BASIC DESIGN STUDY REPORT ON THE PROJECT FOR EXTENSION OF FISHING PORT IN MAURITIUS

AUGUST, 1988

JAPAN INTERNATIONAL COOPERATION AGENCY

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PREFACE

In response to the request of the Government of Mauritius, the Government of Japan has decided to conduct a basic design study on the Project for Extension of Fishing Port and entrusted the study to the Japan International Cooperation Agency (JICA). JICA sent to Mauritius a study team headed by Mr. Yoshinori Ugajin, Inspector, Fishing Port Construction Division, Fisheries Agency, Ministry of Agriculture, Forestry and Fisheries, from March 27 to April 24, 1988.

The team had discussions on the Project with the officials concerned of the Government of Mauritius and conducted a field survey in the Project area. After the team returned to Japan, further studies were made, a draft report was prepared and a mission to explain and discuss it was dispatched to Mauritius. As a result, the present report has been prepared.

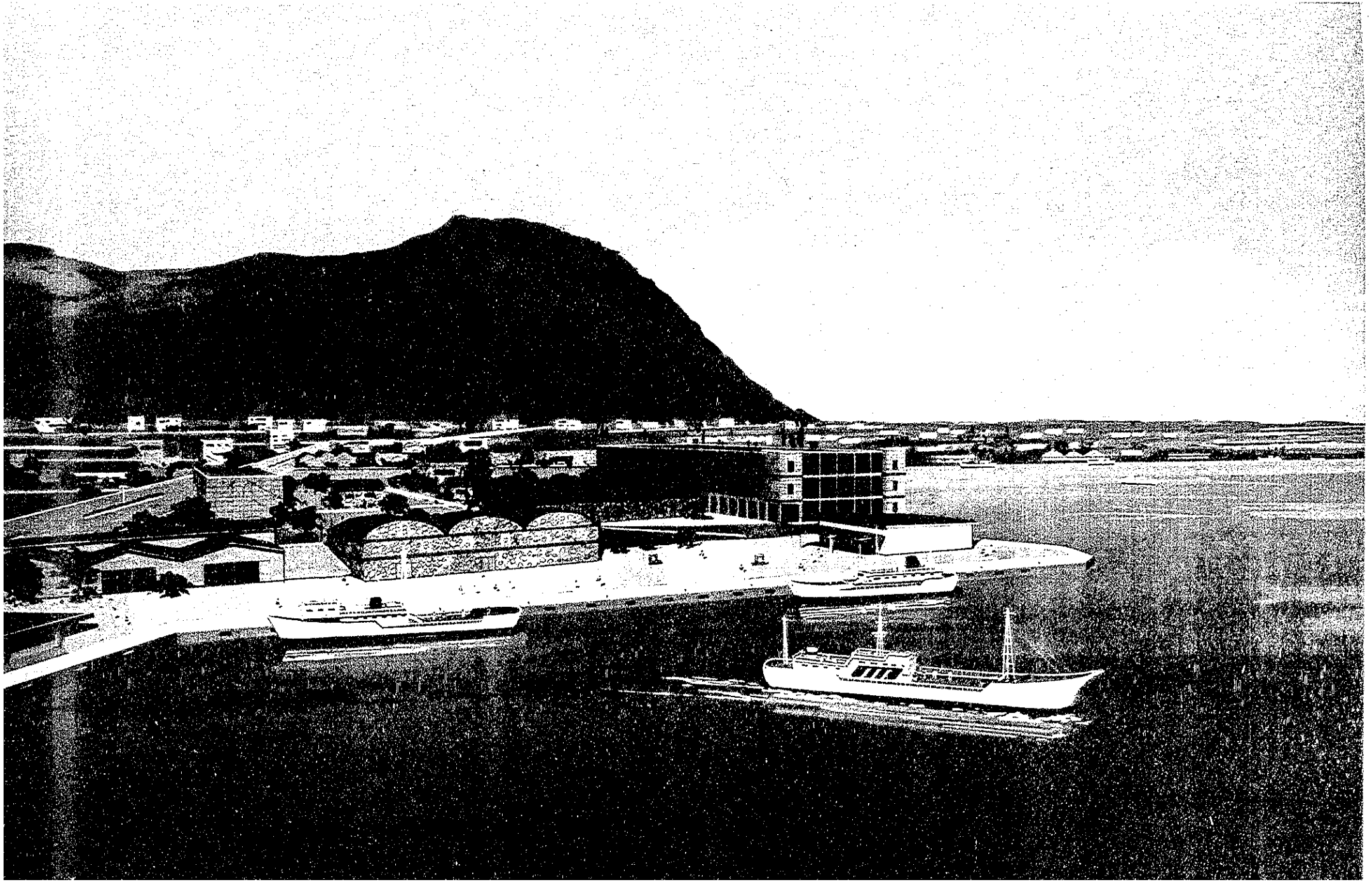
I hope that this report will serve for the development of the project and contribute to the promotion of friendly relations between our two countries.

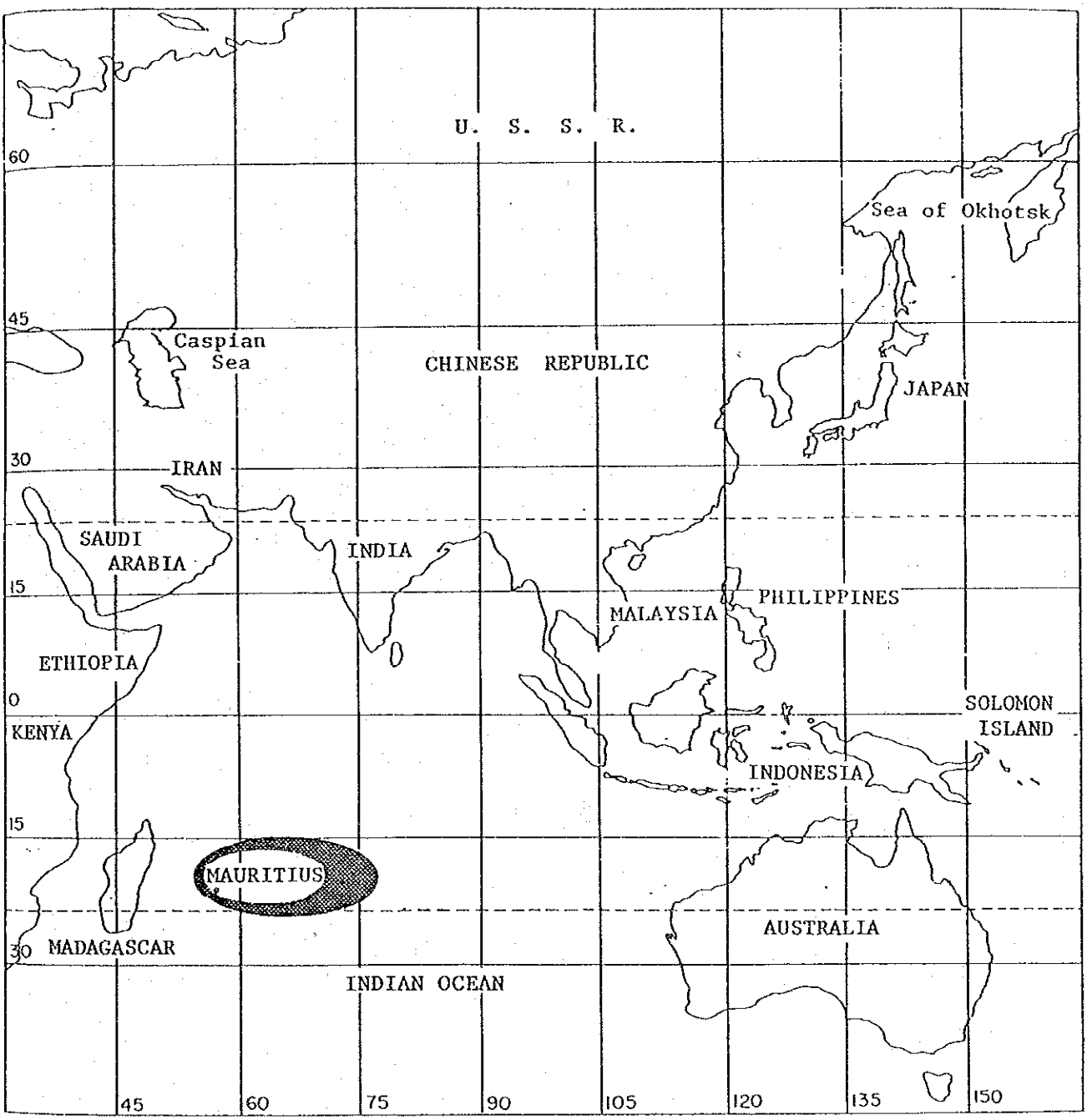
I wish to express my deep appreciation to the officials concerned of the Government of Mauritius for their close cooperation extended to the team.

August, 1988

Kensuke Yanagiya

Kensuke Yanagiya
President
Japan International Cooperation Agency





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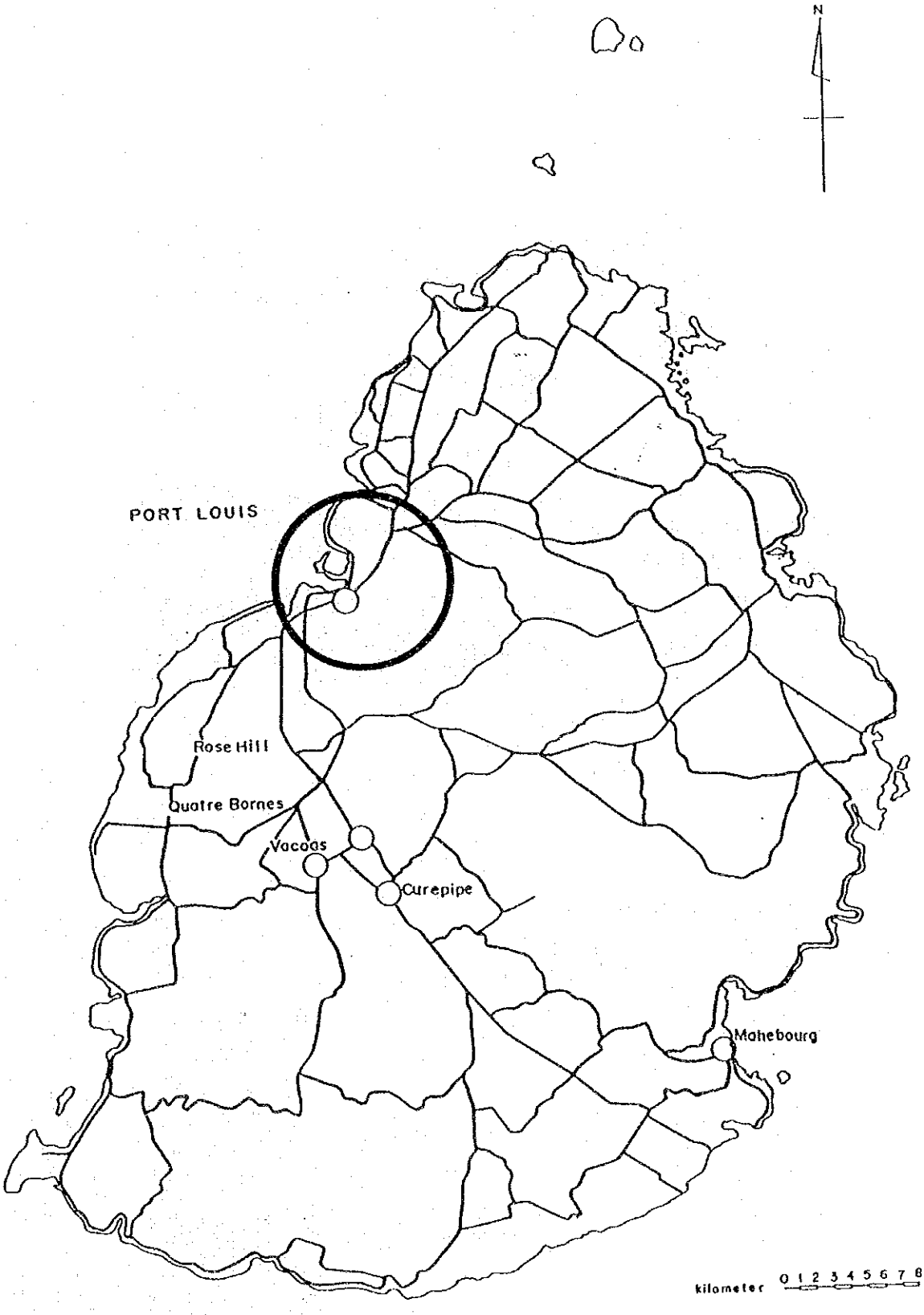
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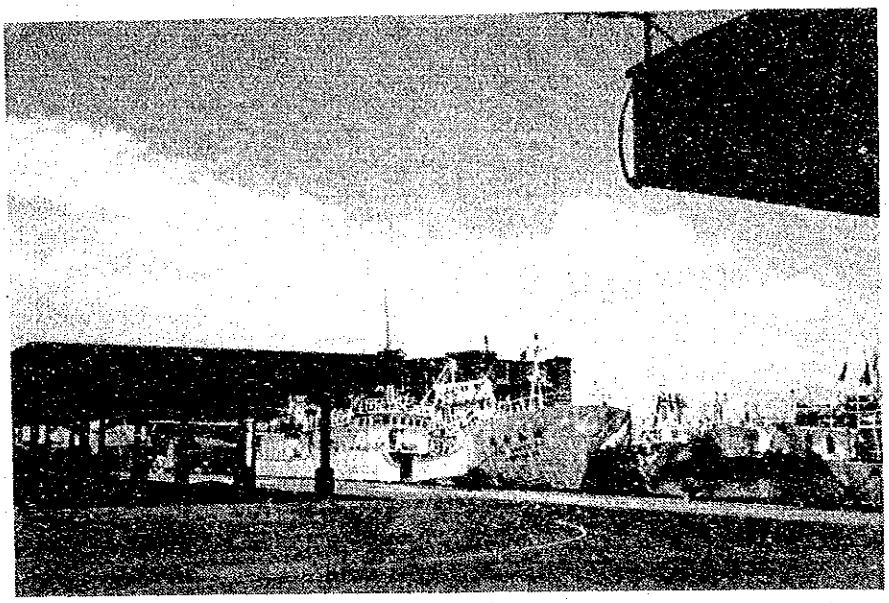
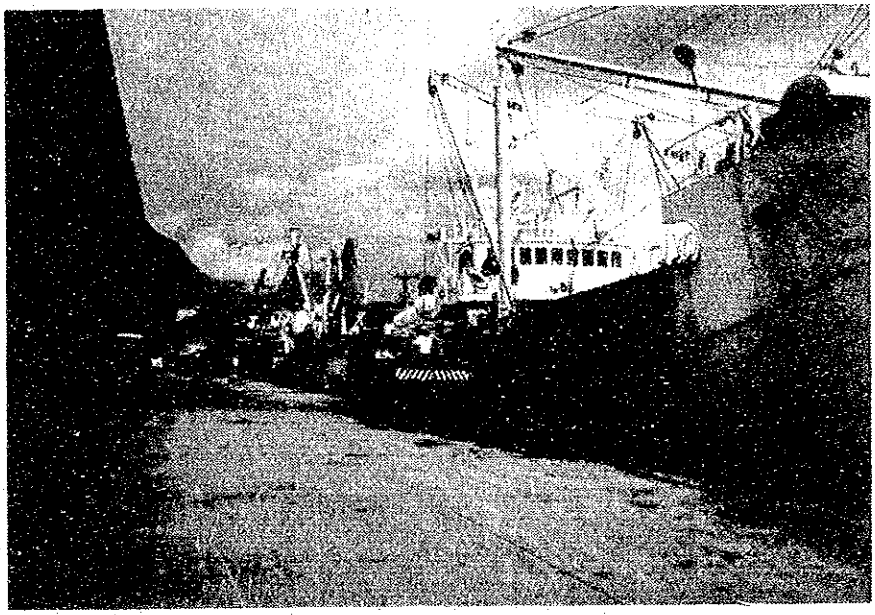
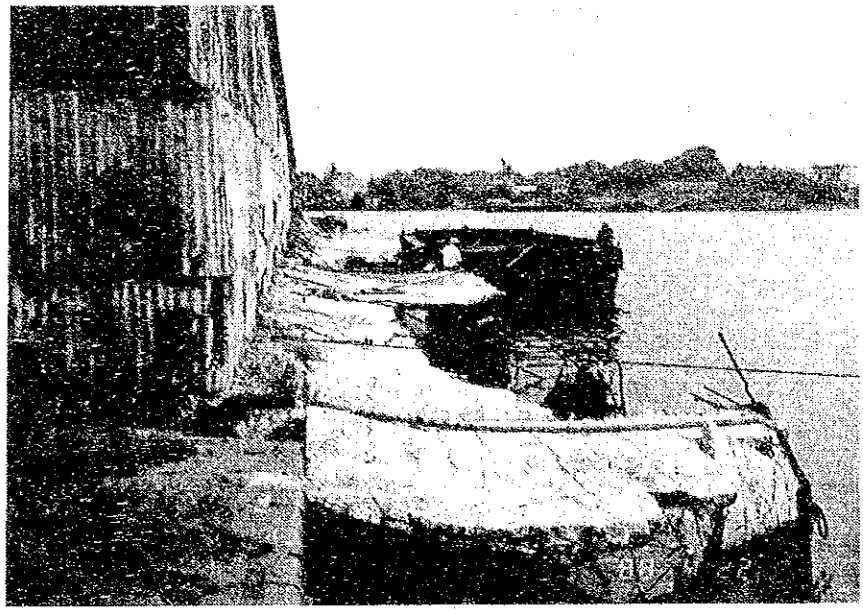
Port Louis



Site View



Landing Catch



Site View

Site View

SUMMARY

Mauritius is an island country with a total territorial land of 2,040 km^2 consisting of Mauritius (1,865 km^2), Rodrigues (104 km^2) and other small islands (71 km^2), situated about 800 km from the eastern coast of Madagascar on the Indian Ocean. The country has a total population of 1,045,000, 96.5% of which is concentrated on the Island of Mauritius.

As the Mauritian economy has depended on the sugar industry, its national economy has been strongly affected by unstable international prices of sugar and by crop fluctuations due to damages by cyclones. In view of such a situation, the Government of Mauritius has tried to diversify its agriculture, promote tourism industries and develop EPZ (Economic Processing Zone) based on its National Development Plan (1984-1986).

As a result, the average growth rate of GDP in the four years since 1983 was 5.5%, reaching 8% in 1986. It shows the growth of Mauritian economy exceeded its target specified in the National Development Plan during 1984 and 1986, i.e. 5%.

The plan emphasized that the fishery is given important roles not only as a supply of fish protein, but as industry for saving or earning foreign currency.

In said development Plan, the following are enumerated as the roles and targets of its fishery sector.

1. The demand for fish is expected to grow in the coming few years as a result of the rising price of meat. Supply of fishing is therefore necessary as an inexpensive source of protein to feed its total population.
2. The target per capita consumption of marine products should be maintained at 18 kg per annum.
3. In order to emerge from its dependence on imports of marine products (mainly canned sardine) and save on foreign exchange expenditures,

increase in domestic catch of fish shall be encouraged, thereby increasing both domestic supply and exports.

In order to accomplish the aforesaid objectives, the Government has established long, medium and short term development programs and is administering its various policy measures accordingly. The per capita consumption of marine products at home is 13 to 14 kg per annum now which is still far from the target value of 18 kg per capita per annum. Fish production, however, has increased from the level of 3,000 tons in 1982 to a level of 5,000 tons in 1987 in bank fishery, from 4,000 tons in 1985 to 6,900 tons in 1987 in pelagic fishery, thus nearing the medium term production targets (for the target year of 1990) of 6,000 tons and 10,000 tons, respectively.

The balance of trade in fish and fish products had turned into the black since 1983 and earned a surplus of Rs 55.7 million in 1986. Major contributing factors to this achievement were the improvement in the self-sufficiency rate of fish at home due to increased fish catch in bank fishery and the increase in foreign exchange earnings due to the successful performance of pelagic fishery and its canning industry. In view of this, the Government of Mauritius is placing great emphasis on the promotion of bank fishery and pelagic fishery.

The base from which the fishing vessels engaged in bank fishery and pelagic fishery operate is the fishing port at Trou Fanfaron in the Port Louis harbour, which was constructed by the grant aid from the Government of Japan in 1985. It has contributed immensely to the promotion of the Mauritian fishing industry and continuously to gaining even greater importance.

However, following problems have arisen in the existing fishing port:

1. Landing efficiency is declining because of the long wait for an open berth due to the increase in the number of fishing vessels using the fishing port.

2. Vessels must lay idle in the port for an extended period due to the shortage of cold storage. This results in decreasing number of fishing days and affecting the price of fish.
3. A tuna purse-seiner with deep draft is unable to come alongside the quay of the existing fishing port and is obliged to use the general cargo quay. She must move with the entry of any cargo vessel, which is resulting in poor landing efficiency.

In order to solve these problems and promote the Mauritian fisheries, the Government of Mauritius has requested the Government of Japan of its grant aid in extending the quay of the fishing port and building a new cold storage, etc.

In response to the request, the Government of Japan has decided to conduct, through JICA, a basic design study to review the request contents and to prepare the optimum scope and scale of the project.

The Agency dispatched a basic design study team to Mauritius from March 27 to April 24, 1988 and upon completing its analytical studies in Japan, the team visited Mauritius for explaining the draft final report to the Mauritian side from July 4 to July 17, 1988.

The results of the basic design study on this project are as outlined in the following.

(1) Basic facilities of the fishing port

The number of fishing vessels calling at the Port Louis harbour was 428 in the year of 1987 (January to December). Of these, the number of bank fishing vessels and pelagic fishing vessels calling at the harbour for landing increased from 94 in 1983 to 158 by 1987, and the berth occupancy of the existing fishing port exceeded 100%. Because of such a congestion, vessels must wait for an open berth for a couple of days before landing their catch.

The shortage in the number of available berths was judged to be evident from the results of the field survey. Therefore, the number of berths on the quay necessary to meet the existing situation was studied

from the existing activities of Mauritian fishing vessels and the number of fishing vessels calling at Port Louis for landing, etc. As a result, it was found that the necessary number of berths would be four or five, and taking the two berths already existing into account, the shortage was found to be two or three berths. In view of this, it is considered necessary to extend the quay to provide at least two more berths. As a result of examining the necessary water depth and extended length of the berth for accommodating the country's largest fishing vessel "Lady Sushil II", a quay depth of 7.0 m and an extension of berth of 150 m were judged to be necessary.

(2) Functional facilities of the fishing port

At present, Mauritius has 11 facilities of cold storage with a combined total storage capacity of 4,789 tons. The cold storage is necessary as the facilities for storing the catch of bank fishery and pelagic fishery and also for storing frozen meat.

In pelagic fishery, each company secures the necessary storage capacity by borrowing cold storage in addition to having its own storage, based on its annual utilization plan. The cold storage companies also secure the necessary storage capacity for frozen meat according to the annual quantity of import. In contrast, enterprises engaged in bank fishery generally do not own any cold storage. According to the result of analysis of available data, the storage space of cold storage companies for storing the catch of bank fishery was found to be commensurate to the monthly mean catch of 429 tons in 1987. However, when the catch exceeds the monthly means, the cold storage capacity becomes short and the fishing vessels are unable to land their catch being obliged to lay idle in the port. In the team's view, inadequate cold storage capacity is reducing the number of fishing days, increasing the running expenses on account of prolonged laytime as well as increasing the stevedoring costs, which all result in pressuring the operating performance of bank fishery enterprises.

As a result of the study, it is concluded that, in the managerial viewpoint, the provision of a 250-ton-class cold storage will be appropriate to cover the shortage of 240-300 tons in available cold storage

capacity. Introduction of such a cold storage is expected to help the liquidation of the protracted unloading time in the port, increase of the number of days and reduction of the running expenses of bank fishing.

As a facility attached to the cold storage, necessity of a packing hall will be confirmed to sort the fish caught by bank fishing, to weigh for receiving into and issuing from the cold storage and to retain freshness of fish.

The scales of the basic facilities and the functional facilities of the fishing port stated above are summarized in the following table.

Basic facilities	Functional facilities
1. Landing quay: extension L = 150m, water depth 7m, apron width 10m	1. Cold storage: capacity 250 tons with ancillary facilities
2. Ancillary facilities: fenders, mooring posts, lighting lamps, drainage facilities.	2. Packing hall: 216.8 m^2
3. Onsite road: 273m	3. Water and fuel supply facilities: 1 set each

(3) Construction plan

This project is planned on the western side of the existing fishing port. The period necessary for constructing said facilities is estimated to be 18 months for the construction work.

(4) Operating plan

It was confirmed that the fishing port will be operated by the Mauritius Marine Authority and the cold storage will be operated by the Agricultural Marketing Board. No problem is likely to arise in recruiting the necessary personnel and financing the maintenance and operation expenses since both organizations are respectively involved in the operation and management of ports and cold storages.

As a result of the extension and improvement of fishing port facilities, a variety of benefits can be anticipated, such as (1) reduction in waiting time for opening of berth and improvement in the landing efficiency, (2) reduction in laytime in the port due to inadequate cold storage capacity and increase in the number of days for fishing operation, and (3) acceleration of investment in the allied industries of the pelagic fishery by virtue of the extension and improvement of the fishing port and the resulting increase in employment opportunities, etc. Thus, the implementation of this Project will contribute greatly to the promotion of the Mauritian fisheries and enhance the significance of providing the grant aid cooperation from the Government of Japan. In this context, it is considered necessary to implement this Project as early as possible.

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CHAPTER 1

INTRODUCTION

CHAPTER 1 INTRODUCTION

1-1 Objective of the Study

The Government of Mauritius has adopted a fishery promotion policy to increase the self-sufficiency ratio in fish consumption by promoting bank fishing, to economize foreign currency by reducing fish and fish product imports and to encourage the earning of foreign currency by promoting pelagic fishing and its related industry.

Constructed with the grant aid cooperation of the Government of Japan in fiscal 1985, the Trou Fanfaron fishing port at Port Louis has been playing a key role in the fishery promotion activities, acting as a base for bank and pelagic fishing. In fact, the quay's occupancy for its exclusive use by fishing boats is 100%. This high occupancy, however, means that the quay has become overloaded and, consequently, the landing efficiency has declined due to congestion. In addition, as the Trou Fanfaron fishing port was designed for its exclusive use by bank fishing vessels, fully loaded purse-seiners with a deep draft cannot come alongside the quay and are forced to use the general cargo quays. Moreover, the shortage of cold storage facilities causes a long waiting for landing the fish catch from the fishing vessels.

