.

App. Table 11 Practical Results and Forecasts of Price

Size		Ave. Wholesale Price (A) (1982-1984)	Forecast (1990)	
Nos/Lb headless	Body weight (converted to head-on)		Wholesale Price (B)	Ratio of (B) to (A)
13-15	58.2-50.5 g	17.4 US\$/kg	16.1 US\$/kg	-7.6%
21-25	36.0-30.3	16.2	14.0	-13.5%
31-40	24.3-19.0	13.2	10.0	-6.1%
51-60	14.8-12.7 g	7.6	8.2	7.7%

In this table, the prices in 1990 are forecasted by size and by statistic computation from the wholesale prices in Japan quoted during the period of 1982-1984. It is presumed that the price is going down due to increase of import.

The projected size of cultured shrimp in Mauritius is 40 g. According to the above table, wholesale price of headless shrimp in 1990 is estimated at ¥6,000 per c/s (2 kg) or US\$15.00/kg. It means the price of head-on shrimp is US\$9.00. However, the price of cultured shrimp is usually 10-20% higher than that of natural catch. Taking the average 15%, it will be estimated at US\$10-35/kg.

2. Purchase Price of Cultured Black Tiger Prawn

Purchase prices of Black Tiger Prawn in the place of production shipped to Japan from Philippines, Indonesia and Taiwan are as follows.



App. Table 12 Purchase Price of Black Tiger Prawn  
in the Place of Production

Unit: US\$/kg

Type	Size Nos. of Lb	Price
headless	8-12	17.5-17.8 <sup>2)</sup> (10.5-10.7)
	13-15	16.8-17.5 (10.1-10.5)
	16-20	15.5-15.8 ( 9.3- 9.5)
	21-25	14.8-15.0 ( 8.9- 9.0)
	26-30	14.1-14.3 ( 8.5- 8.6)
	31-40	10.8-11.0 ( 6.5- 6.6)
1) head-on	up 6	13.5
	6-8	13.5
	8-12	13.0
	13-15	12.8
	16-20	11.5
	21-25	11.5

Note: 1) Generally, only high quality shrimp is adaptable for shipping by head-on basis.

2) Figures in parentheses mean price converted to head-on basis.

40 gr cultured shrimp will become 16-20/Lb on headless basis and 8-12/Lb on head-on basis. As shown in this table, sales price of the producer will be US\$9.40/kg for headless products, US\$3.00 for head-on products and average US\$11.2/kg. Forecast price in 1990 will be about US\$10.00/kg because it will be -11% of the price shown in the table.

3. Forecast of Sales Price of Cultured Shrimp in Maritius in 1990

Forecast price of naturally caught Indian White and cultured Black Tiger Prawn in 1990 is US\$10.35/kg and US\$10.00/kg respectively - say about US\$10.00.

App. 8 Estimate of Production Cost of Cultured Shrimp

Since there is no commercial shrimp culture project in Mauritius, production cost is roughly estimated in conformity with the similar example in Southeast Asia. The model is referred to semi-intensive, mono-culture type, and terms are set as follows.

1. Price of seed: US\$0.02/pc
2. Average body weight of harvested shrimp: 40 g with head
3. Production: 3,000 kg/ha/yr
4. Survival rate from stocking of fry to harvest: 25%
5. Feed conversion ratio: 2.0 on the basis of compound feed  
Price of feed: US\$1.00/kg
6. Operational worker: one person for 3 ha
7. Electricity, repair and other operational cost are applied by the examples in Southeast Asia
8. Operation cost is raised by loan with 15% of interest rate
9. Sales price of producer: US\$10.00/kg
10. Depreciation is applied by fixed method and its duration is 15 years

The simulation of "Income & Outgo" is made under the aboverterms (App. Table 13), and the production cost is estimated about US\$6.73/kg. Actual production cost differs by conditions of the location and operational management but it could be estimated US\$6-7/kg.

App. Table 13 Simulative "Income & Outgo" on Shrimp Culture Project (per ha)

	Amount	Calculation Basis
<b>Income</b>		
Sales of shrimp	<u>30,000</u>	3,000kg US\$10.00/kg
<b>Outgo</b>	<u>20,190</u>	Production cost: US\$6.73/kg
Direct cost	17,860	
1. Seed (Shrimp fry)	6,000	3,000kg + 40g + 25% = 300,000 @US\$0.02
2. Feed	6,000	3,000kg x 2.0 x US\$1.00/kg
3. Personnel expenses	820	2,500 Rs/month + 14.3 Rs x 14 month + 3 ha
4. Electricity & Fuel	2,000	by application of example in Southeast Asia
5. Repair	1,000	" (5% of construction cost)
6. Other expenditure	790	" (5% of direct cost)
7. Interest of loan	1,250	US\$16,610 x 15% x 1/2 year
Indirect cost	2,330	
1. Depreciation	1,330	Construction cost \$20,000/ha x 1/15
2. Legal charge, etc.	1,000	
<b>Balance</b>	<u>9,810</u>	