In order to solve the above problems, the Government of Mauritius prepared the Project for Extension of Fishing Port and requested of the Government of Japan grant aid cooperation for the expansion of the quay and the construction of a cold storage.

1-2 Dispatch of the Basic Study Team

In response to this request, the Government of Japan had decided to conduct a basic design study for the Project, and the Japan International Cooperation Agency (JICA) sent the Basic Design Study Team, headed by Yoshinori Ugajin (Fishing Port Construction Division, Fishing Port Department, Fisheries Agency, Ministry of Agriculture, Forestry and Fisheries), to Mauritius for 29 days between March 27th and April 24th, 1988 to examine the Project's feasibility, determine its optimum scale

and prepare the Basic Design. During the field survey, the Minutes of Discussions were signed by the Study Team leader and representatives of the Government of Mauritius on 8th April, 1988.

1-3 Study Contents

1. Confirmation of background of the project.
2. Confirmation of contents of the project.
3. Site survey and examination of the site condition.
4. Study of natural condition.
5. Study of situation of fishing port facilities and its utilization.
6. Study of situation of cold storage and its utilization.
7. Examination of the project plan.
8. Study of operation and maintenance organization system for the facilities.
9. Confirmation of construction items of Mauritius side.
10. Construction Condition in Mauritius.

CHAPTER 2

BACKGROUND OF THE PROJECT

CHAPTER 2 BACKGROUND OF THE PROJECT

2-1 Outline of Mauritius

2-1-1 Social and Economic Conditions

Mauritius is located 800km east of Madagascar and consists of Mauritius Island (1,865km^2), Rodrigues Island (104km^2) and other small islands with a total land area of 2,040km^2. Of the total population of 1,045,000 (estimated in 1986), 96.5% (1,009,000) lives on Mauritius Island. The majority of the population consists of Indians (52%), followed by Creoles (28%), Pakistanis (17%) and Chinese (3%). There are many religions, Hinduism, Christianity, Moslemism, Buddhism, and so on. Mauritius is, therefore, a multi-racial, multi-religion country. although English is the official language, the majority of the population also speak French and/or Creole.

Mauritius has a tropical marine climate with a prevailing south east wind throughout the year. The country is attacked by cyclones in summer, i.e. November - April. The annual rainfall is 1,000mm in western Mauritius (the location of Port Louis), 2,000mm in eastern Mauritius and as much as 5,000mm in the Central Plateau.

Mauritius was colonized first by the Dutch, then by the French and finally by the British (1814). Mauritius was independent on March 12, 1968.

Following the completion of the National Development Plan started in fiscal 1980, the Government of Mauritius prepared a new plan for fiscal 1984 - 1986 which was subsequently completed in June, 1987. Preparation of the next plan is currently in progress.

The National Development Plan (1984-86) was intended for arresting the economic recession between 1981 and 1983 and to vitalize the national economy. With a main theme of creating a strong economy, the Plan specifically aimed at the restructuring of the Mauritian economy characterized by its heavy dependence on the sugar industry.

The average growth rate of the GDP in the 4 years since fiscal 1983 was 5.5%, reaching 8% in 1986 even though the target rate specified in the National Development Plan (1984-86) was only 5%. This favourable

result was brought about by the success of Export Processing Zone Sector, and success of Tourism Promotion, etc.

As a result of the industrial development so far described, this activation of the national economy has also contributed to the decline of the unemployment rate, from 17% in fiscal 1983 to 12% in fiscal 1986. The ratio of the former in GDP increased from 17% in fiscal 1983 (GDP: Rs 12,288 million) to 28% in fiscal 1986 (GDP: Rs 18,800 million) with the latter increasing from 18% to 20% in the same period. The imbalance in international payments continued for some time and, in fiscal 1983, the deficit was equivalent to 3% of the GDP. However, a strong improvement was seen in fiscal 1986 when it went into a surplus equivalent to 9% of the GDP. Substantial improvements can be seen in terms of the trade balance, as shown below.

Table 2-1-1 Transition of Trade Balance

(Unit: million Rs)

	1982	1983	1984	1985	1986	1987*
Exports	5,520	5,953	6,989	8,885	11,880	13,779
Imports	5,859	5,999	7,470	9,210	10,515	12,333
Difference	-339	-46	-481	-325	+1,365	+1,446

* Estimation (Annual Digest of Statistics 1986)

With the successful management of the economy, economic development has stabilized inflation in Mauritius, from 5.6% in fiscal 1983 to 1% in fiscal 1986.

2-2 Outline of Fishery and Development Plan

2-2-1 Current Conditions

Mauritian fishery is mainly composed of artisanal fishing (lagoon and off-lagoon), bank fishing, pelagic fishing and fish culture.

(1) Artisanal Fishing (Lagoon and Off-Lagoon)

Artisanal fishing consists of the lagoon and off-lagoon fishing of Mauritius and Rodrigues. The fishing grounds extend up to a depth of 200m and cover an area of 1,020km^2 for Mauritius and 1,389km^2 for Rodrigues. Several kinds of fishing gear are used, such as basket traps, nets, lines and harpoons, and the fishing boats are either small wooden boats 6m - 7m long or FRP boats (small boats are locally called pirogues), less than half of which are motorized. The subject fish are octopuses, mullet, scarid, porgy, rabbitfish, etc. Mauritius and Rodrigues currently have some 2,500 and 625 fishermen respectively involved in this type of fishing. As shown in Table 2-2-1, Mauritius has an annual catch of around 1,300 tons which is sold in being fresh.

Lagoon fishing is currently exploited to almost its limit and an increase of the catch appears impossible unless off-lagoon fishing is promoted.

Table 2-2-1 Artisanal Fishing Catch

(Unit: tons)

Year	Lagoon Fishing	Off-Lagoon Fishing	Total Catch
1978	1,262	702	1,964
1979	1,340	605	1,945
1980	935	300	1,235
1981	853	359	1,212
1982	734	320	1,054
1983	822	548	1,070
1984	814	561	1,375
1985	801	533	1,334
1986	758	569	1,327

(The Artisanal Fisheries by C.R.Samboo and D.Mauree)

(2) Bank Fishing

The banks of the Mauritius-Seychelles Ridge and the vicinity of the Chagos Archipelago are good fishing grounds for commercial fishing by

local fishing companies. In general, fishing is conducted by a fishing fleet consisting of 8 - 17 small boats with outboard engines operated by a crew of 3 - 4 persons, and a mother ship which is used for tuna fishing with freezing facilities.

The handline method is employed and the subject fish are grouper, sea bass and rabbitfish and so forth. The catch is frozen on board and sold almost exclusively on the Mauritian market with a small amount exported to Reunion.

At present, 5 - 7 companies are involved in bank fishing. Thirteen mother ships with some 550 crew members are being operated in 1987. Problems include the actual fishing by the boats with outboard engines being largely affected by the weather and the catch being determined in accordance with the crew's skill and work conditions in view of the handline method being employed.

As shown in the table below, the bank fishing catch has recently shown a tendency to increase, from 4,627 tons in 1986 to 5,150 tons in 1987, approaching the target figure given in the 5 Year National Fisheries Development Plan.

Table 2-2-2 Bank Fishing Catch

(Unit: tons)

Year	Nazareth	Saya de Malha	St. Brandon	Chagos	Total
1977	1,482	1,587	95	32	3,196
1978	1,198	1,529	97	-	2,824
1979	1,407	372	77	-	1,856
1980	955	277	173	-	1,405
1981	874	378	140	81	1,473
1982	1,282	1,701	43	135	3,161
1983	920	1,245	119	-	2,284
1984	1,104	833	283	143	2,363
1985	1,072	2,207	388	163	3,830
1986	1,200	2,767	533	127	4,627
1987	1,486	3,231	196	237	5,150

(3) Pelagic Fishing

Pelagic fishing in Mauritius consists of the purse-seining of skipjack and long lining of tuna. Purse-seining is conducted by the 2 purse seiners of the Mauritius Tuna Fishing and Canning Enterprises, Ltd., a joint venture between Mauritian and Japanese private companies. The entire catch of tuna and skipjack is used for the production of canned tuna/skipjack at its own cannery. As much as 95% of the canned fish is exported to the EC, thereby contributing to the country's foreign currency reserves.

As shown in Table 2-2-3, the fish catch largely increased to 6,896 tons in 1987 from the former catch of around 3,000 - 4,000 tons/year, by introducing a new purse-seiner.

Table 2-2-3 Catch of Purse-Seiners "Lady Sushil I & II"

(Unit: tons)

1979	1980	1982	1983	1984	1985	1986	1987
67	1,061	1,755	2,336	2,921	4,125	3,987	6,896

Long liners are mostly operated in the Indian Ocean using the Port Louis harbor as an operation and transhipment base. The total catch of tuna is shown in Table 2-2-4, and is broken down into longfin tuna and yellowfin tuna accounting for 85% and 10% respectively (the remaining 5% was miscellaneous fish). The main tuna transhipment destination is the U.S. (83%), followed by the EC (9%) and Japan (3%) while the miscellaneous fish are for domestic consumption.

Table 2-2-4 Tuna Transhipment Volume

(Unit: tons)

	1980	1981	1982	1983	1984	1985	1986
Catch Weight	6,063	3,119	8,901	7,595	6,518	7,272	8,774

(Tuna Fishery in Mauritius by C.R.Samboo)

(4) Fish Culture

Fish culture can be divided into freshwater culture and mariculture. With regard to freshwater culture, the giant freshwater prawn 'Macrobrachium Rosenbergii' was introduced in 1972 and has been successfully bred and cultured. In addition, 6 species of Indian and Chinese carp are cultured in inland water such as ponds and reservoirs.

Mariculture using barachois (sea compartments made of stone masonry) in lagoons produces rabbitfish, crabs and oysters. The total mariculture production volume was 55 tons in 1987.

While only the culture of Macrobrachium Rosenbergii has so far reached the stage of commercial production in Mauritius, the completion of a Marine Shrimp Culture Experimental Station in December, 1987 with Japanese grant aid cooperation has strongly raised local interest in aquaculture, and the successful development of marine shrimp culture techniques is hoped for.

(5) Potentiality of Fishery Resources in Mauritius

The artisanal fishing catch has rapidly declined since 1979. Despite a slight improvement from 1984 onwards, the catch has remained at the 1,300 ton level. The maximum production level is considered to be 2,500 tons.

The bank fishing catch also continuously declined according to the decrease of fishing vessels between 1977 and 1981 but fully recovered in 1985 and is currently showing a tendency to increase. According to an FAO survey, the possible annual catch of bed fish in the Indian Ocean is 150,000 tons, of which Mauritius can catch up to 10,000 tons.

In regard to pelagic fishing, while the purse-seining catch is increasing, the long lining catch has been stagnant around 6,000 - 8,000 tons. The fluctuation of the catch mainly reflects the fishing efforts, in turn determined by the market price. In the future, however, the question of the actual resource volume will certainly arise. The production volume of aquaculture is only nominal at present and still falls short of a commercial level. Given the current conditions and future prospects of artisanal and bank fishing, however, aquaculture is attracting a lot of attention in terms of the future development of Mauritian fishery.

The development of the off-lagoon pelagic fishing of tuna and shark is in progress along the Mauritian coast in cooperation with the FAO, and the test fishing of deep sea shrimp is also in progress. In addition, the development of the small pelagic fishing resources in the banks is hoped for with an estimated possible annual catch of 13,000 - 26,000 tons.

(6) Fishery Trade Balance

The fish trade balance of Mauritius showed a continuous deficit until 1983 when the export value of fish and fish products exceeded the import value for the first time. In 1985, the balance showed a surplus of Rs 55.7 million.

Table 2-2-5 Fish Trade Balance

Year	Imports (tons)	Value (Rs M)	Exports (tons)	Value (Rm M)	+ Surplus - Deficit (Rs M)
1980	8,249	85.0	1,320	42.2	-42.8
1981	7,794	98.8	1,709	61.3	-37.5
1982	6,055	84.7	1,702	56.0	-28.7
1983	5,387	76.0	2,297	76.2	+ 0.2
1984	5,986	91.8	2,837	107.2	+15.4
1985	5,726	97.0	4,519	152.7	+55.7

The success of tuna fishing (canned tuna exports) is responsible for the trade balance improvement. Long-term objectives have now been set for Mauritian fishery to effectively utilize the potential resources of the EEZ and to develop pelagic fishing in view of earning foreign currency. Against this background, the construction of a tuna cannery (annual production volume of 10,000 tons) is planned in 1988 by a joint venture between Happy World (Mauritius), Marine Resources Management, Inc. (U.S.) and Kailis & France (Australia). In addition, introduction of 3 new purse-seiners is also planned.

2-2-2 Distribution Systems and Cold Storage

The artisanal fishing catch is collected by the fishermen's cooperatives and is stored in the cold storages of these cooperatives (excepting that fish for their own consumption). The cooperatives then retail the catch either on the premises or at the market in towns.

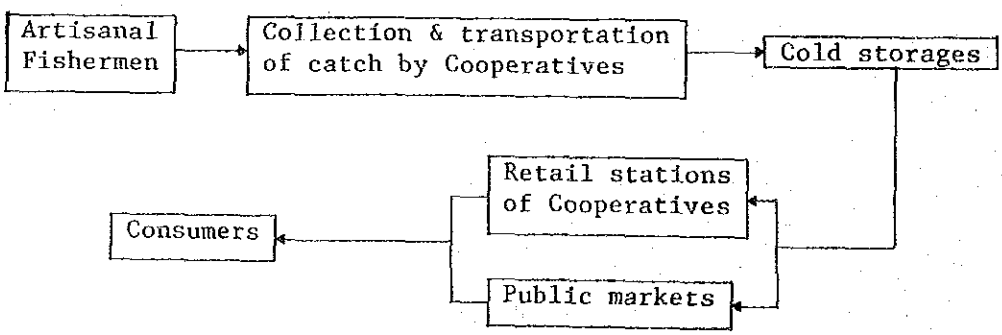
The bank fishing catch is unloaded at the Trou Fanfaron fishing port in the Port Louis harbor. It is purchased by private cold storage companies who transport it to their cold storages and then sell it to retailers through brokers.

There are public fish markets in Port Louis, Curepipe and Quatre Bornes where both artisanal and bank fishing catches are sold.

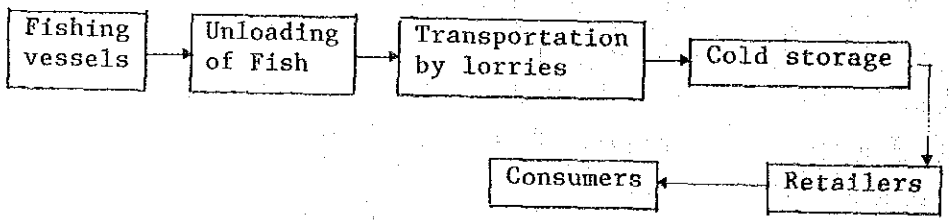
Most of pelagic fish catch such as tuna and skipjack is transported to a canning factory after being unloaded. 95% of can products is exported mainly to EC while the remainder is for domestic consumption. Some tuna and skipjack are transhipped to other countries for canning, and other species from the pelagic fishing are supplied to a domestic market.

The catch distribution system is shown as follows:

• Artisanal Fishery

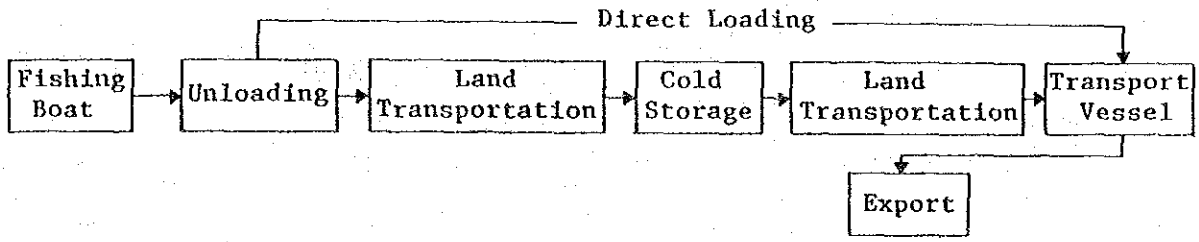


• Bank Fishery

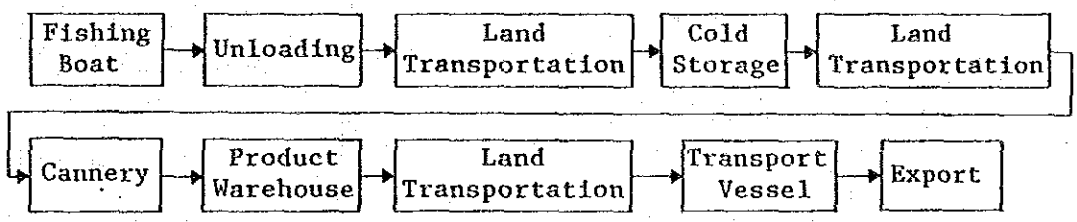


Pelagic Fishery

a) Transhipment



b) Raw Material Use



To keep freshness of fish under the Mauritian climate with relatively high temperatures, cold storages are indispensable for fishing activities and a fish distribution system. Table 2-2-6 is a list of cold storage in Mauritius with a total storage capacity of 4,789 tons. Almost all cold storage firms are involved in selling/buying frozen fish and meat. Only Talbot Fishing Co. and Kaigai Gyogyo manage their own cold storage for frozen fish.

Table 2-2-6 Storage Capacities of Existing Cold Storages
(Storage Temperature: -18°C or lower)

No.	Name	Storage Capacity (tons)*	Cubic Capacity (m^3)	Loading System	Business Contents
1.	New Cold Storage	1,510	6,309	fork-lifts, individual loading, pallets & shelves	purchase & sale of frozen goods, cold storage
2.	ABC Cold Storage	100	416	manual handling	"
3.	Mobimmo (Panagora)	175	725	"	"
4.	Seskel Enterprises	200	833	"	"
5.	Madina Cold Storage	40	167	"	"
6.	National Cold Storage	105	439	shelves, manual handling	"
7.	Happy World, Ltd.	300	1,250	manual handling	"
8.	Talbot Fishing Co.	90	368	"	bank fishing, cold storage
9.	KGKK	1,040	4,320	manual handling with conveyor	transhipment of tuna, cold storage
10.	Zenith Enterprises	984	4,100	"	"
11.	Sodnac Cold Storage	245	1,036	manual handling	purchase & sale of frozen goods, cold storage
	Total	4,789	19,963		

* Storage Capacity = 0.24 tons/m^3 x Cubic Capacity

2-2-3 Fish Consumption

The fish consumption volume of marine products in Mauritius has been 13 - 14 kg/person a year for the last 5 years, as shown in Table 2-2-7.

Although the Government suggests that the minimum consumption volume of marine products should be 18 kg/person a year, the decline of the artisanal fishing catch, the increase of the price of fish and the declining imports of frozen and canned fish have caused the stagnant consumption of fish.

Table 2-2-7 Fish Consumption in Mauritius

	Coefficient for Wet. Wt	1981	1982	1983	1984	1985	1986	1987
								Provisional
1. Local Production								
1. Frensh	1.0	1948	1791	2105	2096	1996	1955	2000
2. Frozen	1.2	1142	2396	2696	2630	4162	4732	5150
3. Salted	2	302	312	241	173	245	296	250
4. Canned	1.4	39	-	81	81	197	158	200
2. Imports								
1. Salted & Dried	2-3	2141	1003	920	954	966	387	
2. Crustaceans	1.1	127	103	107	246	212	227	
3. Canned	1.1-1.6	2684	1739	1751	2454	630	1826	
3. Total								
1. Product Wt		8305	7344	7901	8634	8408	9581	
2. Wet Wt		15718	11879	11723	13768	12169	13371	
4. Population		939477	946686	957301	977129	985210	991300	
5. Per Capita Consumption (Kg)								
1. Product Wt		8.86	7.73	8.25	8.83	8.53	9.66	
2. Wet Wt		16.73	12.51	12.25	14.09	12.35	13.49	

Statistical Unit
AFRC
4/4/88

2-2-4 Fisheries Development Plan

A 5-year Fisheries Development Plan was established in 1985, as mentioned in the White Paper on the "Development of Fisheries and Non-Living Marine Resources".

The medium-term plan aims at increasing fish production in every fishery with the production target shown in Table 2-2-8.

Table 2-2-8 Medium-term Production Plan

	Present Production (tons)	Target Production (tons)
1. Artisanal fishery	1,400	2,500
2. Bank Fishery	2,500	6,000
3. Industrial Fishing	3,000	10,000
4. Aquaculture	41	350
(i) Freshwater		
(a) Prawn	25	100
(b) Carp	5	200
(ii) Marine (Barachois)	11	50

The following plans have been established to promote the fishery in Mauritius.

(1) Short-term action plan

In order to achieve the medium-term production volume targets, a range of policies must first be implemented. Particular priority should be given to the promotion of increasing bank fishing catch in order to restore and maintain the national per capita consumption of fish at the 18 kg/year level while maintaining low dependence on imports. In addition, the promotion of marine products processing industries supplying frozen, canned and smoked fish, and the improvement of marketing techniques are stressed to increase the demand for these products.

(2) Medium-term action plan

There were large fluctuations in the artisanal fishing catch between 1976 and 1984, ranging from 1,000 tons to 2,000 tons and the catch has now almost reached the limit. To reserve the resources, it is necessary to strictly control the use of illegal fishing gear and illegal fishing in restricted seasons. In addition to the above, resources control and culture fishery are deemed necessary. In bank fishing, no specific problems are indicated as the maximum sustainable yield (MSY) is given as 10,000 tons by the FAO survey report. However, bank fishing boats which are fairly old should be replaced although the construction of new boats is slow due to financial reasons. In addition, such managerial problems as the undeveloped distribution network, slow productivity improvement due to local labour customs and the competition from chicken and lamb must be solved. While no problems are anticipated for pelagic fishing in terms of resources, it is suggested that management attention be paid to the fact that the demand for and the price of related canned products are largely affected by the economic situation in Europe and the U.S.

(3) Long-term action plan

The long-term plan to promote the fishing in Mauritius concerns pelagic fishery and other types of fisheries. For the former, the maximum utilization of the tuna resources of the EEZ and the earning of foreign currency through tuna product exports are intended while the effective utilization of marine resources and the promotion of aquaculture are anticipated for the latter. The introduction of new purse-seiners for pelagic fishing, and the imposition of fishing licence fees for the EEZ will be considered. In addition, control-resource fishing is intended in regard to tuna fishing on the basis of international cooperation.

2-3 Current Conditions of Fishing Port Facilities

2-3-1 Utilization of Port Louis Harbour

Port Louis Harbour is the main port in Mauritius and acts as a window on the economic activities of the country. The cargo handling volume in fiscal 1986 was 2.31 million tons and the main items handled were such food as rice and sugar, cement, oil and oil products, etc.

As shown in Fig. 2-3-1, the major facilities are Quays 1 - 4, Quays A - D (although A and B are no longer in use due to deterioration) and quays for the exclusive use of sugar, cement and fish. Quay 1 is exclusively used by a fertilizer factory while Quays 2, 3 and 4 are used for containers and general cargoes. Quays C and D are used for treacle and other general cargoes.

The fish catch is usually unloaded at the fishing quay in the Trou Fanfaron district and Quays C, D or 4 are also used when the fishing quay is occupied.

As shown in Table 2-3-1, the quays have a fairly high berth occupancy of about 70% - 80%. It has been increasing in accordance with the economic development of Mauritius.

Table 2-3-1 Quay Utilization Ratio (%)

	1982/83	1983/84	1984/85	1985/86	1986/87
Quay 1	50.2	46.7	47.8	62.9	70.3
Quay 2	53.8	46.7	44.1	60.5	75.6
Quay 3	64.5	49.8	62.8	64.7	71.8
Quay 4	53.4	46.1	56.2	52.9	67.7
Quay C	37.3	77.8	90.1	82.9	88.6
Quay D	52.5	60.0	66.1	61.6	68.5

(Statistics of Mauritius Marine Authority)

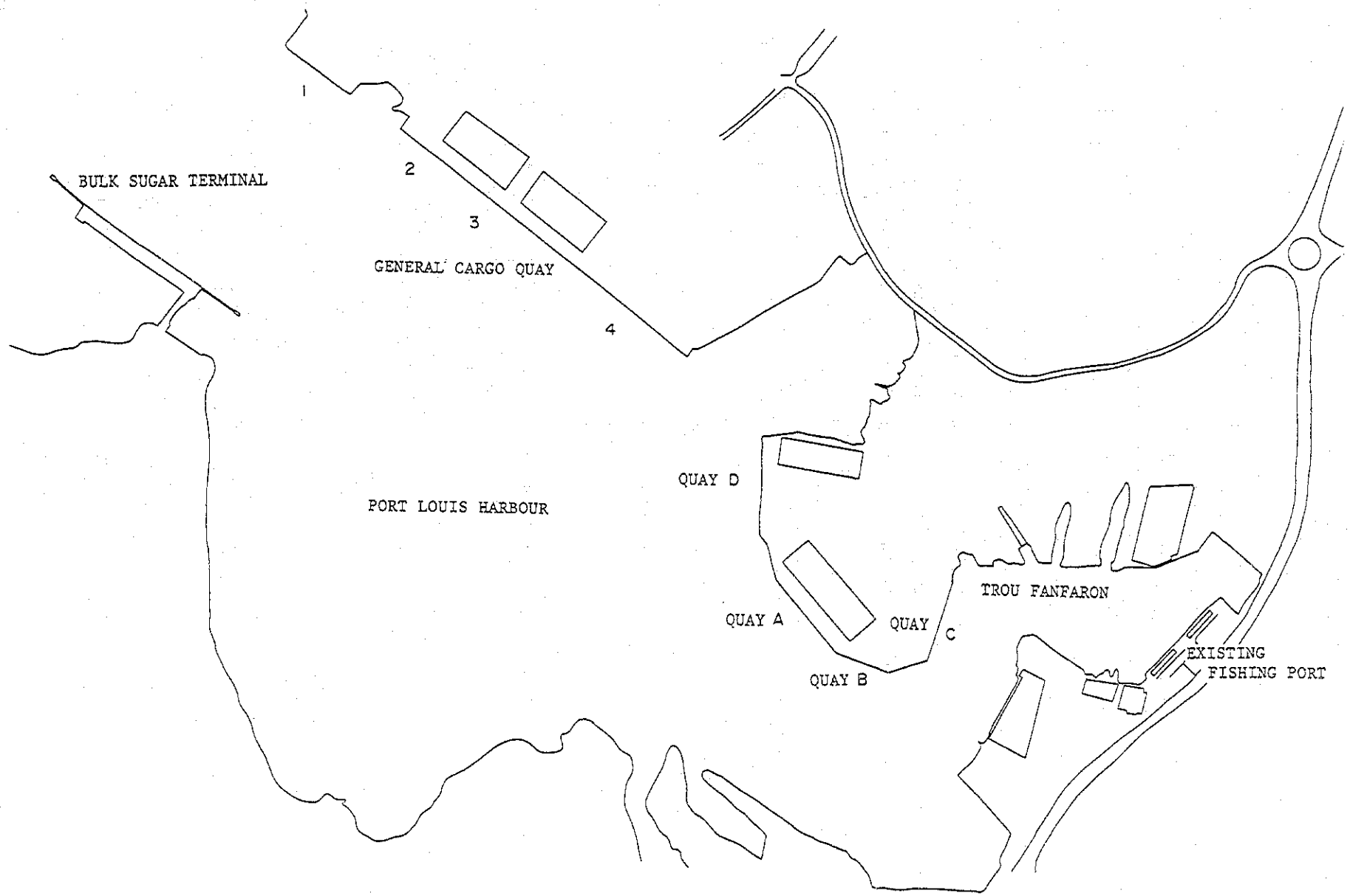


Fig. 2-3-1 General Plan of Port Louis Harbour

2-3-2 Utilization of the Existing Fishing Port

The existing fishing port is located in the Trou Fanfaron district (see Figure 2-3-1) which is at the innermost part of the Port Louis harbour. The total water area of the fishing port, including the project site and the location of the dry dock and temporary unloading facility using an ex-carrier vessel, is approximately 54,000m^2. As the water remains quite calm even during a cyclone, it is used as a place of refuge by fishing and small boats.

The fishing port was donated in May, 1985 by the Government of Japan on the basis of the grant aid program, aiming at the promotion of bank fishery with the primary objective of fish unloading efficiency, thereby achieving stable fish supply. The fishing port has the following facilities.

Quay	Water Depth	5.5m
	Berth Length	140m (2 berths)
Packing Halls		2 (including an office and a warehouse)
Water Supply Station		1 (a valve and piping)
Fuel Stations		2 (valves and piping)

(1) Number of Fishing Boats

The number of fishing vessels being operated using the fishing port in the Port Louis harbor as a base for bank and pelagic fishing as of 1987 is as follows.

a)	Bank Fishing Boats	13
b)	Skipjack Purse-Seiners	2
c)	Tuna Long Liners	3
	Total	18

There are also 25 foreign tuna long liners which operate from the Port Louis harbour in the East Indian Ocean.

(2) Sizes of Fishing Boats

Table 2-3-2 gives the names and sizes of the bank and pelagic fishing boats using the fishing port.

Table 2-3-2 Bank and Pelagic Fishing Boats

	Name	GRT	Net	Length(m)	Maximum Draft(m)
Bank Fishing Vessel	La Perle III	613	225	60	5.0
	Silver Star	235	150	38.4	4.5 or less
	Orient	173	97	32	"
	Star Hope	251	125	49	"
	Sea Horse	66	17	20	"
	Hassam Mian	317	147	40	"
	Hensing Chang 1	284	144	43	"
	Hensing Chang 2	254	150	40.5	"
	Snow Reefer	300	155	52	"
	Faki	299	175	49	"
	Jabeda	327	168	44	"
	Reef	255	-	47.78	"
	Good Hope	160	74	31.72	"
Purse-Seiner	Lady Sushil I	534.04	525.42	56.45	6.0
	Lady Sushil II	1,039	674.64	61.75	6.5
Long Liner	Phoenix	299	(175)	(49)	4.5 or less
	Crown	-	-	(17.4)	
	Swan	-	-	(17.4)	

Most of the bank fishing vessels are converted long liners, largest of which is La Perle III with a length of 60m and a maximum draft of 5m. The largest fishing vessel being operated in Mauritius is the Lady Sushil II which has a GRT, length and maximum draft of 1,039 tons, 61.75m and 6.5m respectively. As the maximum drafts of the purse-seiners are currently deeper than the depth of the existing fishing quay, fully loaded purse- seiners cannot come alongside the quay, and they shift to Quay C, D and 4. However, fishing vessels are sometimes obliged to terminate their unloading and to move away from the general cargo quays in the case that cargo vessels approach to these quays, since the former vessels are afforded low priority on quay operation.

(3) Number of Fishing Boats Entering Port Louis Harbour

Table 2-3-3 shows the number of fishing boats calling at the Port Louis harbour in the last 5 years.

Table 2-3-3 Number of Fishing Boats Calling at the Port Louis Harbour

Year	1983	1984	1985	1986	1987
Number of Boats	319	264	308	477	428

(Statistics of MMA)

The number of fishing vessels entering the Port Louis harbour to unload the catch is shown in Table 2-3-4. It increased to 158 in 1987 from 94 in 1983.

Table 2-3-4 Number fo Fishing Vessels calling at Port Louis

	1983	1984	1985	1986	1987
Number of Pelagic Fishing Vessels	68	81	106	103	114
Number of Bank Fishing Vessels	26	30	54	49	44
Total	94	111	160	152	158

Foreign fishing vessels call at the port to take on food, fuel etc. Japanese vessels usually anchor for 2-3 days and each vessel spends some Rs 350,000 (approximately 3.5 million yen), according to the agents for fishing firms. They are deemed to be important sources of foreign currency.

(4) Berth Occupancy of Fishing Quay

As shown in Table 2-3-5, the existing fishing quay has a berth occupancy of 100%.

The fishing quay was originally provided as an exclusive quay for fishing vessels with conditioning the annual number of 72 fishing vessels. However, as it is the only facility in the Port Louis harbor for exclusive fishing vessel use, pelagic fishing vessels also use the quay, resulting in the increase of berth occupancy. The study team recognized that 10 fishing vessels were moored alongside each other at the quay.

Table 2-3-5 Berth Occupancy of Fishing Quays (%)
FY 1985 - 86

Month	TFFQ		TFFQ	
	Berth Occupied not Working	Berth Occupied Working	Berth Occupied not Working	Berth Occupied Working
July	72	7	93	7
August	61	2	87	13
September	N/A	N/A	100	NIL
October	28	8	83	17
November	67	33	92	8
December	57	8	96	4
January	89	11	81	19
February	90	10	88	12
March	89	11	87	13
April	85	15	91	9
May	88	12	87	12
June	88	12	91	8

(Statistics of MMA)

Average % calculated on 24 hours availability of berth.

As vessels are constantly moored at the quay, those vessels newly entering the port to unload the catch are forced to wait for 1 or 2 days until the boats already moored at the quay leave there.

2-3-3 Fishing Vessel Operation and Unloading System

The present situation of fishing vessel operation are as follows:

• Bank Fishing

The seasons for bank fishing are from January to May (or June) and from September to December. Fishing is suspended in winter, i.e. June to August, due to the rough sea conditions. Table 2-3-6 shows bank fishing boat operation in 1987. The general conditions of those boats regularly involved in bank fishing are given below based on their past performances and their operation rates are generally inferior to those of purse seiners or long liners.

Boat Length			
39m - 45m	September - December	2 trips	5 trips
	January - May (June)	3 trips	
	Average Trip Duration	35 days	
	No. of Fishing Days	35 x 5 = 175 days	
	Days in Port	190 days	
Boat Length			
> 45m	September - December	1 trip	3 trips
	January - May (June)	2 trips	
	Average Trip Duration	55 days	
	No. of Fishing Days	55 x 3 = 165 days	
	Days in Port	200 days	

On return to port, the catch is handled either individually or collectively (in gunny bags) and is loaded onto trucks by mobile cranes for transportation to a cold storage in Port Louis. Unloading capacity is 5-6 tons/hour, or 50-60 tons/day. Catch varies each trip from 100 tons to 200 tons, depending on the size and type of vessels. Therefore,

Table 2-3-6 Bank Fishing Vessels Operation in 1987

S.N	Fishing Vessel	No. of Trips	Days Out	Days T.	inactive B. W.	Fishing Days	Catch (tonnes)	Days in port between cruises
1	La Perle III	3	182	25	15	142	598.540	183
2	Silver Star						297.637	
3	Orient	3	106	24	6	76	131.256	259
4	Star Hope	1	40	6	1	33	107.200	325
5	Hassen Mian	4	45	7	7	31	142.492	320
6	Hen Sin Chang I	5	155	29	16	110	550.540	210
7	St. Christophe	1	49	14	-	35	10.000	316
8	Hen Sin Chang II	5	144	27	16	101	328.293	221
9	Snow Reefer	5	242	28	35	179	904.555	123
10	Faki	5	214	39	18	157	890.677	151
11	Jabeda	4	164	21	11	132	610.802	201
12	Reef	2	69	15	5	49	204.060	296
13	Good Hope	3	74	15	11	48	98.700	291

unloading work needs 2-4 days. As the quay only has an unloading capacity of 50-60 tons/day, unloading can take 2-3 days. It was observed during the field survey that unloading is not always continuously conducted but it is sometimes suspended until sales negotiations with frozen food companies, etc. have been completed, indicating that the fishing vessels are used for temporary cold storage purposes. This situation is the apparent cause of the low operation rates of the fishing vessels (i.e. long stay in port).

• Skipjack and Tuna Fishing

The Lady Sushil I and the Lady Sushil II, both skipjack purse-seiners, made 10 and 5 trips respectively in 1987 (the Lady Sushil II commenced operation in May, 1987) with an average duration of 30-40 fishing days per trip and a catch of 400-500 tons.

As in bank fishing, the catch is unloaded by a mobile crane and is then loaded onto trucks for transportation to a cold storage.

The unlanding quays are usually occupied for 5-6 days when water, fuel, food, etc. are supplied to the fishing vessels. After a week stay in port for unloading and idling, the fishing vessels leave the port. The long liners which are based at the Port Louis harbour are at sea for 3-4 months each trip, making an average of 3 trips/year. Average fishing days is 315 days. They stay in port for 2-3 weeks between trips to unload the catch, make repairs and take on fuel, water food, etc. The unloading system for tuna is basically the same as that for bank and pelagic fishing. The operation of each type of fishing boats is summarized in Table 2-3-7.

Table 2-3-7 Average Operation of Fishing Vessels

	Days at Sea (days/boat/year)	Days in Port (days/boat/year)	Unloading Days (days/boat/year)	No. of Subject Boats
Bank Fishing Boats	165	200	2 - 3	13
Skipjack Purse-Seiners	300	65	5 - 6	2
Tuna Long Liners	315	50	2 - 3	3*

* plus 25 foreign boats

2-4 Background and Contents of Request

2-4-1 Background of Request

Artisanal and bank fishery play an important role in the provision of a fish protein source for the people of Mauritius while pelagic fishery and related industries are important earners of foreign currency.

The basic fishery policy in Mauritius lays stress on (1) improving the fish protein supply self-sufficiency rate and reducing foreign currency spending through the promotion of bank fishing, (2) increasing the fish consumption volume and (3) increasing the earning of foreign currency by pelagic fishing and canned tuna exports.

Due to the various promotion measures of the Government, the number of bank fishing vessels has now increased from 9 in 1982 to 13, and the catch has also increased from the 3,000 ton level in 1982 to the 5,000 ton level in 1987.

The pelagic fishing catch in 1987 was 6,900 tons, showing a large increase from the 4,000 tons in 1986 due to the introduction of a new purse-seiner (1,039 GT) in 1987 (2 purse-seiners are currently in operation) and the expansion of the processing capacity of the cannery is currently planned to deal with the increased catch. Construction of a new cannery is also planned. The industrial development associated with pelagic fishery is expected to tremendously contribute to the Mauritian economy in terms of both the earning of foreign currency and the expansion of employment opportunities.

Due to the above-described improvements, the existing fishing quay which acts as a base for fishing operations has been playing an increasingly important role.

However, the quay is now being fully occupied at a rate of 100% and the demand exceeds the capacity. Fishing vessels are forced to wait for 1-2 days to unload the catch until preceding boats leave the quay, resulting in the reduction of unloading efficiency. In addition, purse-seiners with deep draft cannot approach the fishing quay and are obliged to use the other quays for general cargoes. As the purse-seiners are given low priority in using these quays, however, they are forced to move when cargo ships arrive. In addition, the lack of cold storage facilities in the port and the inadequate facilities of private cold

storage also result in bank fishing boats having to wait a long time to unload the catch, reducing their number of fishing days and also lowering the fish price due to the necessity to sell the catch as quickly as possible for subsequent fishing. These are recognized to be serious problems for bank fishing.

To execute the Fisheries Development Plan in solving the above problems, the Government of Mauritius has requested grant aid cooperation from the Government of Japan to extend the fishing port facilities.

2-4-2 Contents of the Request and Discussions

The Government of Mauritius has requested the expansion of the existing fishing port, including the construction of a cold storage (see Table 2-4-1).

Table 2-4-1 Requested Contents

1	Extension of Landing Quay (180m to the north and 68m to the west of the existing quay)
2	Dredging of Mooring Area (8m in depth)
3	Preparation of Land Adjacent to the Quay
4	Removal of Buildings from the Quay Construction Site
5	Packing Hall
6	Cold Storage: storage capacity of 300 tons, refrigeration and related equipment
7	Service Facilities: water, power and fuel supply facilities
8	Auxiliary Facilities and Loading /Unloading Equipment: office building, warehouse, repair shop, fork-lifts, trucks, etc.

As a result of reviewing the requests through the field survey, the team has concluded that the urgent expansion of the fishing port facilities at Trou Fanfaron is necessary for the promotion of bank and pelagic fishery.

The Minutes of Discussions were signed by the Team Leader and representatives of the Government of Mauritius. The scope of the facilities and their order of priority are as follows:

1) Landing quay (including dredging, road and pavement)
2) Cold storage (including forklifts and weight balance)
3) Packing hall (including office)
4) Other services (crane, water, power and fuel supply)

CHAPTER 3

CONTENTS OF THE PROJECT

CHAPTER 3 CONTENTS OF THE PROJECT

3-1 Problems in the Fishing Port Facilities and the Objective of this Project

Catch in bank fishery increased from the 3,000 ton mark in 1982 to the 5,000 ton mark in 1987, while catch in tuna purse-seining leaped from 3,987 tons in 1985 to 6,896 tons by 1987 with the introduction of a new vessel (the 'Lady Sushil II' which went into commission in May, 1987).

The bank fishing is positioned as the industry for supplying domestic fish protein and its fish catch is expected to increase. Tuna purse-seining is positioned as the industry for earning foreign currency by processing and exporting its catch as canned products. The fishing port facilities assume an important role as the base for these fishing activities. The following problems, however, may be pointed out with respect to the existing fishing port facilities.

(1) Increasing number of fishing vessels utilizing the port and the declining landing efficiency on account of inadequate quay facilities

The existing fishing port was planned for the exclusive use by bank fishing vessels, with a target of 72 vessels operated in a year. However, the number of vessels which actually called at the port for landing their catch in 1987 was 158, which far exceeded the target and caused a shortage of berths. Besides this, as the quay of the existing two berths was designed for unloading without any facilities for idling and fitting, fishing vessels which call at the port are compelled to moor at the quay for a protracted period to prepare for the next voyage. Because of these conditions, an incoming fishing vessel wishing to land its catch must remain inside the port until the fishing vessels moored at the quay move away, which entails extra cost burden.

(2) Lack of infrastructure for tuna purse-seiners

The draft of the tuna purse-seiners in Mauritius now is 6.0m or more which precludes the use of the quay of the existing fishing port. Because of this, the tuna purse-seiners use the general cargo quay for landing their catch, but the current condition is such that the fishing vessels with low priority in using the general cargo quay must either wait for a long time before the berth becomes available or terminate landing and make room for an incoming cargo vessel. Also, the occupancy rate of the general cargo quay which was on the 50% mark in 1982 rose to the 70% mark in 1986 on account of the increase in the number of incoming cargo vessels, which has made it even more difficult for fishing vessels to use the general cargo quay.

The development of infrastructure facilities for the tuna purse-seiners is urgently called for as the fisheries development plan of the Government of Mauritius is predicated on the earning of foreign currency through pelagic fishery.

(3) Protracted laytime due to inadequate cold storage facilities

The cold storage with a total capacity of 4,789 tons in Mauritius is operated by private firms, which deal with not only bank fish but frozen meat. They usually reserve necessary space in the cold storage for frozen meat, according to the annual import volume of frozen meat. Due to the above, increase in bank fishing catch sometimes causes a shortage of cold storage.

Among the companies involved in bank fishing, only one company has its own cold storage now. The catch of the rest of the companies is purchased and stored by private cold storage companies, and whatever left is stored on board motherships. The fish stored on board motherships is landed according to the condition of purchases by cold storage companies so that the motherships must remain inside the port for a long time. Thus, the shortage of cold storage facilities is not only leading to the reduction in the number of fishing days, but is increasing the running expenses and the stevedoring costs for bank fishing vessels. These additional financial burdens are pressuring the financial condition of the small fishing operators and keeping them from remodelling their old

fishing vessels or purchasing replacement vessels, which are problems in promoting bank fishing.

In order to solve the problems and improve the services of the fishing port facilities and thereby promote the Mauritian fishery, extension and improvement of the fishing port facilities are considered necessary.

The objectives of this Project are to set up a new quay which can accommodate tuna purse-seiners and to provide infrastructure for fishing such as cold storage in order to improve landing efficiency and stabilize fish prices by reducing the expenditures of fishing operators, and to increase fish catch by increasing the number of fishing days, thereby contributing to the promotion of the Mauritian fishing industry.

3-2 Determination of Facilities Size

3-2-1 Necessity of Fishing Quay

(1) Required number of berths

For smooth fishing operation, fitting and idling berths are also required together with a landing berth. The size of the existing fishing quay is determined to be 140m long for two berths, assuming that there are 72 calls/ year of bank fishing vessels, 3 days/call/vessel for unloading and 25 working days/month. The fishing quay is used not only for unloading purposes but also for preparation to put back to sea. The quay is also used by long liners operating in the Indian Ocean which call at the Port Louis harbour for transhipment purposes. As a result, the number of fishing vessels calling at the Port Louis harbour for either unloading or transhipment is double the planned figure, as shown in Table 2-3-4. While not all these vessels use the fishing quay, it is apparent that the number of berths for fishing boats is inadequate.

Since the Project is intended through grant aid cooperation, for providing facilities required for the promotion of fishery in Mauritius, the design facility size should be determined on the basis of the number of fishing vessels either registered in Mauritius or using the Trou Fanfaron fishing port for unloading or transhipment purposes, excluding those boats calling at the port for bunkering or other reasons. The

required number of berths is, therefore, examined here based on the following 2 cases.

Case 1: Actual situation of Mauritian fishing vessels being operated

Case 2: Number of fishing vessels calling at the Port Louis harbour for unloading or transhipment purposes

1) Case 1

Thirteen bank fishing vessels, 3 long liners and 2 purse-seiners are currently operating under the flag of Mauritius. Table 3-2-1 shows the average annual operation of these boats.

Table 3-2-1 Fishing vessel Operation

		Days out	Days in Port			Operation Rate (%)	No. of Subject Boats
			unloading & preparation	Idle	Total		
Bank Fishing Boats	Small Vessel	175	100	90	190	45	9
	Larger Vessel	165	110	90	200	45	5
Purse-seiners		300	65	-	65	82	2
Long Liners		315	50	-	50	86	3

Assuming that the idle bank fishing vessels are moored to mooring buoys instead of at the quay, the aggregate number of days at the quay for all fishing vessels can be calculated as follows.

Bank Fishing Vessels : 100 x 9 + 110 x 5 = 1,450 days

Purse-seiners : 65 x 2 = 130 days

Long Liners : 50 x 3 = 150 days

Total 1,730 days

The operation days of a berth includes the days for preparing fishing at the quay and thus each berth can be used 365 days/year. Therefore, the required number of berths is given to be:

1,710 days ÷ 365 days = 4.68 ≒ 5 berths

As the existing fishing quay already has 2 berths, 3 extra-berths will be required. The main reason for the shortage of berths, calculated from the current performance of Mauritian fishing vessels, lies with the low operation rate of bank fishing boats (see Table 3-2-1) vis-a-vis that of purse-seiners and long liners. It is also caused by having to wait to unload the catch due to the lack of their own storage facilities, keeping the catch in the vessel's storage until the fish can be sold.

2) Case 2

Table 2-3-4 gives the number of fishing boats calling at the Port Louis harbour to unload their catch. While the results for the last 4 years widely fluctuated, the highest monthly figures for fishing boats unloading at the port are as follows.

Table 3-2-2

Highest Monthly Figures of Fishing Boats Unloading at the Port Louis harbour in the Last 4 Years

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No. of Boats	20	14	21	15	15	15	20	15	16	20	13	18

The largest number of fishing vessels unloading at the Port Louis harbour in a month is, therefore, 21.

Assuming that the fishing quay is used only for unloading, bank fishing boats, long liners and purse-seiners will require 3, 4 and 6 days respectively, with an average of 4.3 days/boats. Given the operation days of the quay to be 25 days/month (excluding Sundays), the required number of berths is

21 boats x 4.3 days/boat ÷ 25 days = 3.6 = 4 berths

Based on this equation, additional 2 berths is considered necessary for the fishing quay.

The above 2 cases suggest the existing fishing quay to have a current shortage of 2 - 3 berths. Therefore, the provision of at least two new berths should be needed for the Project.

3-2-2 Contents of the Basic Facilities of the Fishing Port

The Government of Mauritius has requested an extension of the quay by 68m on the northern side of the quay of the existing fishing port and by 180m on the western side. On the northern 68m section, however, the width of the frontal water area is only 80m, and if the quay is extended, the width of the water area will be reduced to about 50m and make it difficult for a vessel with a length of 45m to maneuver, whether it may be a bank fishing vessel or a tuna long liner. It is therefore considered advisable to secure this water area as an anchorage of fishing vessels for idling. Accordingly, extension of the quay only on the western side of the existing quay will be considered.

Fishing vessels that utilize the fishing port facilities are bank fishing vessels, long liners and purse-seiners. Of these, purse-seiners cannot use the existing fishing port because of their deep draft. Accordingly, the design depth of the extended quay will be determined to be suitable for the draft of purse-seiners. At present, the Lady Sushil II is the largest purse-seiner in Mauritius and her maximum draft is 6.50m. In this facility, therefore, the Lady Sushil II will be considered as the target vessel in formulating the plan. The water depth of the quay requested by the Government of Mauritius is 8m in anticipation of the size of fishing vessels becoming larger in the future, but a water depth shallower than 8m will be sufficient since the size of the projected vessels is not specified at the present stage.

Unloading is carried out by means of a mobile crane but the fishing port does not have one for its exclusive use yet, so that the crane used at the general cargo quay must be moved to the fishing port for unloading catch. As the fishing port quay is about 1.6km away from the general cargo quay, it takes time for the old crane to cover that distance, which results in poor unloading efficiency. A crane is therefore necessary for the new quay to improve unloading efficiency. Although purse-seiners are equipped with an on-board crane, bank fishing vessels do not have any. It is considered necessary to provide a crane for exclusive use for bank fishing vessels at the new fishing port.

The ancillary facilities attached to the basic facilities include water supply, power, and bunkering facilities. The existing quay is provided with one water supply valve and two bunkering valves, but purse-seiners are unable to come alongside the quay of the existing fishing port. Therefore, water supply and bunkering facilities must be provided at the new quay. Pipelines for these will be extended from the existing fishing port.

As the new fishing quay will be designed to have the water depth to accommodate purse-seiners, anchorage and a channel 7m deep will be necessary. Predging of the anchorage and channel will be necessary to provide a depth of 7m. In addition, onsite roads, an open storage yard for bank fishing vessels and fishing gear will be necessary. As ancillary facilities for a quay, fenders, mooring posts and lighting facilities will also be necessary.

In view of the above, the basic concepts of design for the fishing port will be as follows:

1) Extension of the fishing port quay will be planned on the western side of the existing quay.
2) The new quay to be installed will be designed for the use by fishing vessels based at the Port Louis harbour including bank fishing vessels, long liners and purse-seiners so as to mitigate congestion at the existing quay and raise efficiency of the unloading of catch.
3) The new quay will be designed to accommodate purse-seiners with deep draft.

The contents of the basic facilities of the fishing port will be planned as follows:

1) Channel and anchorage 7m deep
2) Two berths for the landing quay and a crane
3) Water supply and bunkering facilities (valves) with piping
4) Onsite road and open storage yard (with low-cost paving)
5) Ancillary facilities of the quay: fenders, mooring bitts, lighting.

3-2-3 Review of the Needs for the Functional Facilities of the Fishing Port

The following discusses the needs for the facilities requested as the functional facilities of the fishing port such as cold storage and a packing hall.

(1) Cold storage

All fish caught in bank and pelagic fishing are frozen on board and landed at the Port Louis fishing port, and stored in the cold storage in Port Louis.

The 1987 entry record of cold storage was 19,338 tons of frozen fish as shown in Table 3-2-3 and 10,533 tons of imported frozen meat as shown in Table 3-2-4, with the total entry for the year reaching almost 30,000 tons.

On the other hand, the accommodating capacity of the cold storage in Port Louis consists of 11 facilities of cold storage with a combined total capacity of 4,789 tons.

The fish caught in pelagic fishing in 1987 reached 14,187 tons, which was equivalent to 47.5% of the total frozen cargoes. The industry secures necessary storage space for its exclusive use on the basis of its annual fish catch plan.