App. 9-1 List of Collected References

No.	Title	Collected from, or Issued by	Remarks	
			Original	Copy
1	1/100,000 Map (Whole Island)	M.H.	<input type="radio"/>	
2	1/25,000 Map (Set of 13 Maps for Whole Island)	M.H.	<input type="radio"/>	
3	1/2,500 Map (Set of 2 Maps for Albion Area)	M.H.	<input type="radio"/>	
4	Tide Table	MAFNR	<input type="radio"/>	
5	Data of Tide Level	MAFNR	<input type="radio"/>	
6	The Climate of Mauritius	b.m.padya Meteorological Office	<input type="radio"/>	
7	Hydrographic data of major rivers and Belle Eau River Hydrology Yearbook 1978-80	CWA	<input type="radio"/>	
8	Agrarian Map (Albion)	MAFNR	<input type="radio"/>	
9	White Paper on the Development of Fisheries and non-living Marine Resources	MAFNR	<input type="radio"/>	
10	White Paper for a National Conservation Strategy	MAFNR	<input type="radio"/>	
11	Organization Chart of MAFNR - Fishery Division -	MAFNR	<input type="radio"/>	
12-1	Breeding of P.monodon & Mp.monoceros and Prospects for Marine Shrimp Culture in Mauritius	MAFNR - Y.Enomoto and 2 others	<input type="radio"/>	
12-2	Studies on Culture of Marine Penaeid Prawns in Mauritius in English	MAFNR - Y.Enomoto and 2 others	<input type="radio"/>	
12-3	Ditto in Japanese	Y. Enomoto	<input type="radio"/>	
13	Guide de Cultures Vivrieres et Potageres	Imprimeur du Government	<input type="radio"/>	
14	Data of Tide Investigation	MAFNR	<input type="radio"/>	
15	Information on Trial Well in Albion Area (S-A, S-C, S-D)	CWA	<input type="radio"/>	

App. 9-2 List of Collected References

No.	Title	Collected from, or Issued by	Remarks	
			Original	Copy Hearing
16	Results of Water Analysis of Sea & River Water in Albion Area	CWA	○	
17-1	Annual Digest of Statistics	MEPD	○	
17-2	Basic Commodity Prices	MAFNR		○
18-1	Budget of Government - Fisheries Sector	MAFNR		○
18-2	" - Albion Fisheries Research Centre	MAFNR		○
18-3	" - La Ferme Fish Farm	MAFNR		○
19-1	Bank Loan Conditions (Fisheries Sector)	MAFNR		○
19-2	Application Form	The Development Bank of Mauritius	○	
20-1	Tax - Corporation Tax & Income Tax for Foreigners	MAFNR		○
20-2	Assessment 1985-86 (Income Tax Form)	MAFNR	○	
21-1	Conditions of Work of Various Grades of Employees	MAFNR		○
21-2	The Industrial Relations Act	MAFNR (Government Notices '83)		○
22	Labour Standard Law	MAFNR		○
23	Prices of Diesel Oil, Gasoline	—		○
24	Electric Power	MAFNR 1984 (General Notice No. 1090)		○
25	Feed Components available locally	MAFNR		○
26	Customs Tariff	MAFNR	○	

App. 9 -3 List of Collected References

No.	Title	Collected from, or Issued by	Remarks	
			Original	Copy Hearing
27	Freshwater Resources	CWA		○
28	Forseeable Rate of Inflation			○
29-1	Facilities available at Albion Fisheries Research Centre	MAFNR		○
29-2	Research Equipment & Instrument for AFRC	MAFNR		○
29-3	Facilities available at La Ferme Farm	MAFNR		○
29-4	Layout of AFRC, set	MAFNR		○
29-5	Layout of La Ferme Farm, set	MAFNR		○
30	Oceanographic Data for Collection Station Albion	AFRC		○
31	Proceedings of Seminar on Marine Fisheries Development in Mauritius, 1983	MAFNR		○
32-1	Outline of Mauritius (Japanese)	Ministry of Foreign Affairs of Japan, Africa Section 1		○
32-2	Mauritius (Japanese)	Yearbook of Africa		○
32-3	Mauritius	Africa Review '85		○
33	The Forest and Reserves Act 1983	MAFNR	○	
34	Land Resources and Agricultural Suitability	MAFNR		○
35	Tide Table (Atlantic & Indian Ocean)	MAFNR		○
36	List of Phytoplankton Composition by month (Qualitative)	AFRC		○

Abbriatiation: M.H. - Ministry of Housing, Mauritius  
 MAFNR - Ministry of Agriculture, Fisheries and Natural Resources, Mauritius  
 CWA - Central Water Authority, Mauritius  
 MEFD - Ministry of Economic Planning, Mauritius  
 AFRC - Albion Fisheries Research Centre









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