Table 3-2-3 Monthly and Yearly Fish Catch

Unit: ton

	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total	Annual Average
1985														
Bank fishing	74	320	510	190	620	109	357	111	45	199	775	526	3.836	319
Pelagaic fishing	1.893	513	673	422	845	778	1.444	1.189	1.022	787	855	786	11.207	933
TOTAL	1.967	883	1.183	612	1.465	887	1.801	1.300	1.067	986	1.630	1.312	15.043	1.252
Deviation in bank fishing	-245	1	191	-129	301	-210	38	-208	-274	-120	456	207	Average of surplus	199
Deviation in pelagic fishing	960	-420	260	-511	-88	-155	511	256	89	-146	-78	-147	ditto	454
1986														
Bank fishing	0	335	251	829	235	480	207	172	43	790	220	1.063	4.625	385
Pelagic fishing	1.493	1.157	551	683	669	1.375	1.582	424	325	871	759	975	10.854	904
TOTAL	1.493	1.492	802	1.512	904	1.855	1.789	586	368	1.661	978	2.038	15.479	1.289
Deviation in bank fishing	-385	-50	-134	444	-150	95	-178	-213	-342	405	-165	678	Average of surplus	406
Deviation in pelagic fishing	589	253	-353	-221	-235	471	678	-490	-579	-33	-145	71	ditto	412
1987														
Bank fishing	2	92	517	696	703	519	361	227	0	547	583	904	5.151	429
Pelagic fishing	1.849	1.360	737	845	1.179	1.273	1.558	591	1.314	1.522	694	1.265	14.187	1.182
TOTAL	1.851	1.452	1.254	1.541	1.882	1.792	1.919	818	1.314	2.069	1.277	2.169	19.338	1.611
Deviation in bank fishing	-427	-337	88	267	274	90	-68	-202	-429	118	154	475	Average of surplus	209
Deviation in pelagic fishing	667	178	-445	-337	-3	91	376	-591	132	340	-488	83	ditto	267

Table 3-2-4 Frozen Meat Imports in 1987

	Kg	Qty.
Beef bolive bone-in	Total	226,156
" " boneless	"	4,740,428
Mutton	"	4,955,415
Pork	"	101,023
Horsemeat, etc.	"	233,787
Offals	"	50
Poultry	"	277,112
	Kg	10,533,971

Of the storage capacity shown in Table 2-2-6, the storage capacity for the exclusive use of the industry consists of (1) New Cold Storage: 791 tons, (2) KGKK: 1,040 tons, and (3) Zenith Enterprises: 980 tons, totaling 2,811 tons.

Imported frozen meat is handled by the cold storage firms who import it according to the trend of consumption requirements, and the quantity of frozen cargo was 10,533 tons, accounting for 35.3% of the total.

As both of these two business sectors secure a certain level of cold storage space for their exclusive use, the fluctuation in the quantity of frozen cargo handled by them has only a minor impact on the storage capacity.

In contrast, enterprises engaged in bank fishing are small in size. Only one company has its own cold storage while the others do not, so that they sell their catch to cold storage firms and unload the fish accordingly. The frozen fish landed was 5,151 tons, accounting for 17.2% of the total frozen cargo. The cold storage firms who purchase frozen fish from the bank fishing industry are independent enterprises who operate both the cold storage business and marketing business while also handling other frozen goods including frozen meat. As such a firm does not make its storage space available to another firm and, what is more, places higher priority on terms and conditions of buying and selling, the result is a decline in the utilization rate of its cold storage space. These circumstances are aggravating the shortage of cold storage space to the extent that a fluctuation in the catch tons has a major impact on storage capacity. These are the problems in distribution, but the fishing vessels which have returned to the port during the season when the catch tons of bank fishing increases (March through May, and October through December. Refer to Table 3-2-3) are compelled to remain long in the port waiting for their turn for landing because of the cold storage being full. According to the landing statistics of bank fishing in 1986, there were 750 tons of frozen fish which could not be landed from the fishing vessels in December, and a large decline of 33% in the price of fish was reported as an inevitable consequence of fishing vessels having rushed to sell off frozen fish in the ship's hold in order to sail from the port again.(*) The decline in the selling price of frozen bank fish due to the shortage of cold storage space is seriously encroaching upon

the profitability of fishing operation. Also, the fish distribution system in Mauritius causes the protraction of vessels' stay in the port, which results in a reduction of fishing days. Besides, the cost of storing fish aboard a vessel and the cost of stevedoring due to increased unloading frequency also increase, which collectively exert a big financial burden on the fishing operators.

When the utilization status of cold storage is expressed in terms of the annual turnover of accommodating capacity, the annual turnover calculated from the annual quantity of entry into storage of about 30,000 tons and the accommodating capacity of 4,789 tons is:

30,000 tons ÷ 4,789 tons = 6.26 times a year.

The above turnover far exceeds the normal one in Japan of 3 to 3.5 times a year which in certain areas near the markets is around 5 times a year. This may be interpreted as, despite the cold storage being utilized quite effectively, lack of the flexibility of it to cope with fluctuations in the quantity of incoming cargo, resulting in an occasional shortage of storage space.

The shortage of cold storage space is a very basic and critical problem and it must be solved in order to prevent abnormal declines in the price of frozen fish and a reduction in the number of operating days of fishing vessels.

From the above viewpoint, therefore, a new facility of cold storage in the port will be indispensable for the promotion of the fishing industry.

(*) Appraisal of Bank Fishing Industry in 1986, C.R. Samboo, the Albion Fisheries Research Centre.

* Shortage in the accommodating capacity of cold storage

The necessary storage space for the catch of the Mauritian pelagic fishing companies is secured within the company's own or borrowed cold storage facilities, the accommodating capacity of which is 2,815 tons in total, consisting of: (1) 791 tons of New Cold Storage, (2) 1,040 tons of KGKK, and (3) 984 tons of Zenith Enterprises. In the bank fishing industry, only one company has its own cold storage, which is 90 tons in accommodating capacity. Therefore, the storing capacity available for frozen meat and the catch of bank fishing is

4,789 tons - 2,815 tons - 90 tons = 1,884 tons,

of the total accommodating capacity of all cold storage in the city.

Assuming that the respective share of meat and the catch of bank fishing in the frozen cargo is 35.3% and 17.2% and that the turnover of both frozen cargoes is the same 6.26 times per annum, the capacity available for the bank fishing catch in the accommodating capacity of 1,884 tons is calculated to be:

1,884 tons x 0.172 = 324 tons.

As there is 90 ton cold storage which is exclusively used for bank fishing, the combined accommodating capacity available for bank fishing is calculated to be 414 tons.

The monthly mean landing quantity of fish in 1987 shown in Table 3-2-3 is 429 tons, which means that the accommodating capacity roughly commensurate to the monthly mean landing quality of fish is secured. Shortage of cold storage space will therefore arise when there is a positive variance in excess of the monthly mean fish catch. The mean value of this positive variance was 199 tons in 1985, 406 tons in 1986 and 209 tons in 1987.

Table 3-2-5 shows the calculation of the shortage in the cold storage capacity in each year from the monthly mean fish catch and the monthly mean variance of the fish catch on the assumption that the accommodating capacity of cold storage available for bank fishing is 414 tons.

Table 3-2-5 Shortage of Cold Storage Capacity

	(Monthly mean catch + Monthly mean variance) - 414t =	Shortage of storage space	Moving average	
			1985-1986	1986-1987
1985	(319 + 199) - 414t	104t	240.5t	-
1986	(385 + 406) - 414t	377t		
1987	(429 + 209) - 414t	224t	-	300.5t

The large shortage of accommodating capacity in 1986 means that the range of fluctuation was large in this year, while in 1987, the shortage became smaller even though the fish catch was larger compared to a year before, which means that the month-to-month changes were small and the landing quantity in every month was more even. Thus, the magnitude of shortage in the cold storage capacity naturally corresponds to the magnitude of variance in the catch, but if the size of the cold storage were to be made large enough to accommodate to the largest variance, a large loss in operating expense would be incurred. Accordingly, the provision of a storage of the 250-ton class in accommodating capacity is considered to be reasonable for coping with the average shortage shown in the above table.

* Purposes for using cold storage

Operation of cold storage in Mauritius may be classified into the following three:

(1) Fishing company's own cold storage
(2) Cold storage owned by supermarkets and other retail establishments
(3) Larger sized cold storage for operating the businesses of purchasing, selling, and storing of frozen fish.

The total accommodating capacity of these cold storage consisting of 11 store rooms is 4,789 tons as shown in Table 2-3-6.

According to the survey findings on the state of actual use of cold storage, the utilization rate of larger sized commercial cold storage is almost 100% even in the normal months, with barely any room to accommodate newly entrusted cargo. Accordingly, in the months when the landing quantity increases and in the year-end peak season, there is not enough accommodating capacity to cope with a positive variance, so that some of the bank fishing vessels have to be moored at the quay until their fish can be landed. The protracted laytime of the fishing vessel affects its next voyage and invites a decline in its operating rate, which in turn becomes a big financial burden on the fishing operator.

To solve the above problems, the cold storage which will be built in the fishing port under this Project aims to accelerate landing operation of fishing vessels and thereby liquidate their protracted laytime and stabilize fish prices.

The introduction of the new cold storage will solve any problems on fish supply for market demands and its relevant shortage of the cold storage. Therefore, the fish catch will be unloaded whenever fishing vessels call at the port.

In order to accomplish the above, it is most important to accelerate the turnover by shortening the term of fish storage as much as possible.

(2) Packing hall

In bank fishing, unloaded fish are packed either in bulk or in gunny bags (with a content of 50kgs. each), which are loaded onto a truck by a mobile crane and hauled to each cold storage. Sorting of landed fish is not practiced at present in the existing fishing port, but the fish are sorted at the cold storage at their incoming and outgoing.

The catch of skipjack is packed in bulk, and is loaded onto a truck by a crane on the deck of the fishing vessel or by a mobile crane on the quay and hauled to the cold storage. Trash fish mixed into the catch are sorted out aboard the vessel.

In this Project, the packing hall is positioned as one of the ancillary facilities of the cold storage, and provides necessary space for weighing and sorting the fish by type at the time of their entry and issuance to and from the cold storage. The packing hall will therefore be planned to secure a shade to retain the freshness of fish and a space

for sorting and weighing them.

Accordingly, the area size of the packing hall will be commensurate with the plane size of the cold storage. Considering the necessity of a shade for weighing fish, a packing hall of 8m between centers of adjacent columns, which are of the same sizes as those of the handling yard at the existing fishing port, will become necessary, with a 27m-wide shed.

3-2-4 Contents of the Functional Facilities of the Fishing Port

The cold storage is planned mainly for promoting bank fishing, and low-temperature distribution of the frozen fish is a necessary condition for retaining both freshness and quality. The temperature in the fish hold of the bank fishing vessels is maintained at -30°C, and in order to retain the freshness and the quality of fish, cold storage of an equal functional performance is necessary. Also, in order to alleviate a rise in temperature within the storage by the infiltration of outside air at the time of opening and closing the heat-insulating door during stevedoring service, a preparation room must be provided to the cold storage. The temperature in the room shall be maintained at -10°C.

In order to carry out the receiving and issuing services to and from the cold storage, and also to utilize the cold storage capacity to the maximum extent, the use of box pallets with a standard loading capacity of one ton will be planned. For this purpose, the use of a forklift will also be planned.

Besides a packing hall which will be necessary as an ancillary facility of the cold storage, a chilling plant and a standby power generator set will be installed in a machine room. A repair shop which will be used concurrently for charging the forklift for inspection and repair of machines and a spare parts room will also become necessary. An office for the administrative officers who will administer and operate the cold storage and perform control of the quantity landed will be needed.

From the above, the contents of the fishing port facilities to be planned will be as follows:

1. Cold storage, 250t class, (refrigerating capacity -30°C),
   Preparation room (temperature to be maintained at -10°C)
2. Ancillary facilities of cold storage
   Packing hall
   Machine room
   Repair shop
   Spare parts storage
   Office
3. Equipment
   Box pallet
   Forklift
   Weighing system

CHAPTER 4

BASIC DESIGN

CHAPTER 4 BASIC DESIGN

4-1 Basic Policy

With the aim to promote the fishing industry in Mauritius, the facilities for the Project will be designed in accordance with the basic policy mentioned below, through analysis of the data and information collected during the study period.

(1) The new fishing port shall be planned to create the national fishing port zone at Trou Fanfaron by organically connecting the existing fishing port district.

(2) The new port will be coordinated with the development plan in and around the site.

(3) In planning the construction, local construction conditions must be given full consideration with local materials and labor used as much as possible.

(4) As the construction term is short, the construction method which affords the swiftest possible progress should be adopted.

(5) With regard to the design standards, Japanese standards shall be applied, owing to the scarcity of local marine structures. The design standards on criteria for buildings shall be applied, referring to the local building work.

4-2 Project Site Conditions

(1) Outline of the site

The plan of the Port Louis harbour is shown in Fig. 2-3-1. Trou Fanfaron district, located at the innermost part of the Port Louis Harbor, consists of a dry dock currently being used privately, the

fishing quay which was donated by the Japanese Government in 1985, and tuna unloading facilities with deck cranes of an old fish carrier.

There also remain old seawalls of stone blocks constructed in the colonial era, an old pier composed of H-shape steel beams and concrete piles, and a floating pontoon where a tuna carrier is moored.

(2) Seabed configuration

Fig. 4-2-1 shows the bathymetric sounding results conducted with an echo sounder for the open sea, and a hand lead for supplementary purposes. The figure indicates the bathymetric information as follows:

1) The central part of the bay is about 6m to 7m in depth, indicating maintenance dredging was conducted.
2) The sea depth along the face line of the quay proposed is about 5m, and the sea depth in front of the granary is less than 5m.
3) A waterway of 6m deep is prepared to the dry dock.

(3) Topographical situation

The seawalls just in front of the granary made of stone blocks with old cantilever-type concrete decks.

Since they don't have any firm foundation, which was made clear through dredging work for the existing fishing quay, special attention must be paid in dredging to prevent any failure of the seawalls. Some seabed material is needed to support them.

The seawall height between the west side of the granary and the slipway is about 1.6 meters.

The height of the east side of the slipway to the corner of the existing fishing quay is about 1.0 meter.

The ground height around the granary is about 2.2 meters.

(4) Access

As shown in Fig. 4-2-2, a new road is under construction under the "Motor Way through Port Louis Project".

The present access road from the new road to the existing fishing port, indicated as Arrow 1 in the figure, is frequently used for transporting unloaded fish by lorries. An additional access road 2 will be available, as shown in the same figure, for the new fishing port.

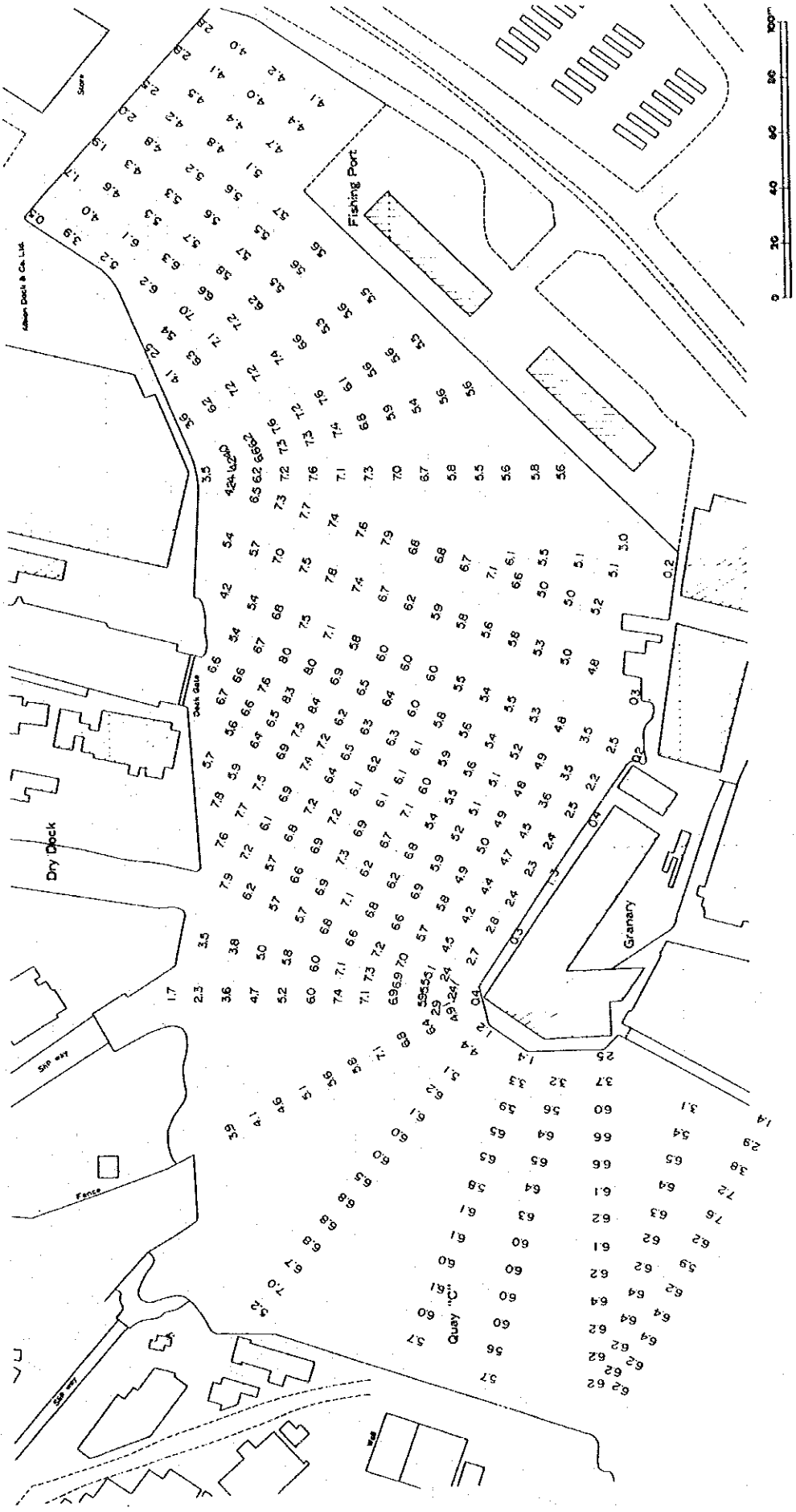


Fig. 4-2-1 Bathymetric Chart

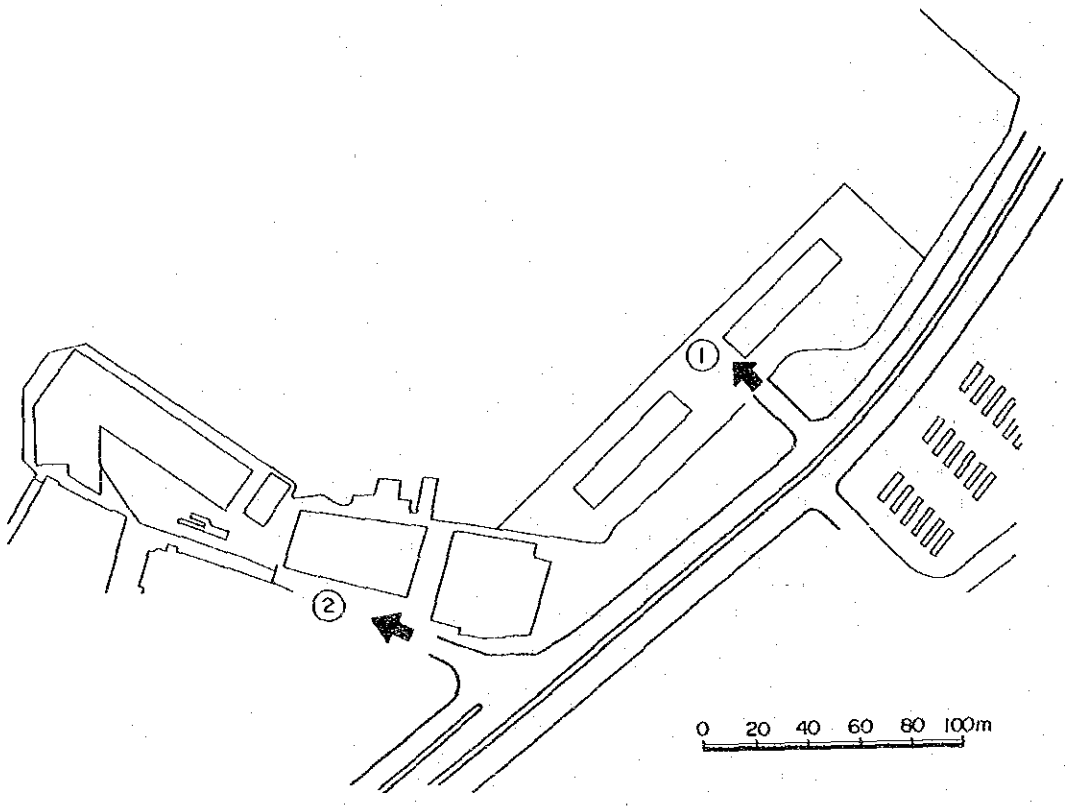


Fig. 4-2-2 Access to Fishing Port Area

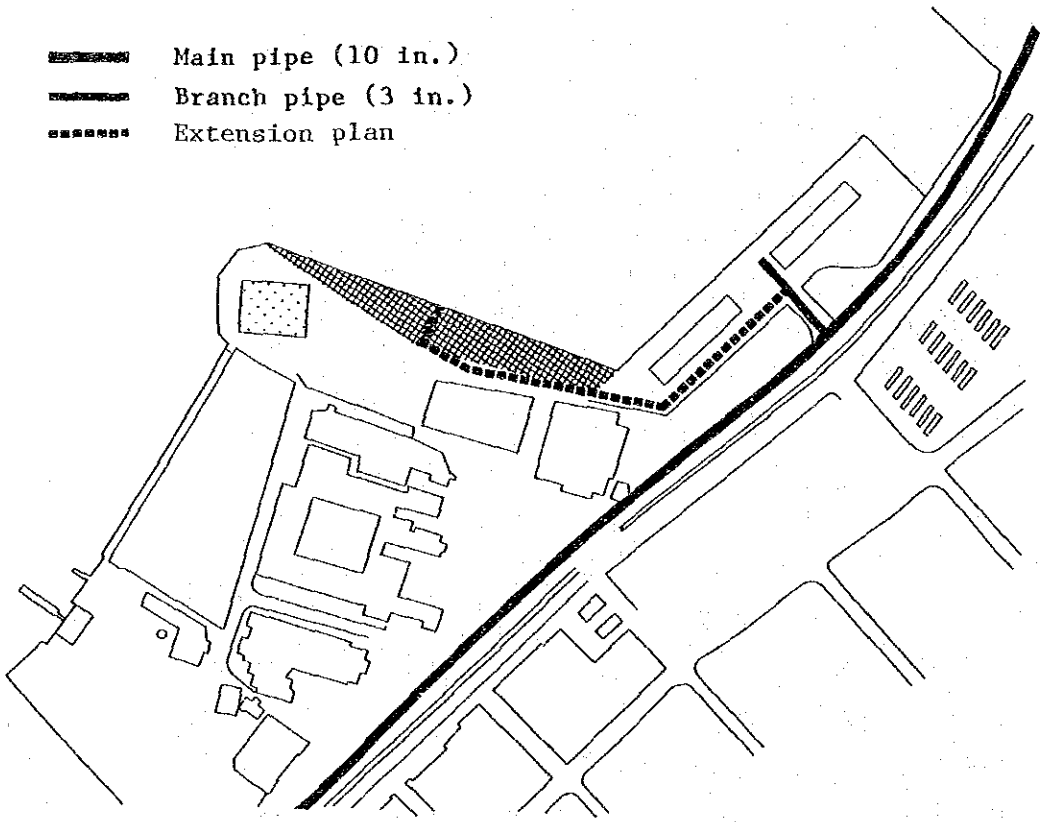


Fig. 4-2-3 Water Supply Network

(5) Water Supply

As shown in Fig. 4-2-3, a 10 inch diameter pipeline has been installed along the new motorway. A 3 inch diameter pipe is provided branching off the main pipe line, and can be extended to the new quay district for water supply to fishing vessels.

4-2-2 Earthquakes

No earthquakes have been recorded in Mauritius from the beginning of the European immigration in the 17th century. Therefore, seismic force has not been considered in designing the existing port facilities and buildings.

4-2-3 Soil Condition

Soil investigation by boring is indispensable to determine the quaywall structure. It was conducted by the local firm DDS Irrigation, under the supervision of the study team.

(1) Outline of boring

A boring machine fixed on the floating pontoon was directed to an appropriate position by a tug boat and winch, following the surveyors instructions on the land.

Boring work and in-situ tests were based on BS 5930, and physical strength tests were carried out at the laboratories of Ministry of Works and University of Mauritius in conformity with BS 1377.

(2) Borehole location

As shown in Fig. 4-2-4, drilling work was conducted at 4 holes in the sea and a hole on the land.

These holes at the stage of the basic design study were determined, aiming at confirming the depth and gradient of basalt bed rock, and soil characteristics of silty clay on the bed rock.

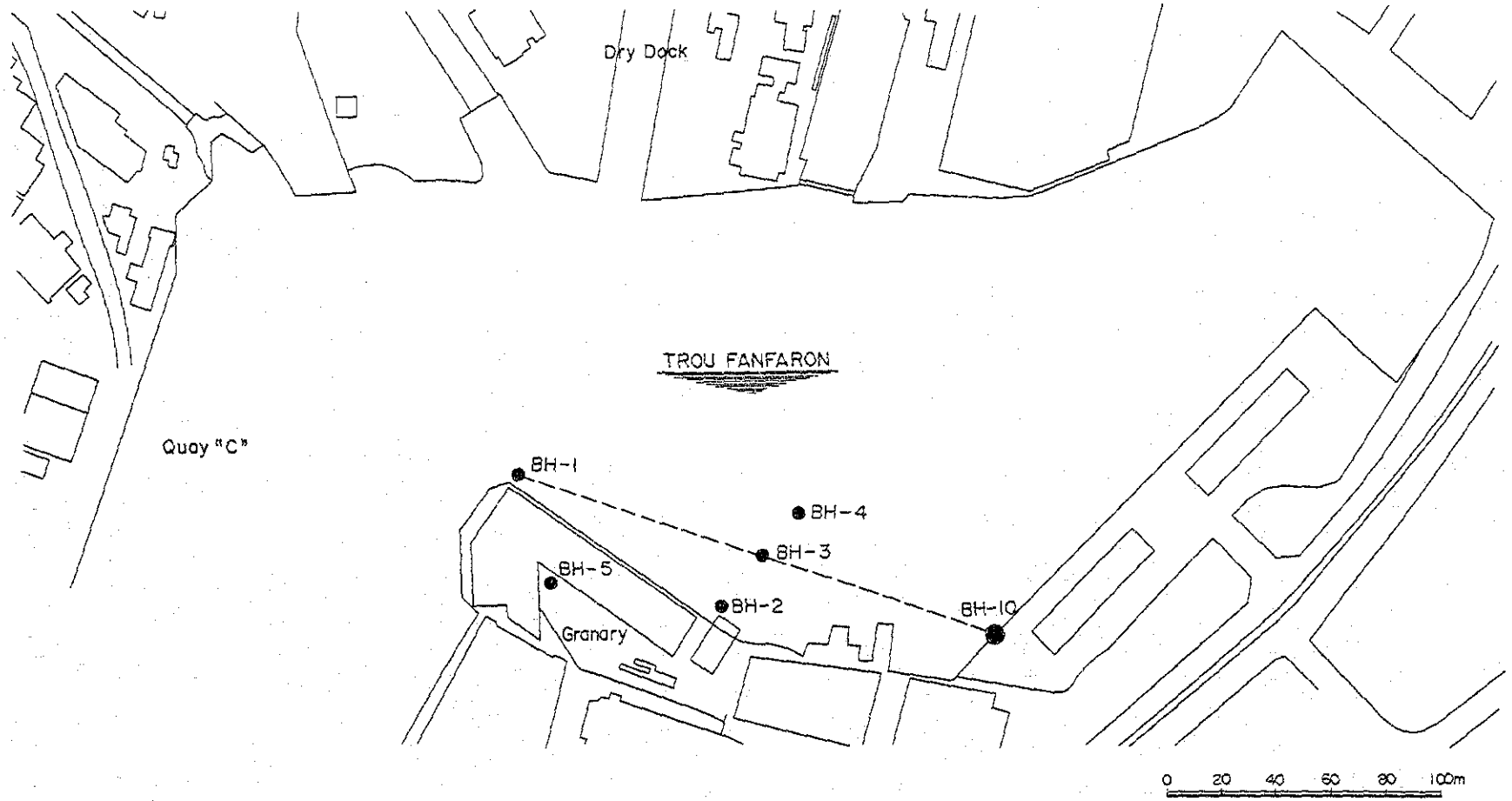


Fig. 4-2-4 Bore Hole Location

(3) Investigation results

a) Soil property

Figs. 4-2-5 and 6 illustrate the boring logs sustained from the basic design study with BH-10 for the detailed design study of the existing fishing port. Other information on the soil data in connection with the existing fishing port was attached in the Appendices.

The submarine soil strata of the project site are estimated and classified into the following categories.

* Fist layer : Noncohesive organic silt or loose clay. This layer at BH-3 is about 9 meters thick, i.e. thicker than the soil strata around the existing fishing port.
* Second layer : Silty clay This layer is 4 meters at BH-3 but scarcely any at BH-1.
* Third layer : Coral and basalt-type conglomerate partly with clay.
* Fourth layer : Weathered and non-weathered basalt rock.

As shown in Fig. 4-2-5, the gradient of the bed rock around the construction site is estimated at 1:6, inferring from the fact that the bed rock level is -6 meters at BH-1 and -18 meters at BH-3. The gradient of the bed rock between BH-3 and BH-10 deemed to be 1:25. Fig. 4-2-6 shows the soil profile along the proposed faceline of the quay. The gradient of the bed rock is very steep as much as 1:2.4 between BH-2 and BH-3, and 1:2.9 between BH-3 and BH-4.

b) Results of Laboratory Tests

Laboratory tests were conducted for the samples of cohesive soil to obtain their soil characteristics such as bulk density, natural moisture content and unconfined compression strength. The results are shown in Table 4-2-1. Natural moisture contents of the said soil are in the range between 49% - 69%, which is almost equivalent to the test results for the existing fishing port.

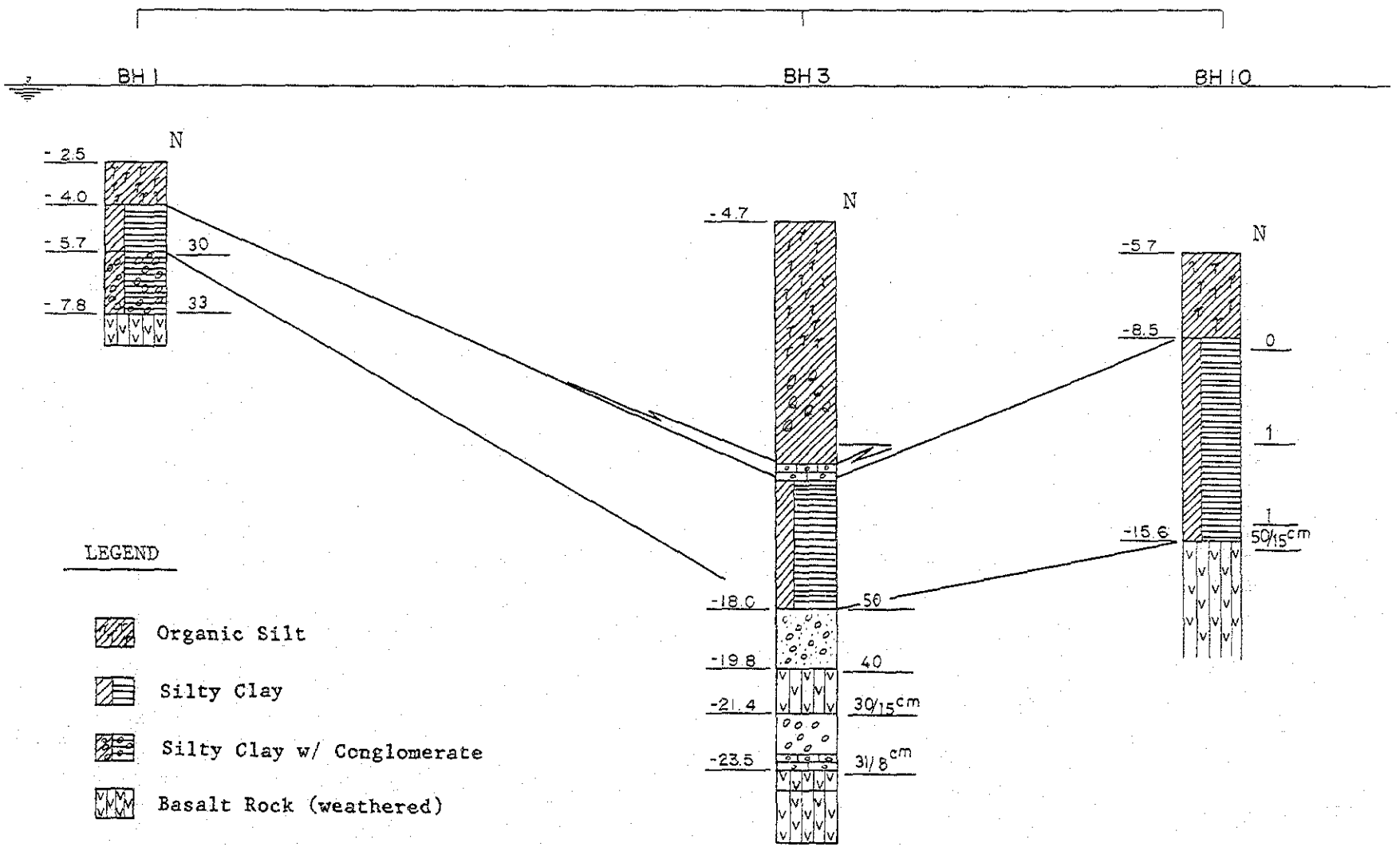


Fig. 4-2-5 Boring Logs (longitudinal profile)

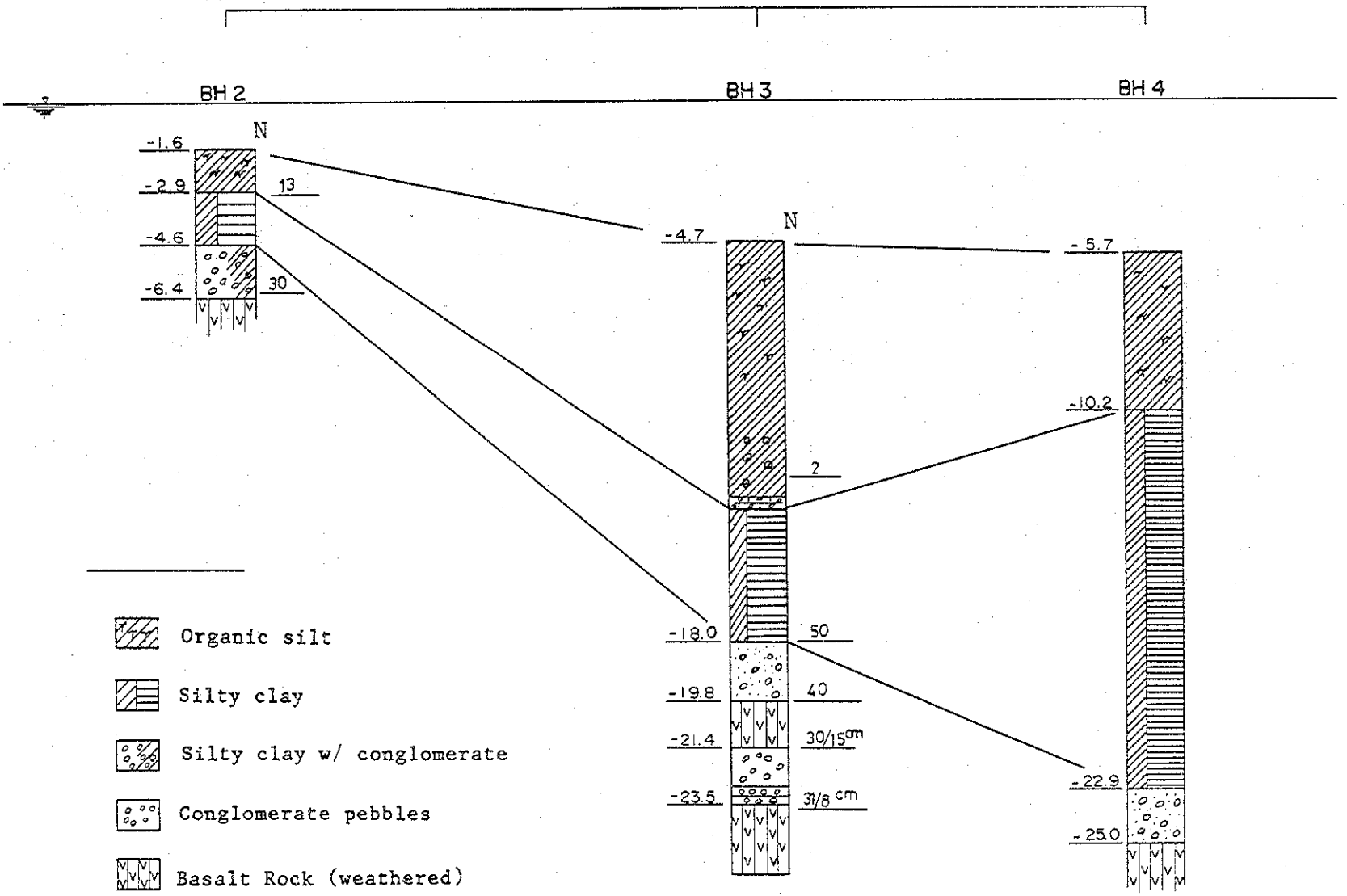


Fig. 4-2-6 Boring Logs (cross sectional profile)

Table 4-2-1 Results of Laboratory Tests

Bulk Dnesity (ton/m²)

Sampling points / Depth (m)	BH-3		BH-4		
	No.1	No.2	No.1	No.2	No.3
-9.1 - -9.55	1.81	1.86	-	-	-
-11.15 - -11.6	-	-	1.77	1.75	-
-13.5 - -13.95	-	-	1.69	1.83	1.78
-18.0 - -18.45	-	-	1.68	1.66	-
-20.5 - -20.95	-	-	1.77	1.71	1.76
-22.9 - -23.35	1.68	1.73	-	-	-

Natural Moisture Contents (%)

Sampling points / Depth (m)	BH-3		BH-4		
	No.1	No.2	No.1	No.2	No.3
-9.1 - -9.55	49.5	47.2	-	-	-
-11.15 - -11.6	-	-	61.9	55.9	-
-13.5 - -13.95	-	-	63.6	49.3	49.0
-18.0 - -18.45	-	-	68.8	63.3	-
-20.5 - -20.95	-	-	58.5	55.7	60.8
-22.9 - -23.35	47.7	51.2	-	-	-

Unconfined Compression Tests (kgf/m²)

Sampling points / Depth (m)	BH-3		BH-4		
	No.1	No.2	No.1	No.2	No.3
-9.1 - -9.55	0.2	0.2	-	-	-
-11.15 - -11.6	-	-	0.14	0.22	-
-13.5 - -13.95	-	-	0.24	0.18	0.17
-18.0 - -18.45	-	-	0.48	0.22	-
-20.5 - -20.95	-	-	0.26	0.28	0.3
-22.9 - -23.35	1.25	0.75	-	-	-

Bulk density seems to vary in proportion to the variation of depth (Z), however, the average bulk density of all should be adopted for the design purpose, considering the accuracy of sampling methods and test procedures. The value is 1.75 t/m^3. Fig. 4-2-7 illustrates the vertical distribution of the maximum compression strengths, qu. It shows qu values do not vary in proportion to the variation of depth(z)., and an average of the values is about 0.2 - 0.3 kg/cm^2. The qu value of the cohesive stratum near the bedrock indicates 0.7 kgf/cm^2 or more.

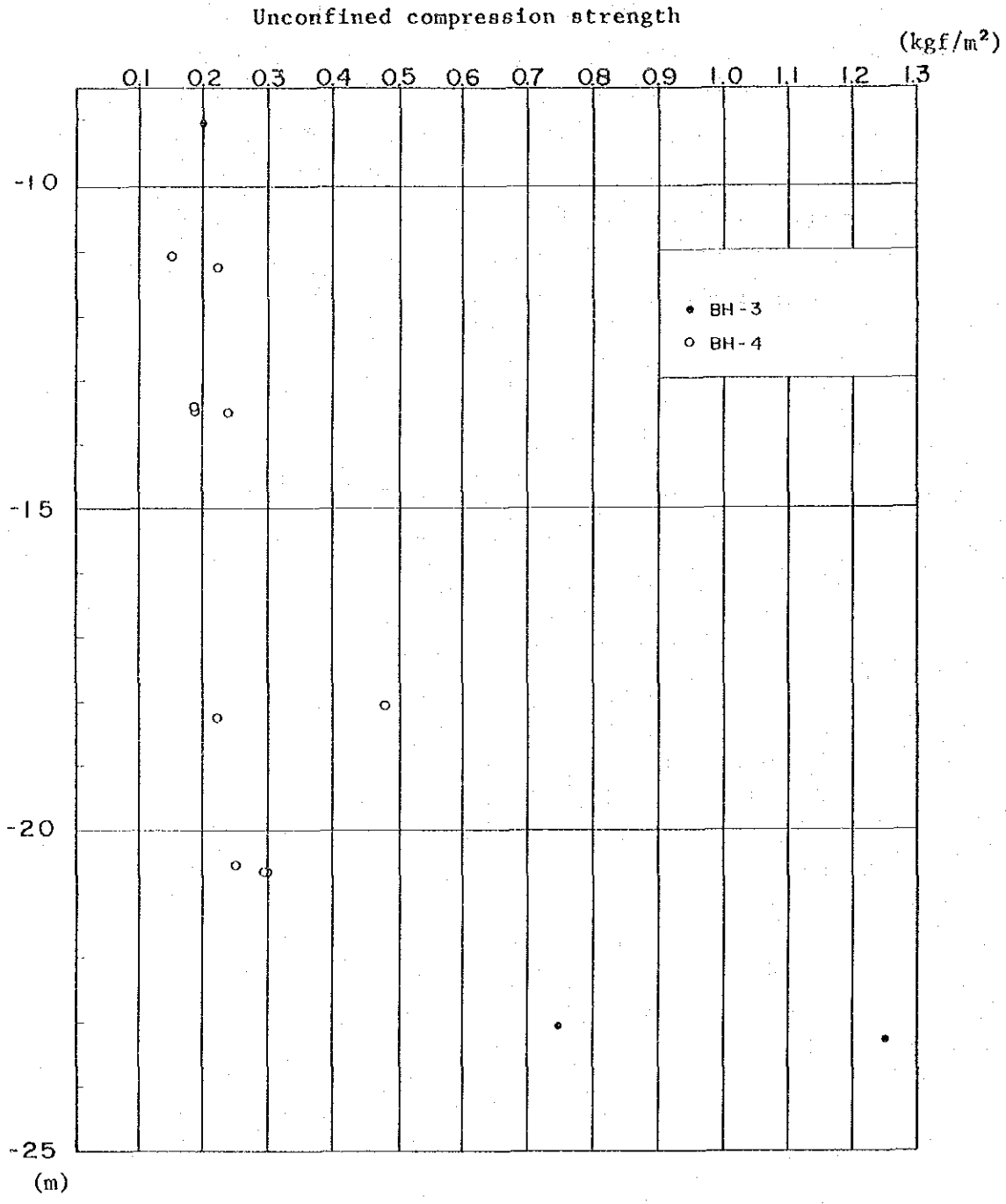


Fig. 4-2-7 Results of Unconfined compression tests

4-2-4 Filling Material

The Mauritius island produces a large amount of stone material from the abundant natural resources. Stone, crusher-run, and crashed sand are appropriate material for reclamation. Since soil is small in quantity, it is valuable material for farming. A large amount of coral sand cannot be obtained due to the government's regulation.

The stone material can be used in large amounts for filling material for the reclamation of the existing fishing port district. Fig. 4-2-8 shows the grain size distribution of the crushed sand for ready-mixed concrete to have good compactability, and to be suitable for filling material.

Dredged material could be proposed for such a purpose. It is unveiled that some layer of a surface part is of loose silt or ooze, and the layer below the surface comprises silty clay with high moisure content, characteristics of which is altered to loose material depending on the increase of water content.

Considering that the necessary bearing power of ground does not follow the rapid consolidation settlement of the said material during the construction period due to the above-mentioned soil nature, it is concluded that the dredged material is not appropriate for reclamation filling.

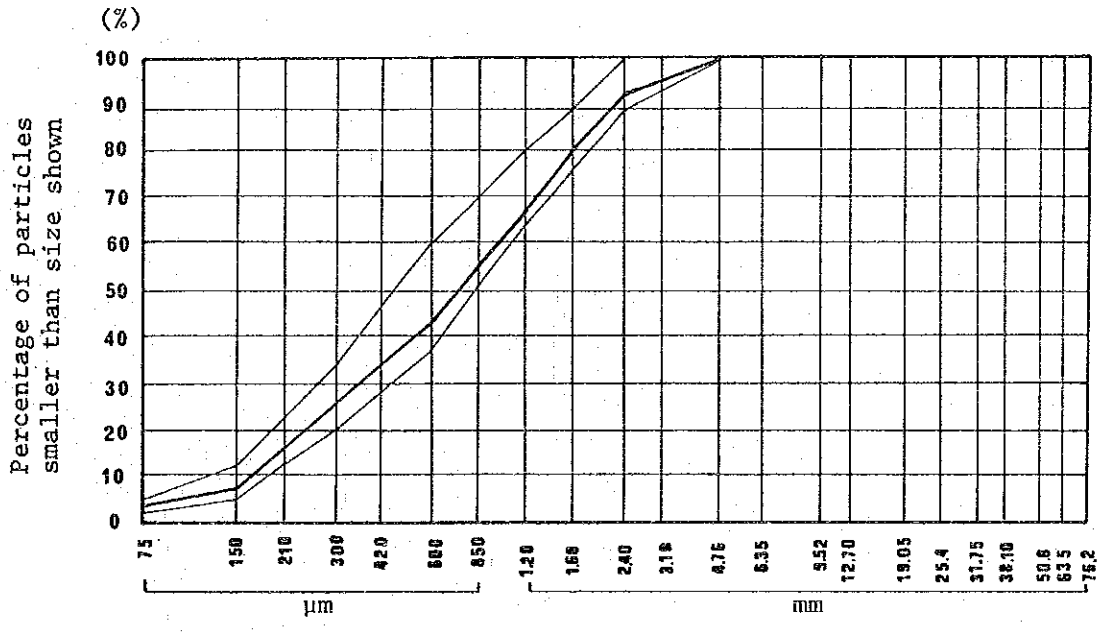


Fig. 4-2-8 Grain Size Distribution

4-2-5 Meteorological Conditions

The Mauritius island has a subtopical oceanic climate and is situated within the south-easterly trade winds zone. However, Port Louis, located on the northwestern coast of the island with hills 800m high in the background, receives foehn winds, resulting in a hot, relatively dry climate in the city.

The months of November through April are considered to be the summer months, while May through October are winter months.

(1) Temperature

Table 4-2-2 shows the annual temperature fluctuation at the Port Louis harbor. In summer the mean highest and lowest temperatures are 31°C and 23°C respectively, averaging 27°C during these months. The mean daily range of temperature in summer is about 8°C. In winter the mean highest temperature is 27°C, while the mean lowest one is 20°C and the average temperature is 23°C. The mean daily range of temperature is 7°C.

Table 4-2-2 Monthly and Yearly Mean of Temperature

(Unit: °C)

MONTH	JANUARY		FEBRUARY		MARCH		APRIL		MAY		JUNE		JULY		AUGUST		SEPTEMBER		OCTOBER		NOVEMBER	
	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
1984	-	-	32.1	23.7	32.0	23.8	29.4	22.5	28.8	20.1	27.3	18.8	25.6	17.4	26.4	17.8	27.1	17.8	28.9	20.1	30.5	21.3
1985	31.2	23.8	30.8	23.7	31.1	23.0	30.6	22.3	29.4	19.6	27.6	18.9	26.6	19.3	26.7	18.5	28.0	18.7	28.5	19.1	29.5	19.9
1986	31.9	22.7	31.1	23.1	31.4	23.0	31.6	21.7	29.6	20.2	26.7	15.8	26.7	16.0	26.0	17.7	28.0	17.9	28.3	19.1	30.9	21.5
1987	31.5	22.9	30.9	22.6	31.8	23.3	30.5	22.4	29.3	20.5	28.3	17.5	28.4	18.2	27.7	18.6	28.7	18.6	28.7	19.9	30.5	21.5
Hightest	Max / 34.3	19.1	32.1	19.8	33.8	20.2	33.0	18.5	31.7	14.5	31.0	12.5	30.1	11.5	29.6	11.8	29.9	13.0	31.9	16.5	33.2	17.1
Lowest	Min in Jan86	Jan87	Feb87	Feb86	Mar86	Mar86	Apr84	Apr85	May85	May87	Jun87	Jun86	Jul87	Jul86	Aug87	Aug86	Sep87	Sep86	Oct86	Oct84 &86	Nov86	Nov84

(2) Rainfall

Fig. 4-2-9 shows the annual rainfall over Mauritius in the form of isohyets at 400mm intervals, and Port Louis is relatively dry district because the prevailing foehn winds blow in the west side of the island. This results in a lot of rain due to dominant eastern winds on the east side of the island.

Table 4-2-3 indicates the annual average rainfall over 30 years at Fort William. An average rainfall of 1,095mm in Port Louis shows a relatively dry climate throughout the year, although seasonal variations in rainfall are apparent, with less than 50mm being registered during June and November, and over 100mm during the months of January through March.

Table 4-2-4 shows the number of days when the rainfall reached or exceeded 5mm at the survey station in the Port Louis harbor.

Table 4-2-3 Monthly Mean Rainfall

(1931-1960)

Station Location & Name	Ht ft	Jan mms	Feb mms	Mar mms	Apr mms	May mms	Jun mms	Jul mms	Aug mms	Sep mms	Oct mms	Nov mms	Dec mms	Yearly mms
091287 Fort William	20	179	182	175	127	103	42	30	23	27	46	49	112	1095

Table 4-2-4 Number of Days on which Rainfall reached or exceeded 5mm

Month / Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Itl
1985	9	9	9	3	1	4	1	4	6	1	5	7	59
86	6	13	12	6	4	2	1	9	1	4	0	3	61
87	5	11	8	10	4	1	2	0	2	3	0	0	46
Aver-age	6.7	11.0	9.7	6.3	3.0	2.3	1.3	4.3	3.0	2.7	1.7	3.3	55.3

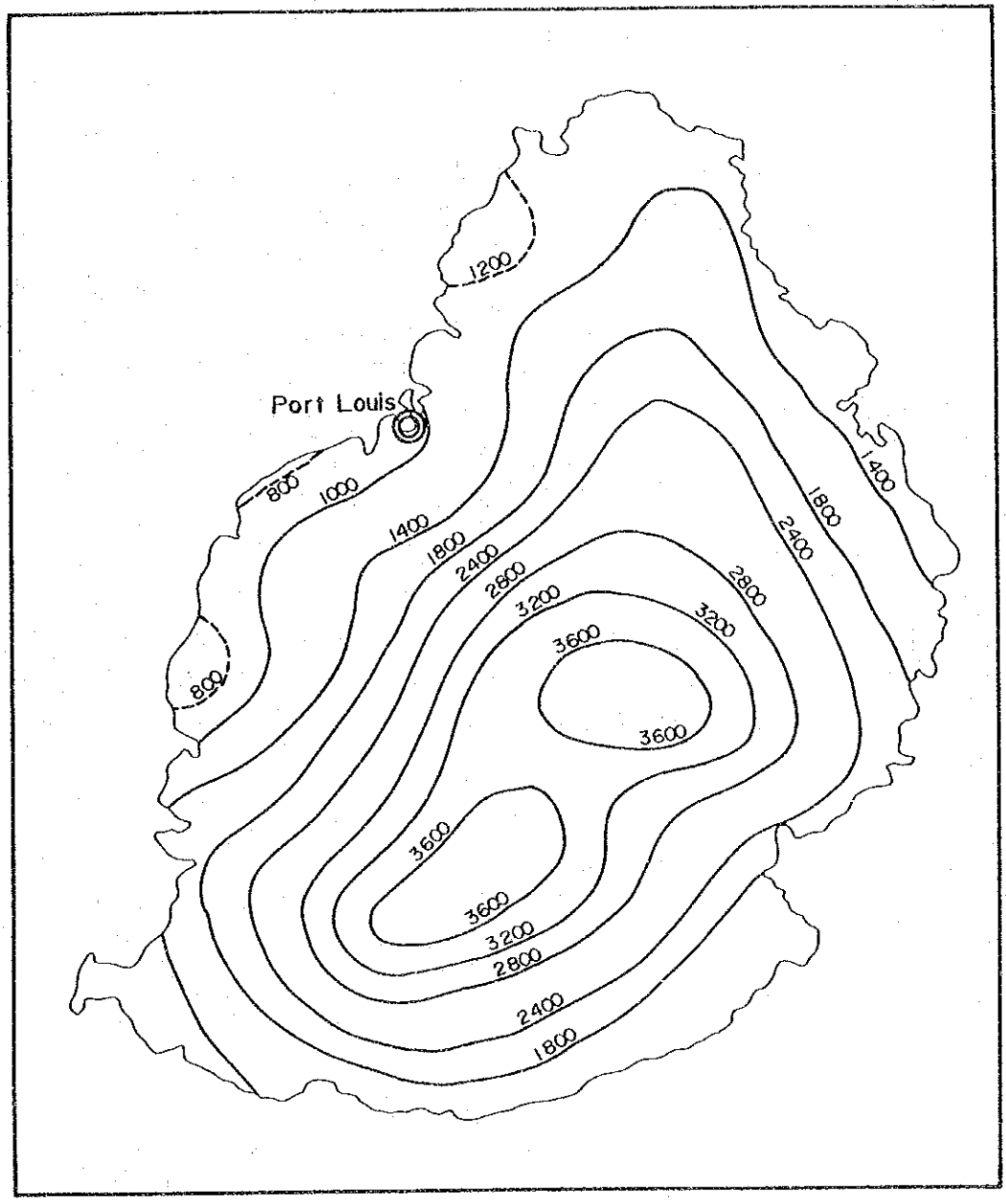


Fig. 4-2-9 Rainfall Normals 1951-1980

(3) Relative humidity

The mean monthly humidity is somewhat low (61-62) during the winter months. During the other months, the humidity is 17%.

A recent record of humidity during 1985 and 1987 also shows the above-mentioned conditions with daily variations.

(4) Wind (cyclones)

The wind roses in Appendices show easterly winds in a category less than 18 knots prevailing throughout the year. On a seasonal basis, easterly winds are most frequent in summer (November-April), with winds from the E30°N direction being second in frequency. On the other hand, in winter (May-October), winds from the E30°S direction are most frequent, followed by winds from the E30°S direction. Winds of greater than 18 knots are frequent in January, February and July.

In the summer season tropical cyclones sometimes attack the Mauritius island causing damage to houses and sugar cane fields.

Table 4-2-6 shows the max. velocity and date of occurrence of cyclones which affected the island between 1876 and 1987. Wind velocity was recorded at the Pamplemousse survey station, where 130kmph gusts were observed during the cyclones Carol and Jenny.

Table 4-2-5 is a summary of the return period of the hourly wind velocity through the wind records.

Table 4-2-5 Return Period Years and Highest Gust

Return period, years	100	50	14	5
Hourly wind Km.p.h.	125	112	90	72
Highest gust Km.p.h. probable	230	200	160	130

Table 4-2-6 Cyclones of Highest Wind Speed of 30 MPH and above

YEAR		Date	mph
1876	February	19	56.8
	February	26	41.1
1877	February	10	47.8
1878	January	15	33.6
1879	February	26	46.6
	March	21	58.9
1881	January	21	36.5
1883	December	7	32.9
1888	January	5	30.1
1892	February	12	34.8
	April	29	75.8
1894	January	13	30.1
	February	22	45.6
1896	February	20	37.6
1897	December	5	52.1
1899	March	6	31.9
1901	January	12	52.8
1902	February	5	57.2
	February	9	39.6
1904	March	21	32.4
1905	January	23	35.9
1906	December	29	35.2
1908	March	1	44.2
1910	January	11	35.2
1911	February	6	32.3
	March	29	35.2
1916	May	26	41.6
1921	March	11	42.3
1922	February	10	33.8
1924	January	3	41.2
1925	December	12	42.5
1926	April	19	41.2
1927	January	28	37.1
1929	February	9	34.4
1931	March	5	51.2
1932	April	10	34.2
1934	January	29	40.5
1935	February	28	30.0
1939	March	20	31.5
	December	16	45.0
1940	March	21	31.5
1943	March	27	37.8
1944	February	8	34.7
	April	10	31.1

YEAR		Date	mph
1945	January	16	58.8
	February	2	48.8
	April	7	38.7
1946	February	1	40.3
1954	January	12	35
1955	February	27	30
1960	January	16 – 20	
	Alix		49
	February	28 – 29	
	Carol		81
1961	December	22 – 26	
	Beryl		45
1962	February	27 – 28	
	Jenny		80
1964	January	17 – 20	
	Danielle		61
	February	25 – 28	
	Gisele		33
1966	January	5 – 7	
	Denise		43
	March	22 – 24	
	Kay		40
1967	January	11 – 14	
	Gilberte		38
1970	February	19 – 21	
	Gane		34
	March	27 – 30	
	Louise		46
1972	February	11 – 13	
	Eugenie		39
	March	3 – 4	
	Ilemione		34
	November	29 – 30	
	Ariane		35
1975	February	5 – 7	
	Gervaise		55
1978	January	21	61
1979	December	23	108
1983	December	25	74
1985	January	12 – 14	42
	February	14 – 15	49
1986	February	2 – 5	30
1987	February	12 – 14	50

4-2-6 Oceanographic Conditions

(1) Tide levels

The harmonic constants of the tide in the Port Louis harbour have been analysed on the basis of the tidal record.

It was confirmed that the tide observed during the construction period for the existing fishing port, and visual survey in this study period conformed with the forecast of the tide through the above analysis.

Accordingly, the tidal levels listed below will be applied to the present study.

M.H.W.L.: + 2ft (+0.61m)
M.S.L. : + 1.2ft(+0.37m)
M.L.W.L.: + 0.00

(2) Tidal currents

According to "Tidal Information, Year 1950", a greater quantity of river water flowing into the port was observed following torrential rain, but its velocity barely reached one knot. Currents in and around Trou Fanfaron are usually quite mild.

(3) Waves

The calm water area, a wave height of less than 0.8m, will be secured in Trou Fanfaron even when waves caused by cyclones will assail the island. It was described in the Basic Design Report issued in 1983, and its summary is in Appendices.

(4) Littoral drift

No littoral drift is observed because the project site is located at the innermost part of the harbour.

4-3 Design for Basic Facilities of Fishing Port

This chapter discusses the design of the landing quay as a function of basic facilities of the fishing port.

4-3-1 Planned Facilities

The following are the facilities newly planned for the promotion of fishery in Mauritius.

1) Turning Basins and access channel
   Turning Basins for fishing vessels and an access channel to Trou Fanfaron from the main harbour are planned in the scope of the Project.

2) Landing quay
   Two landing berths will be designed for fishing vessels involved in bank and pelagic fishery. Both sides of the quay where depths may not be sufficient for berthing will be considered as their transition parts of berth.

3) Water supply facilities
   A water supply pipe will be provided for fishing vessels.

4) Fuel supply facilities
   A fuel supply pipe for bunkering will be extended from the existing pipeline installed by Mauritius Marine Authority near the site.

5) Ancillary facilities
   The following facilities will be provided.
   1 Fender system for absorbing berthing force of ship
   2 Mooring posts
   3 Curbing for traffic safety

4-3-2 Planning of Facilities

(1) Conditions of design

The design basis of the quay shall be the Lady Sushil II, the biggest of all Mauritian fishing vessels for bank and pelagic fishery. The dimensions of the vessel are as follows:

Gross tonnage : 1,039 tons
Overall length : 61.75 m

Width	:	12.0 m
Depth	:	4.55 m
Full draft (Extreme draft)	:	6.5 m

(2) Turning Basins and channel

According to the "Technical Standards for Port and Harbour Facilities in Japan", a basin for turning the bow of fishing vessels by using tugboats requires a circular area with the radius of the overall length of a fishing vessel or more. However, in a very calm basin for vessels with high bow turning capacity, the area can be reduced to the extent not to hinder the bow turning. Under the usual conditions for a vessel with an overall length of 61.75m, the necessary width of the turning basin can be calculated as follows:

$$61.75 \times 2 = 123.5 \text{ m}$$

Since the water area at the site is calm and since the shortest distance to the opposite seawall is 110m, the planned width of the turning basin can be reduced to 100m as shown in Fig. 4-3-1. The area of the turning basin will be 9,680m^2.

Dredging of the channel is required to effect the projected quay since the present water depth of the access channel is about 6m which does not suit the full draft of the biggest fishing vessel.

As indicated in the "Guideline for Planning of Fishing Port" (All Japan Fishing Port Association), the depth of waterway shall be an appropriate value adding full draft of a vessel and 1.0 meter. However, the depth of waterway is designed to be the same as the basin, 7m, due to calmness of the sea. The width of the channel shall be five times as much as the width of a vessel as instructed in the above guideline. The design width of the channel will be 60m for a vessel with 5m width. The dredging area for the access channel will be 11,820m^2 as shown in Fig. 4-3-1.

(3) Planning of Facilities

1) Required total berth length

The total berth length (L) shall be calculated as follows:

L = (Overall length of vessel) x (1+(allowance)) x (number of berths) = 61.75x(1+0.15)x2 = 150 m.

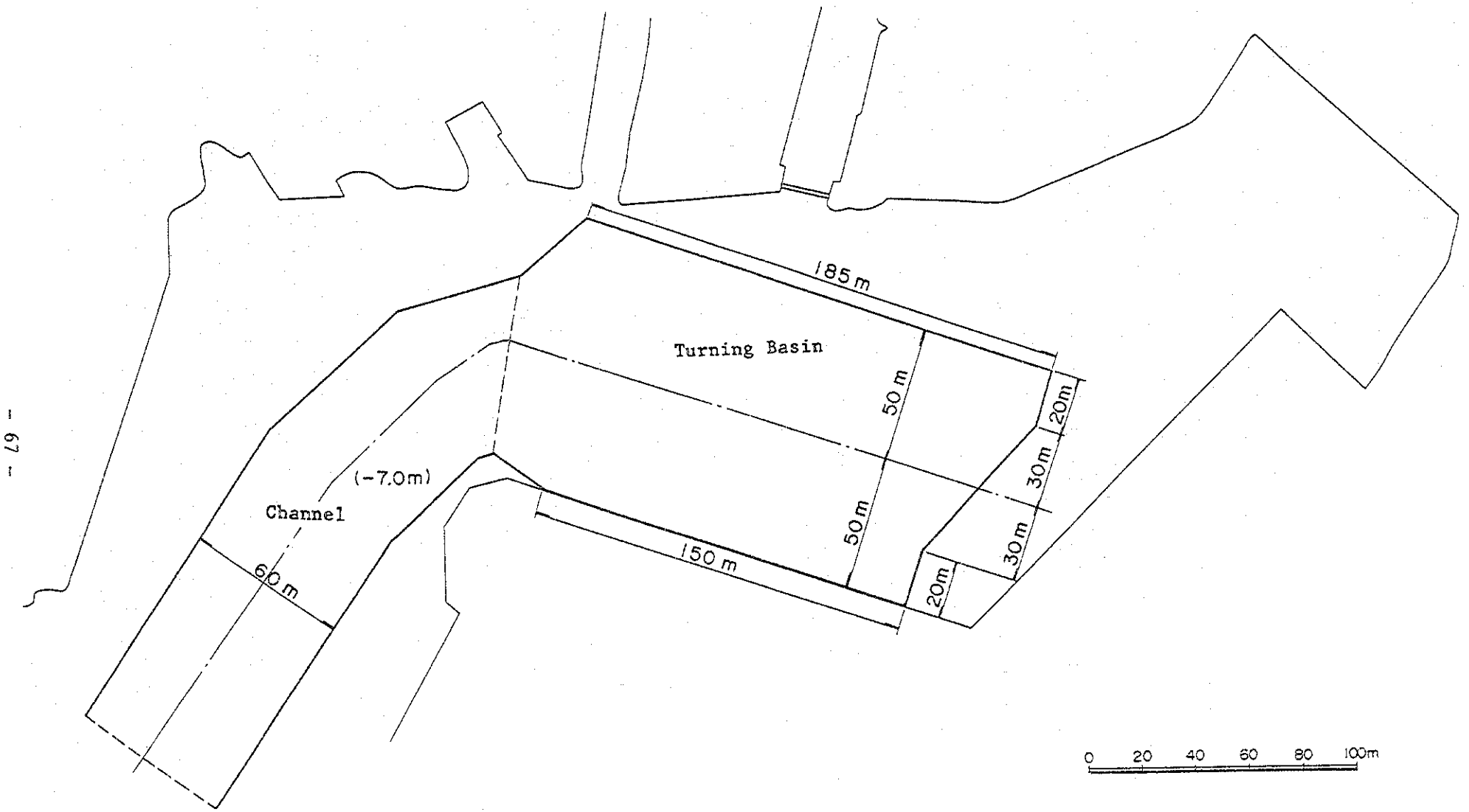


Fig. 4-3-1 Layout of Turning Basin and Channel

The east side of the new quay is considered a transition part for different depths of both quays, and it plays an important role for smooth functional connection with the existing port. As shown in Fig. 4-3-2, a transition pat of 20m will produce an allowance of 9.5m between two vessels mooring at both quays. This allowance satisfies the provision of the "Design Standards for Fishing Port Structures in Japan" (All Japan Fishing Port Association) for an allowance between two vessels, demanding 15% of the overall length of a ship. Therefore, 20m length is required for a transition part of the east side of the quay.

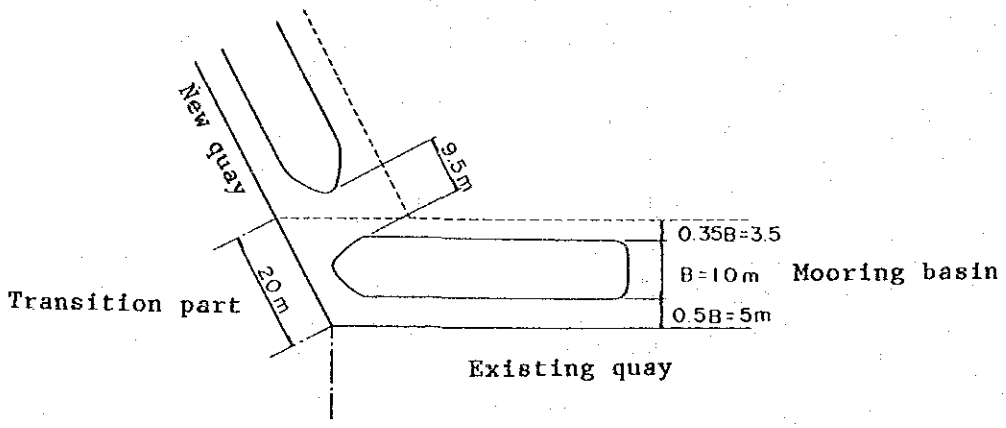


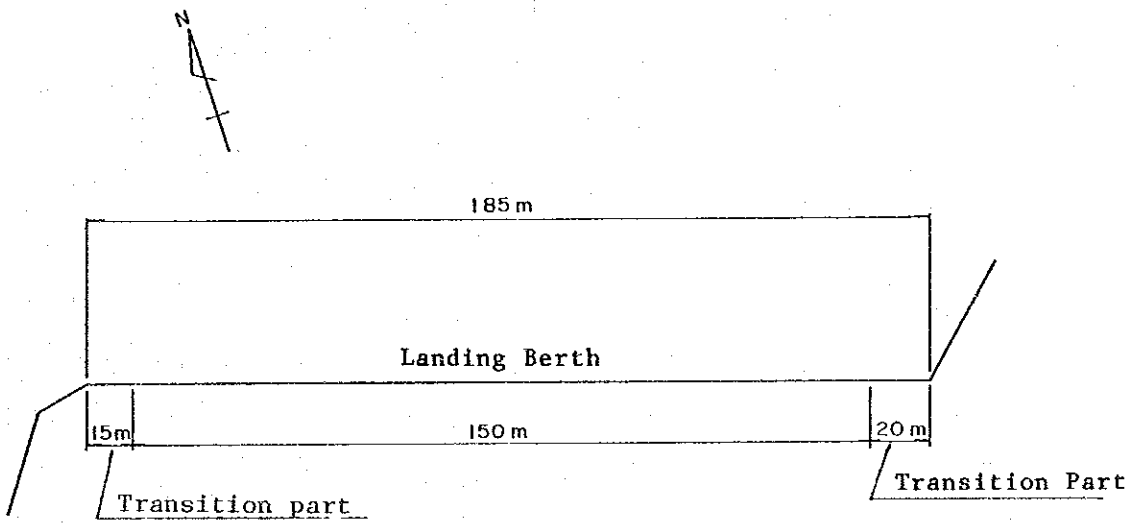
Fig. 4-3-2 Transition Part of East Corner

The west side of the new quay is required to smoothly connect with the existing seawall without any corner. Such smooth connection helps safe approach to the quay and prevention of wave overtopping.

This part will not be provided for a quay because of shallow bed rock as illustrated in Fig. 4-2-6. To secure 7m depth for basins, a bed rock level shall be at least -8.5m, which means the necessity of a 1.5m allowance from the seabed level for structural stability. Considering a gradient of bed rock between BH-1 and BH-3 as shown in Fig. 4-2-6, 15m length from the west end of the quay shall be a transition part and shall not be provided as a quay due to a shallow level of bed rock.

Therefore, the total length of both transition parts will be 35m.

Fig. 4-3-3 shows the allocation of a quay of 150m length and both transition parts of 35m length, and the total length of the faceline will be 185m.



2) Quaywall depth

According to "Design Standards for Fishing Port Structures in Japan" Published by the All Japan Fishing Port Association, the quaywall depth defines the value summing the full draft of a vessel plus 0.5m, in the case of soft seabed material.

Therefore, the required quaywall depth will be

6.5m (max. draft) + 0.5m = 7.0m.

3) Quaywall height

The same design standard defines that quaywall height can be obtained by summing Mean High Water Level and figures listed below.

Table 4-3-1 Quay Elevation

Tidal Range (H.W.L. - L.W.L.)	Gross Ton of Fishing Vessel			
	0 - 20t	20 - 150t	150 - 500t	500t -
0 - 1.0 m	0.7m	1.0m	1.3m	1.5m
1.0 - 1.5	0.7	1.0	1.2	1.4
1.5 - 2.0	0.6	0.9	1.1	1.3
2.0 - 2.4	0.6	0.8	1.0	1.2
2.4 - 2.8	0.5	0.7	0.9	1.1
2.8 - 3.0	0.4	0.6	0.8	1.0
3.0 - 3.2	0.3	0.5	0.7	0.9
3.2 - 3.4	0.2	0.4	0.6	0.8
3.4 - 3.6	0.2	0.3	0.5	0.7
3.6 -	0.2	0.2	0.4	0.6

The calculation results in 2.1m of the height of the new quay as mentioned below:

Height = 0.6 + 1.5 = 2.1 (m)

The present height of the existing fishing quay is 2.0m for the bank fishing vessels.

Considering the slight difference between the above two values and availability of bank fishing vessels at the new quay, the height of the quaywall is determined to be 2.0m.

4) Apron width

According to the same Japanese standards, the width of apron requires the figures mentioned in Table 4-3-2.

Table 4-3-2 Apron Width

Landing quay	Transfer of fish to packing halls	3.0 m
	Transportation by lorries	10.0 m
Fitting quay		10.0 m
Idling quay		6.0 m

The apron width of the new quay requires 10m, which is equivalent to the existing one, since the fish catch by both bank and pelagic fishing is unloaded onto lorries by mobile cranes.

(4) Water supply

The new water supply system shall be at the existing fishing port for the said services to be provided to the fishing vessels. A supply facility will be rendered there by extension of the line from the existing port.

(5) Fuel supply system

Since the present port facilities cannot afford to render fishing vessels respective services such as landing, preparing, and idling, due to insufficiency of the fishing quays, the fuel supply pipe will be extended to the new fishing port for their availabilities.

(6) Ancillary facilities

1) Fender System

Fenders shall be provided with equipment for absorbing berthing force of the fishing vessel, the Lady Sushil II with a self-approach velocity of 0.3m/sec. 23 pieces of LMD type, the size of which is 400H x 1,700L, will be installed with an interval of 7.5m, aiming at protection of direct collisions of small fishing vessels.

2) Mooring equipment

Mooring bitts shall be installed with a spacing of 10-15m for vessels of less than 2,000 tons, as instructed in the "Technical Standards for Port and Harbour Facilities in Japan". Eleven pieces of 15-ton type for the Lady Sushil II will be installed with a spacing of 15m.

3) Curbing

The mooring facilities with vehicle traffic shall have curbings. Total 49 pieces of curbings will be installed at an interval of 30cm.

4-3-3 Location Plan of Port Facilities

The last chapters discussed the scope and size of the basic facilities of the fishing port to enable the promotion of the Mauritian fishery and to help their economic development, through full consideration of the requests by the Government of Mauritius. As shown in Fig. 4-3-4, a location plan is proposed embodying an outline of planned facilities on the basis of policy as follows:

(1) The new port shall function as a part of the fishing port zone which will be established in systematic connection with the existing fishing port.

(2) All services for fishing vessels shall be available at each fishing quay.

(3) Access ways to and from the fishing port district shall provide smooth traffic flow for fish transport smoothly connecting to the new motorway.

(4) The new quay shall not obstruct vessels maneuvering into/out of the dry dock.

(5) No building on the reclaimed land is essential to effect the completion of the whole work in the limited period.

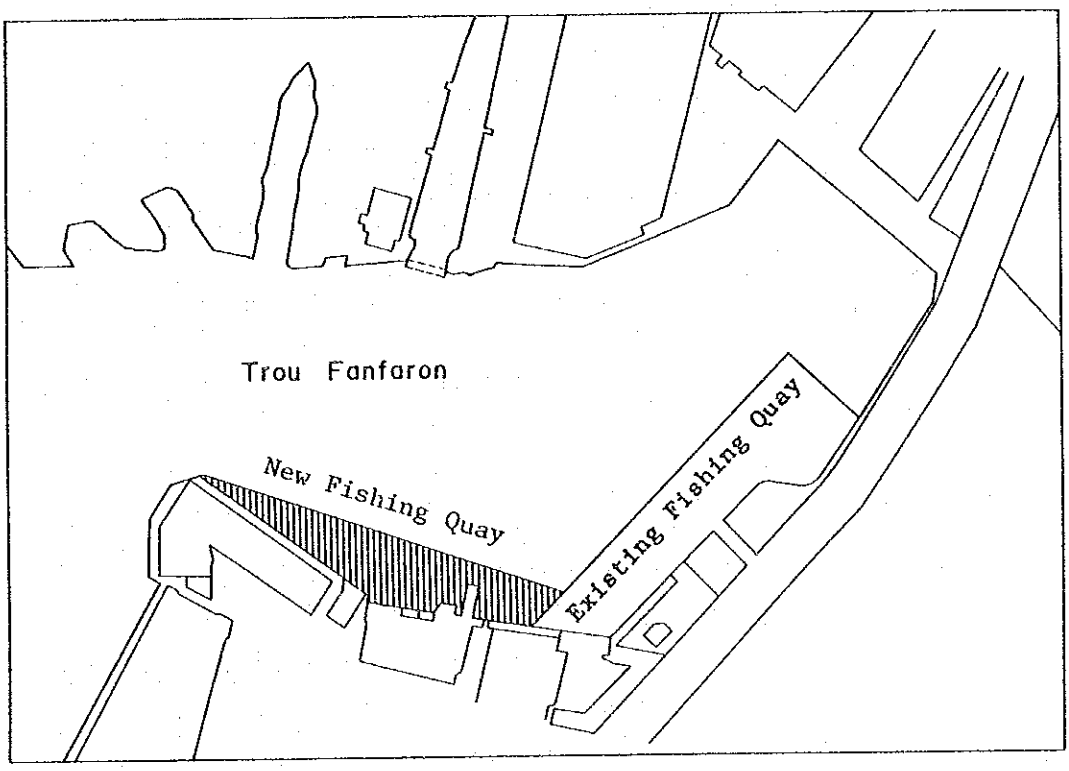


Fig. 4-3-4 Layout of New fishing Quay

4-3-4 Design of Basic Facilities of Fishing Port

(1) Design conditions

1) General

a) Facilities to be designed for the Lady Sushil II (1039 GRT)

b) Size of facilities

* Landing quay

Number of berths : 2

Overall Length of berth : 150 m

Width of apron : 10 m

Quay depth : 7.0 m

Quay height : 2.0 m

* Reclamation area

Total area : 9,136 m^2

Road system : 1,636 m^2

Access road : 1,636 m^2

c) Conditions for structures

* Surcharge load

1.0 t/m^2 is applied to surcharge load of the quay structure, according to the following table shown in the "Design Standards of Fishing Port Structures".

(ton/m^2)

Facilities	+ Load	+ Facilities	+ Load
Landing quay	1.0	Revetment	0.5
Fitting quay	1.0		
Idling quay	0.5		

* Approach speed of fishing vessels to quay

The same standards give the following figures for the approach speed in the two categories, and 0.3m/sec is applied to the design.

Dead weight of boat	Speed
less than 100 t over 100 t	0.5 m/sec 0.3 m/sec

* Live load

A fully loaded lorry shall be considered as in the live load condition. The total weight of such a lorry is over 14 tons, i.e. over 8 tons of maximum cargo load and 6 tons of its own weight.

Therefore design live load is "T-20", which means a total weight of 20 tons on the apron.

2) Natural conditions

a) Tide

M.H.W.L. : + 0.6 m

M.L.W.L. : 0.00 m

b) Seismic force

Kh = Kv = 0.0

c) Soil conditions of bed rock

* A bearing stratum is located at -18 m on the quay line. The inclination of the bearing statum is 1:2. The submarine soil above the bed rock shall be filled with soft silty clay having an N value of 0 - 4.

3) Materials

(kgf/cm^2)

Kind of stress \ Kind of steel	SY 24	SY 30	SY 40
Bending tensile stress (per net sectional area)	1,400	1,800	2,400
Bending compressive stress (per gross sectional area)	1,400	1,800	2,400
Shearing stress (per gross sectional area)	800	1,000	1,800

(2) Study on the quay structure

According to the soil investigation at the proposed site for the extension of the fishing port, there remains a stratum of very soft silt and silty clay (with N values of less than 4), the width of which is about 13 m, and a bearing stratum of weathered basalt and/or pebbles (with a gradient of 1:2) underneath the above stratum.

The "Basic design Report on the Fishing Port Construction Project in 1983" proposed the steel tube pile type as the best structure, after comparing steel tube type structure without improvement of the seabed material and the steel sheet pile with improvement. But the result of more detailed boring work at the detailed design stage, it was revealed that the seabed inclination was too steep as 1:2 or 1:3 to drive piles into the strata, and this resulted in design modification due to the insufficient lateral resistance. The steel sheet pile structure shown in Fig. 4-3-5 with improving the seabed material was suggested as an alternative.

Considering the above circumstances, success of the existing facilities, and similar soil conditions synthetically, steel sheet pile type structure with improvement of seabed material is proposed as the most suitable structure for the new fishing quay.

(3) Design of the steel sheet pile quay

In the design of the steel sheet pile quay, the following conditions shall be considered in addition to those listed under 4-3-4 (1).

a) Tide level
   Residual level : + 0.5 m

b) Reclamation material
   Angle of internal friction : 30°
   Angle of friction between soil and wall : 15°
   Bulk density : 1.8 t/m^2 (in air)
   Bulk density : 1.0 t/m^2 (in water)

(4) Structural design

The typical cross section shown in Fig. 4-3-6 is proposed for the new quay of the fishing port, as a result of detailed calculation with a circular failure study.

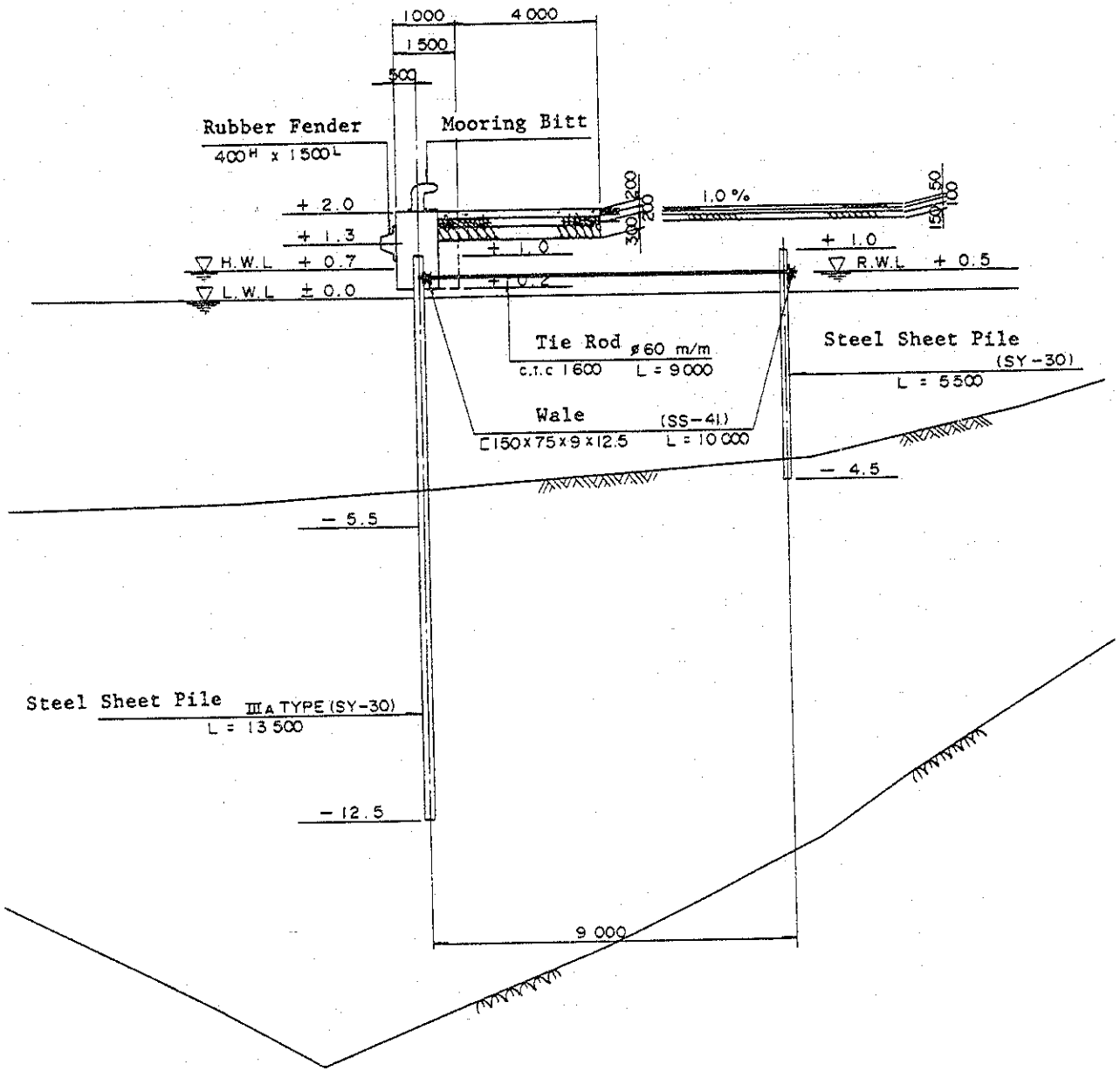


Fig. 4-3-5 Typical Cross Sectoin of Exising Fishing Quay

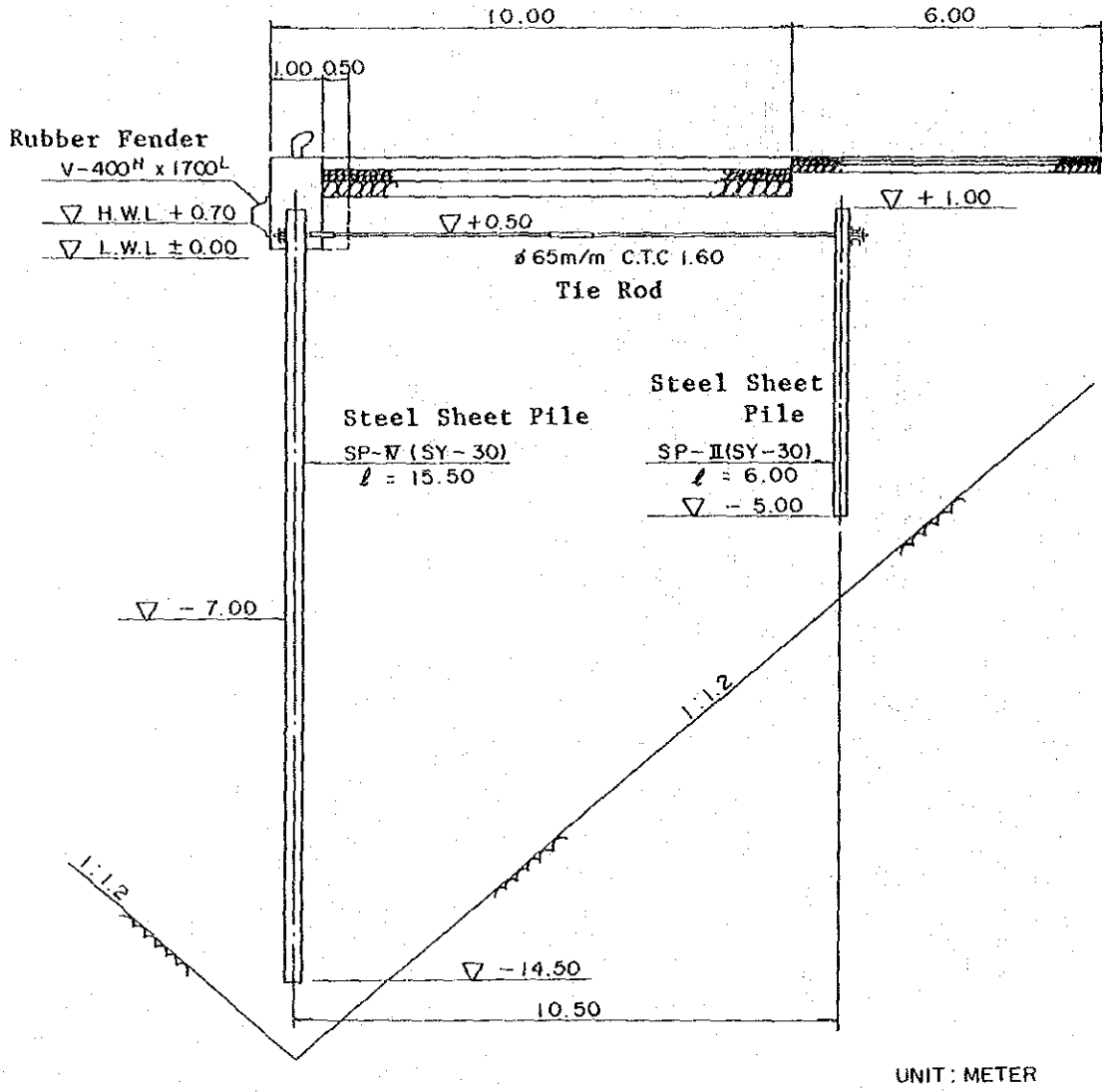


Fig. 4-3-6 Typical Cross Section of New Landing Quay

4-4 Design for Functional Facilities of Fishing Port

This chapter discusses the design of cold storage, packing halls, etc. as functional facilities of the fishing port.

The capacity of the cold storage will be a 250 ton class for the Project. Considering the provision of a site for possible future extension of the cold storage, the total plan will be prepared.

4-4-1 Planned Facilities

The following facilities for the Project have been planned with consideration given to the current port utilization, sorting and transportation, cold storage utilization and management conditions, as well as the current technical level in Mauritius.

1 Cold Storage
2 Office
3 Spare Parts Storage
4 Packing Hall
5 Repair Shop
6 Machine Room
7 Wash Room
8 Box Pallets
9 Electric Forklift
10 Weighing System
11 Mobile Crane

4-4-2 Design of Facilities

(1) Design conditions

1) Design Criteria

Atmospheric Temperature	15.8°C - 32.1°C
Relative Humidity	61% - 78%
Wind Velocity	Max. 60 m/sec
Rainfall	727 mm/year
Bearing power of soil	5 tons/m^2
Seismic force	Nil
Water	City water
Electric power source	200V/400V, 3 phase, 4 wire, 50Hz

2) Applicable standards

Although BS Codes are used in Mauritius, the Government of Mauritius has not specified any special standards for the Project and the standards are to be selected at the discretion of the Project Manager. As the Government of Mauritius has already approved the application of Japanese standards, the following Japanese standards and acts will apply for the Project with due attention paid to the relevant BS Codes.

- Japan Industrial Standards (JIS)
- Building Standards Act
- High Pressure Gas Control Regulation in Japan
- Standards of the Japanese Electro-Technical Committee (JEC)
- Standards of the Japan Electrical Manufacturers' Association (JEM)
- Japanese Cable Makers' Association Standard (JCS)

(2) Cold Storage plan

The subject facility is planned for cold storage at the fishing port and has the following specifications.

1) Construction Method

Steel frame, single-story building with 2 stories in part using polyurethane sandwich panels.

2) Measurements

Cold Storage - 20.6 m x 15.5 m x 5.8 m (H)

Preparation Room - 20.6 m x 5.0 m x 5.8 m (H)

3) Storage capacity

A central way with 4.1 m width divides the storage into two spaces where box pallets are installed. In each space the following number of box pallets will be stored.

4 x 6 x 4 = 96 (pcs)

6 x 1 x 3 = 18 (pcs)

6 x 1 x 2 = 12 (pcs)

126 (pcs) for a space

Total number of Box pallet 252 pcs (= 126 x 2)

4) Storage method

4 layers of 1 ton box pallets (2,200mm W x 1,200mm L x 1,300mm H) using electric forklifts to transport them from the quay to the cold storage.

5) Storage temperature

Cold storage : -20°C or -30°C

Preparation room : -10°C (minimum)

Designed temperature can be -30°C by means of two cooling machines. Even in the case of break down of a machine, the other can keep temperature at -20°C.

In the case of the preparation room, as hot outside air with high humidity enters at the time of loading or unloading, causing frequent changes in the room temperature, the average temperature is considered to be -5°C.

6) Stored items

Frozen fish (individual frozen tuna, skipjack and bed fish)

7) Incoming capacity

25 tons/day (10% of the storage capacity)

8) Raw fish temperature

-15°C

9) Cooling capacity

The cold air temperature in the cold storage should be reached -20°C/-30°C in 24 hours after finishing storing.

10) Heat insulation

The two existing facilities of the large cold storage were constructed with panels and the same construction method will be adopted for this new cold storage. Polyurethane sandwich panels will be used for the ceilings, walls and partition walls and will be covered on both sides by 0.7mm thick, coloured flat aluminium sheets. The panel thicknesses are as follows.

Cold Storage	Ceiling	150mm
	Exterior Walls	150mm
	Partition walls	100mm
Preparation room	Ceiling	100mm
	Exterior Walls	100mm

Wooden shelves will be installed in both the preparation room and the cold storage.

11) Floor

Extrusion moulded polystyrene boards (150mm thick) will be used for the floor. Both sides of these boards will have rubber asphalt adhesive sheets (1mm thick) and aluminium sheets will be applied using the dry method to provide waterproofing. The

floor will be finished with waterproof fine gravel concrete (120mm thick) with a concrete strength of 280kg/cm^2, acting as weight for the heat insulation materials.

12) Insulation doors

- Electric double sliding doors will be installed for both the cold storage and the preparation room to facilitate the work and to shorten the time of the doors being open.
- The door measurement should be sufficiently large enough to facilitate the handling of the box pallets, i.e. 2,800mm (W) x 2,700mm (H) x 100mm (T).
- The doors will have a stainless steel finish.
- The entrance door of the front room will have an air curtain while split curtains will be employed for all double sliding doors to minimize the intrusion of air from outside.
- The building attached to the cold storage will contain the machine room, repair shop, forklift recharging room and toilet. Building measurements: 6.5m x 20.5m (centre-to-centre).

(3) Office plan

The office will be provided for traffic officers of the MMA and the management staff of the Agricultural Marketing Board. A general manager, manager, assistant manager and engineer will be involved in the management of the cold storage, and two traffic officers of the MMA will be employed for traffic control. Therefore, the office is planned for the above six people.

The equipment in the office comprises desks, chairs, cabinets, reception chairs and a water heater. The total floor area requires 52.7m^2 (= 6.5 x 7.5 + 1.5 x 2.625) for the layout of the equipment. According to the Architectural Design Criteria in Japan, the necessary floor area for the above-mentioned staff will be as follows:

A general manager	:	13 - 18 m^2 (per person)
An engineer and a manager	:	13 - 17 m^2 (6.5 - 8.5 m^2 per person)
Three officers	:	13.5 - 22.5 m^2 (4.5 - 7.5 m^2 per person)
Total	:	39.5 - 57.5 m^2

Compared with the appropriate floor density of persons of 0.11 - 0.28 person/m^2 indicated in the above criteria, the planned density of 0.11 person/m^2 meets the criteria.

(4) Spare parts storage

The storage will be provided for keeping the spare parts of chilling plants, forklifts, a crane, weigh machine, heat insulation, etc. The spare parts are stored in lockers and shelves, area of which requires 10.5 m^2 (= 4.0m x 2.625m).

(5) Packing hall

This facility will provide the space for loading and discharging cold fish, weighing control, packing and sorting, and also the shed for keeping fish freshness in torrid heat.

The required area for the facility will be 216.8m^2 (= 27.1m x 8.0m) conforming to the size of the cold storage.

(6) Repair shop

This room will provide the space for the maintenance and repair of chilling plants, heat insulation, box pallets and electric forklifts which will also be charged here. The forklifts should be kept inside the room for prevention of briny injury.

A chain block with a lifting capacity of 2.0 tons, a set of spanners, a set of electric and gas welder, oxygen cylinders, two acetylen cylinders, an electric drill and a vice bench are installed for maintenance/repair.

A vice bench, a pipe vice, electric and gas welders, machine shop tools, an electric charger forklifts need their own area in the room as follows:

1)	Vice bench	2.1 x 2.2 = 4.41 m^2
2)	Pipe vice	3.6 x 2.0 = 7.2 m^2
3)	Electric welder	1.0 x 2.1 = 2.1 m^2
4)	Gas welder	1.2 x 3.0 = 3.6 m^2
5)	Machine shop tool	1.9 x 1.2 = 2.28 m^2
6)	Electric charger & forklifts	5.1 x 6.5 = 33.15 m^2
		52.74 m^2

Including the above area and the necessary passage area, the total area of the repair shop is:

$(6.5m \times 7.69m) + (1.5 \times 2.56) = 53.825m^2$

(7) Machine room

This room is for installing three refrigerating machines, a standby diesel generator, transformer and control panels.

The total area of the room will be

$6.5 \times 10.25 = 66.625m^2$

(8) Wash room

The room with a closet and shower system for the officers of the storage requires

$5.0 \times 2.56 = 12.80m^2$

Another wash room built outside the cold storage for stevedores requires

$6.0 \times 2.5 = 15.0m^2$

(9) Box pallets

With the adoption of a simple throw-in structure in view of good workability, large transportation capacity and easy handling in the cold storage, the use of box pallets will provide easy storage control in terms of systematic storage, short working time and the prevention of a rise in the temperature of the frozen fish.

Measurements	2,200mm (W) x 1,200mm(L) x 1,300mm(H)
Weight	approx. 280kg
Maximum Load	1,500kg
Stowage	4 layers
Materials	zinc plated steel
Quantity	265 pieces
Assembly	local knock-down method
Working Tables	for loading/unloading (2)

(10) Electric forklifts

In view of the relatively long transportation distance along the quay, counter-balance type forklifts with a large tyre diameter will be used to ensure stable and fast operation.

The lifting height of a box pallet weighing 1,580kg reaches 4m above the ground and the forklifts move around lifting a box pallet. A lifting capacity of 2,000kg will be required with its safety allowance to meet the above requirements.

Two forklifts should be prepared in transporting and weighing the fish because of speedy alternate unloading work for temperature control of fish.

Type	counter-balance type
Lifting Capacity	2,150kg
Lifting Height	4,000mm
Battery charger	separate type
Special Specifications	for use in cold storage of -35°C
Quantity	2 sets

(11) Weighing System

1) Platform scale

The weight of the box pallet filled with fish will be inspected for confirming the stock quantity in the cold storage and the catch. Max. weighing capacity of 2 tons will be prepared to meet the design weight of a 1.5 ton box pallet.

Type	:	Stationary type
Weighing capacity	:	2 tons (min. 2kg)
Quantity	:	1 set

2) Weighbridge

A weighbridge will be provided for inspection of the frozen bank fish and tuna for transhipment transported to the port from the cold storage in the city.

Type	:	weighbridge without pit
Weighing capacity	:	max. 2 tons (min. 10kg)
Platform dimension	:	3m x 8m

Electricity	:	AC 230V ± 10% single phase, 50Hz
Quantity	:	1 set

(12) Mobile Crane

The capacity of a crane for the quay shall be planned for unloading fish from the vessel the Lady Sushil II. A mobile crane with a maximum capacity of 5 tons will be needed to carry out the unloading, due to its frequent shifts on the quay.

4-4-3 Ground Plan

The building subject to the Project consists of (a) cold storage, a machine room, a repair shop and a toilet, (b) a packing hall, (c) an office and (d) related facilities. The ground plan should be decided with careful consideration of the following points.

1) The location of the building should be determined considering the location of an access and onsite road, and a functional traffic flow.

2) The construction period should be shortened by avoiding duplication of the quay work area and the building work area.

3) If the subject site covers the reclaimed and existing ground, differential settlement may occur. Therefore, the building should be constructed on the existing site and newly reclaimed land should be avoided.

4) Space should be secured in the newly constructed quay area for the future extension of the cold storage.

In view of the above, the ground plan of the facilities are proposed as shown in Fig. 4-4-1. The respective areas of the facilities are shown as follows:

* Building area	20.5m x 27.10m =	555.55m^2
	8.00m x 27.10m =	216.80m^2
	Total	772.350m^2

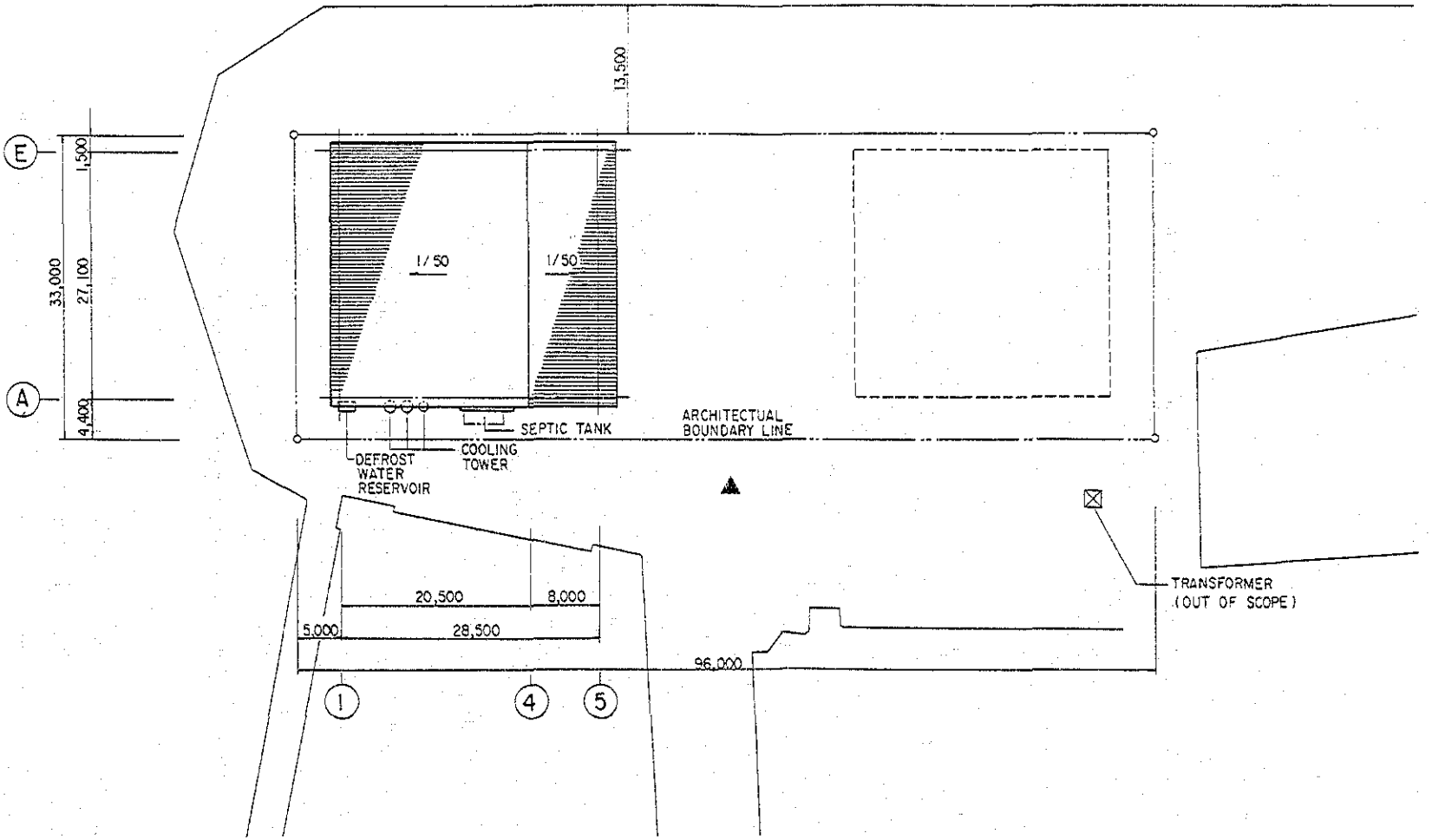


Fig. 4-4-1 Ground Plan of Cold Storage Facility

* Floor area	ground floor	28.50m x 27.10m =	772.350m^2
	1st floor	10.25m x 6.50m =	66.625m^2
		Total	838.975m^2

* Detailed floor area	ground floor	Cold storage (-30°C)	15.5m x 20.6m =	319.30m^2
		Preparation room (-10°C)	5.5m x 20.6m =	103.00m^2
		Machine room	10.25mx 6.50m =	319.30m^2
		Repair shop	10.25mx 6.50m =	66.625m^2
			Δ3.00 x 4.50m =	Δ13.50m^2
				53.125m^2
		Toilet	3.00 x 4.50m =	13.50m^2
		Packing hall	8.00mx 27.10m=	216.80m^2
		Total		772.350m^2
	1st floor	Office	7.75mx 6.50m =	50.375m^2
			2.50mx 1.50m =	3.750m^2
		Spare parts storage	2.50mx 5.00m =	12.50m^2
		Total		66.625m^2
		G. Total		838.975m^2

4-4-4 Building Plan

(1) Section plan

Attention must be paid to the following factors when planning the building sections.

1 Summer lasts for 5 months with an average temperature of 25°C and highest and lowest temperatures of 31.2°C and 20.9°C respectively. However, this temperature range does not present any special problems.

2 The annual rainfall of 1,150mm is not high by Mauritius standards and the humidity is, therefore, relatively low.

3 As two large cold storage using urethane sandwich panels are already in operation, the same system will be employed for the Project.

1) Roofing

The building will have 0.8mm weatherable steel sheet roofing with 4mm thick soft polyfoam on the inside of the sheets acting as thermal insulation material to block solar radiation and to prevent condensation.

2) Walls

Urethane sandwich panels with a coloured aluminium finish will be used for the cold storage and 0.4mm thick coloured steel sheets will be used for the sloping walls. Louvres will be introduced on the sloping walls to facilitate natural ventilation in view of preventing a temperature rise in the attic. With regard to the machine room, repair shop and office, the walls will consist of concrete up to a height of 1,200mm and the remainder will be composed of coloured sheets.

3) Doors and windows

Electric, heat insulated doors with an SVS finish will be used for the entrance of the cold storage. In view of the site being located on the coast, aluminium doors and windows will be mainly used with due attention paid to the securing of adequate ventilation.

4) Floors

All floors will have a mortar finish excepting the office and toilet floors which will have a coloured concrete mortar finish.

5) Interior finish (Walls and Ceilings)

Wooden shelves will be fitted to the urethane sandwich panels with a coloured aluminium finish in the cold storage and front room. The office will have a dressed plywood finish while the toilet will have a semi-ceramic tile finish. Woodwool slabs will be directly used for the ceilings excepting the office and toilet ceilings where boards will be used.

(2) Structural plan

1) Structure

A steel frame structure with a steel frame truss will be employed.

2) Structural design

Japanese structural standards will be referred to with due attention paid to the relevant BS Codes.

3) Foundation

Long-term soil bearing of 5 tons/m^2 will be adopted.

4) Seismic force

As in the case of the design criteria, the seismic force is not considered.

5) Wind pressure

The strongest wind velocity ever recorded was 36.1m/sec on February 20, 1960 due to a cyclone. The wind pressure is calculated using the following equation with a maximum wind velocity of 60m/sec.

p (wind pressure) $= C \cdot q$ kg/m^2

q (velocity pressure) $= 60\sqrt{h}$

C = wind pressure coefficient

h = height (m)

6) Materials

Cement	ordinary Portland cement
Coarse aggregate	crushed stone
Fine Aggregate	sand or coral sand
Concrete	design standard strength: FC = 210 kg/cm^2 (in 28 days)
Reinforcing Bars	SD30
Structural steel	SS41

7) Cross-section Calculation

The equations and drawings prepared by the Japanese Association of Architects will be basically used taking the local conditions into consideration.

(3) Machinery and Equipment Plan

1) Water supply system

Domestic water will be supplied to the office, toilet, machine room, cooling tower and packing hall. Water will be directly supplied to each point through branch pipes in the fishing port.

2) Drainage facilities

a) Sewage - In accordance with the standard system employed in Mauritius, sewage will be firstly treated by a septic tank and will then be drained into the ground through infiltration culverts.

b) Miscellaneous waste water and rainwater will be drained to ditches for direct discharge to the sea.

3) Sanitation fixtures

The sanitation fixtures to be installed will be either those made in Japan or their equivalents.

4) Ventilation system

While natural ventilation will be mainly adopted, mechanical ventilation will be employed for the machine room, battery recharging room and the toilet to remove odours.

5) Airconditioning

The office will be provided with a window type airconditioner.

6) Power System

a) The construction of a substation and wiring up to the port boundary will be conducted by the Mauritius side for the supply of the necessary power while all wiring work on the Project site is included in the Project.

b) Power distribution system

- The power distribution system for the subject facilities is planned based on the following.

Trunk Line	400V, 3 phase, 4 line, 50Hz
Power Circuit	400V, 3 phase, 4 line, 50Hz
Lighting Circuit	230V, single phase, 2 line, 50Hz

- The power receiving board will be capable of receiving power from the commercial power source and emergency power source and a main interlock switch will be provided for each of these sources.
- Power distribution boards will be separately provided for the power and lighting circuits.

c) Emergency power generating system

An emergency power generator will be provided in the case of power failure during a cyclone. The capacity should be large enough to operate one refrigeration unit for the cold storage to maintain the temperature inside the cold storage at -20°C.

d) Lighting Fixtures

Waterproof incandescent lamps will be used inside the cold storage and fluorescent lamps will be used at all other places. The luminous intensities are planned as follows.

Office	400 Lux
Cold Storage	30 - 50 Lux
Packing Hall	60 Lux
Other Rooms	60 Lux

All electrical facilities must anti-salt and anti-corrosion treated in view of Mauritius being located in a subtropical zone.

e) Refrigeration system

- Refrigeration Method - High speed multi-cylindrical type. Two stage and multiple stage compression, direct expansion and dry type water cooling condensors.
- The refrigeration system for the cold storage should be capable of satisfying the design temperature of -30°C. If a single refrigeration unit is employed, the cold storage operation will be jeopardized by the possible breakdown of the unit. Therefore, the system is divided into 2 units to avoid the complete suspension of cold storage operation.
- While a storage temperature of -30°C will be maintained by the simultaneous operation of the 2 units, each unit will have a cooling capacity capable of maintaining a storage

temperature of -20°C even if the other unit is out of operation due to breakdown or other reasons.

- The design temperature for the preparation room is -10°C and a refrigeration unit capable of satisfying this condition will be accordingly installed.
- The design conditions for the refrigeration system are as follows.

Refrigerant	R-22
Room Temperature	Cold Storage -20°C/-30°C Front Room -10°C
Design External Temperature	31°C
Cold Storage Capacity	250 tons
Handling Capacity & Temperature	25 tons/day, -15°C
Cooling Capacity	The cold air temperature in the cold storage will reach -20°C/ -30°C 24 hours following the completion of loading/unloading
Control Panel	To control the refrigeration system and the room temperatures of the cold storage and front room

f) Telephone system

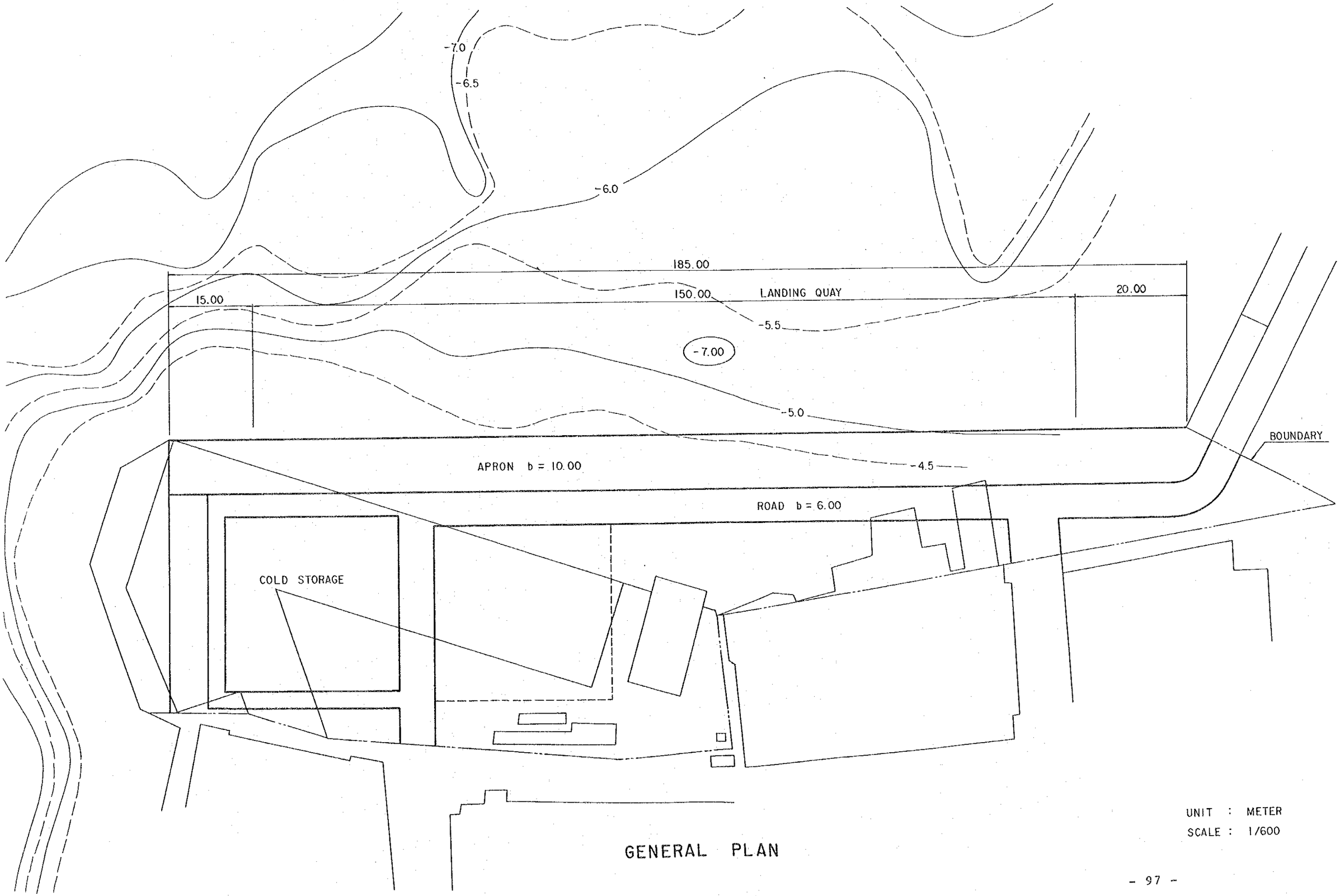
Conduit piping will be installed to provide the office with a telephone line.

g) Outdoor lighting system

Necessary street lamps will be provided both on the site and on the quay.

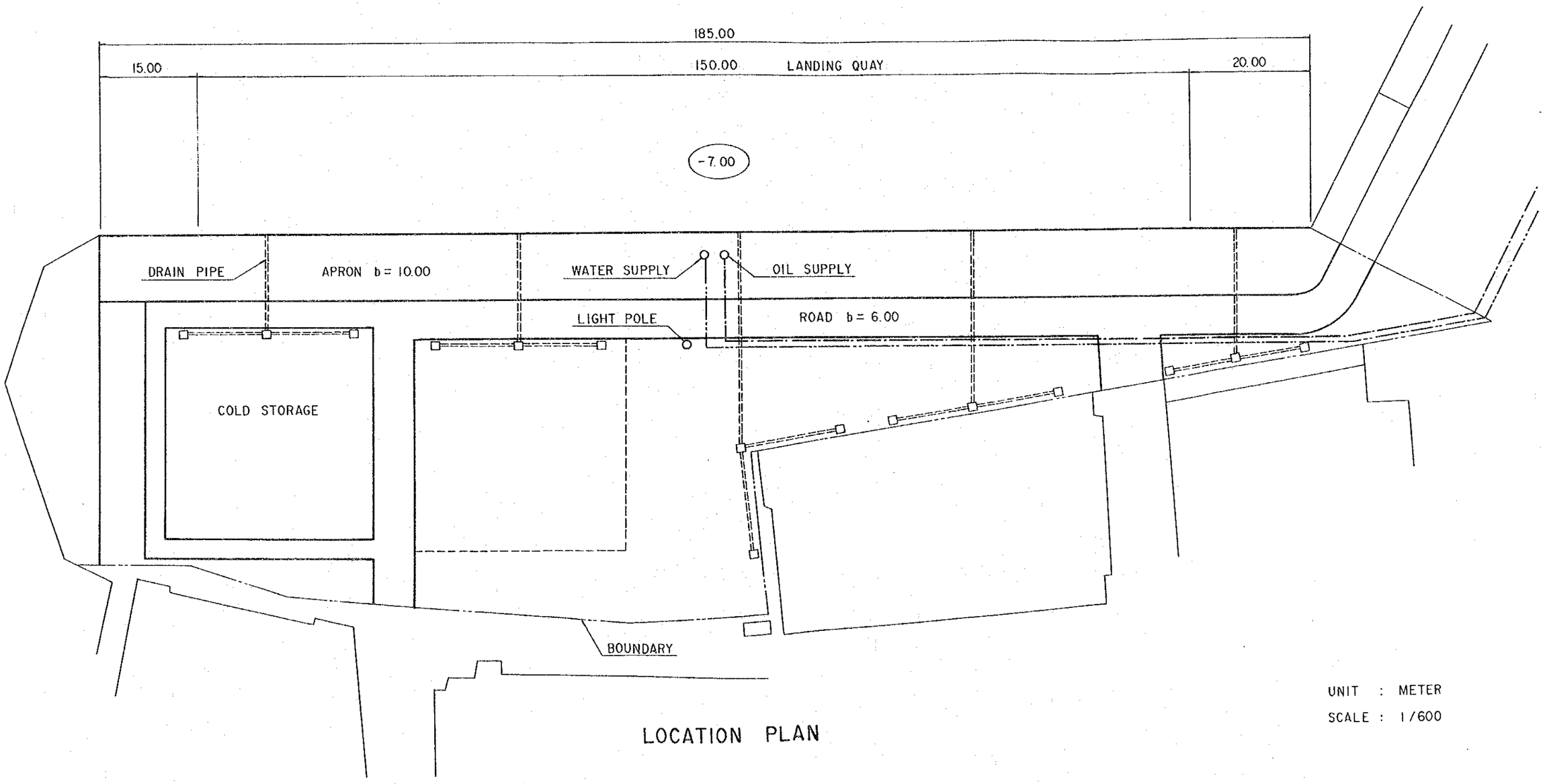
4-5 Drawings

(1) General Plan
(2) Location Plan
(3) Cross Section and Plan
(4) Cross Section for Dredging
(5) Site Plan (Cold Storage Facility)
(6) Floor Plan
(7) Section



GENERAL PLAN

UNIT : METER
SCALE : 1/600

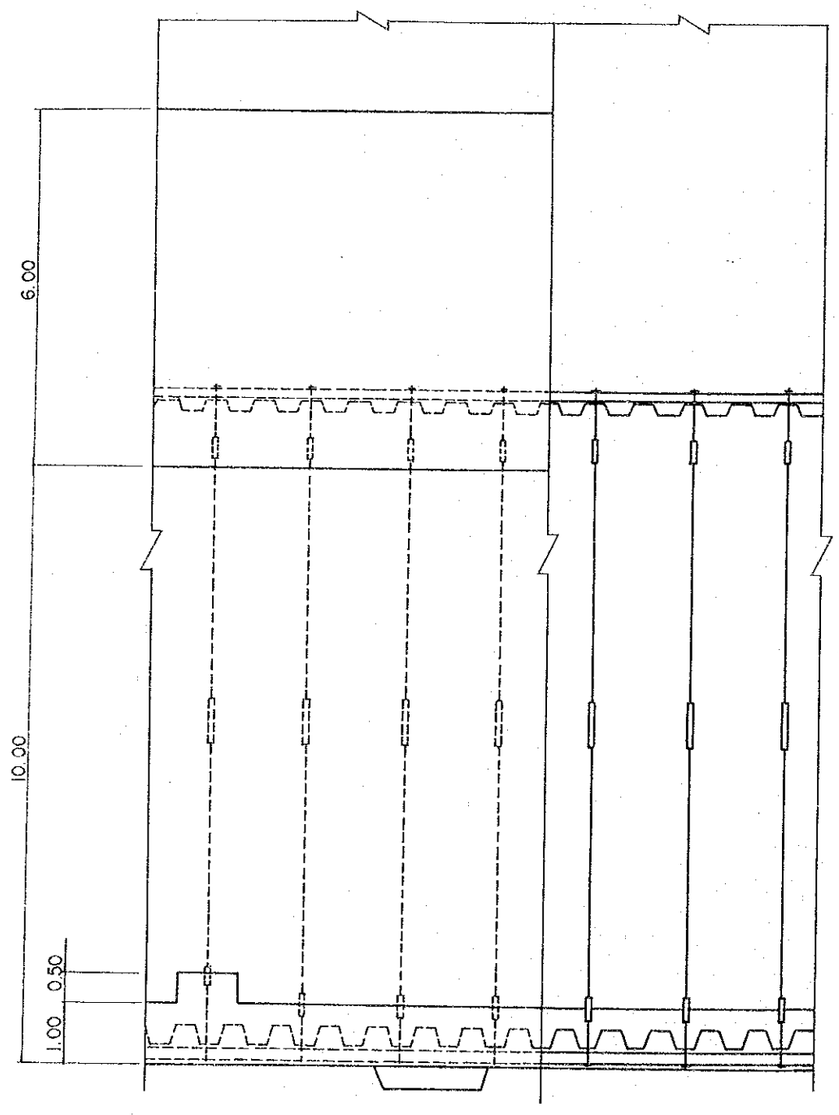


UNIT : METER

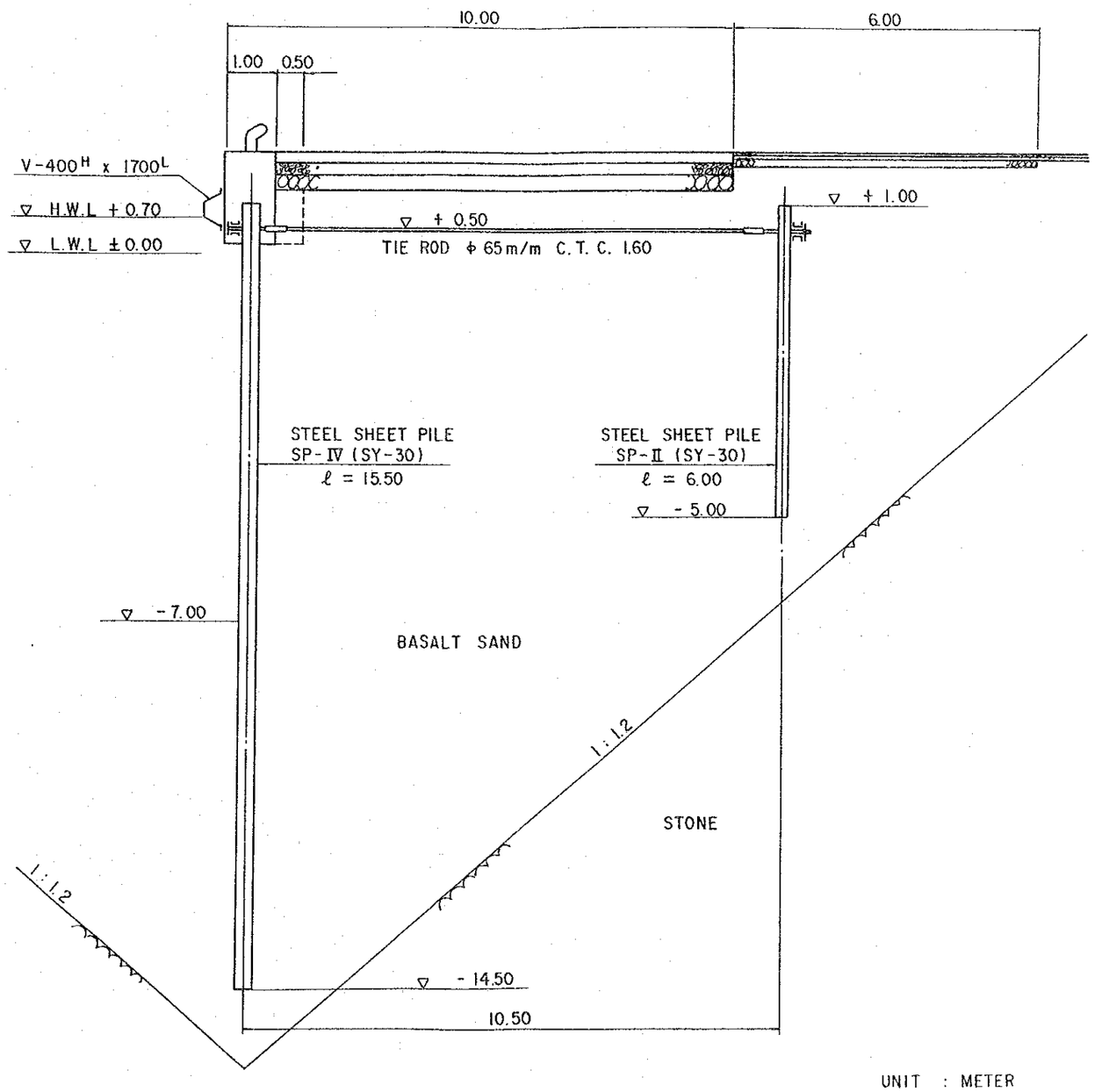
SCALE : 1/600

LOCATION PLAN

PLAN



TYPICAL CROSS SECTION



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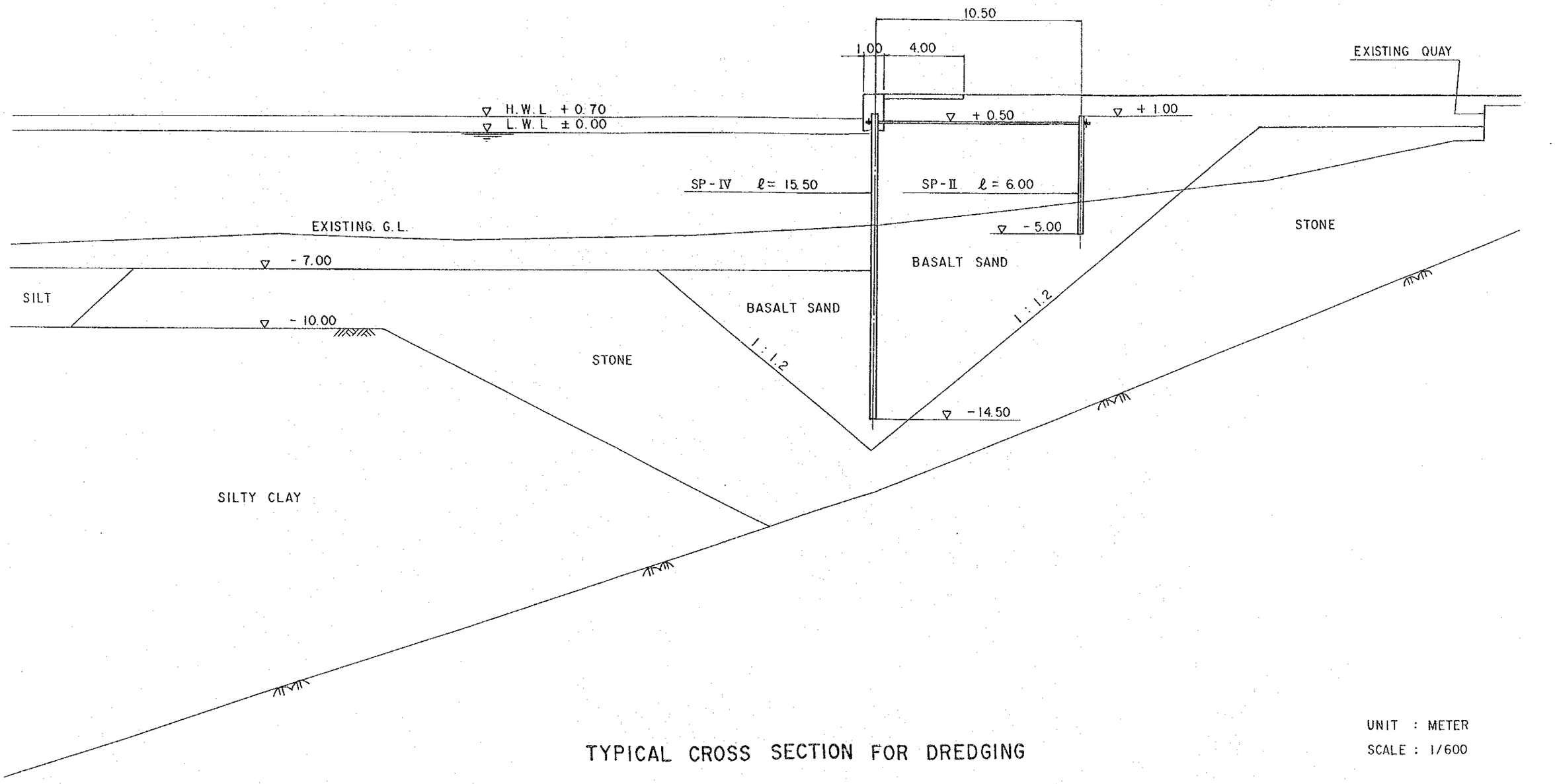
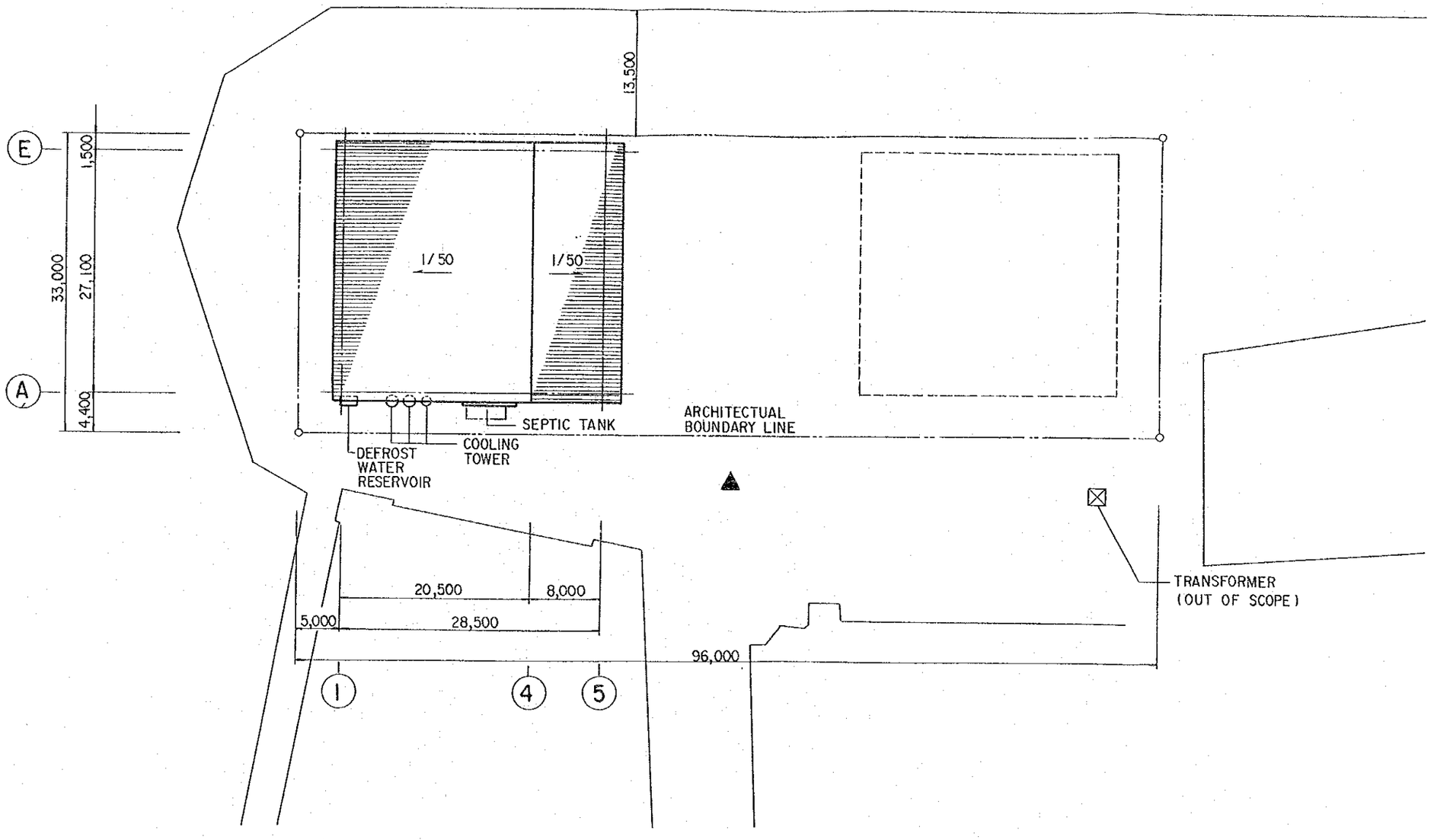


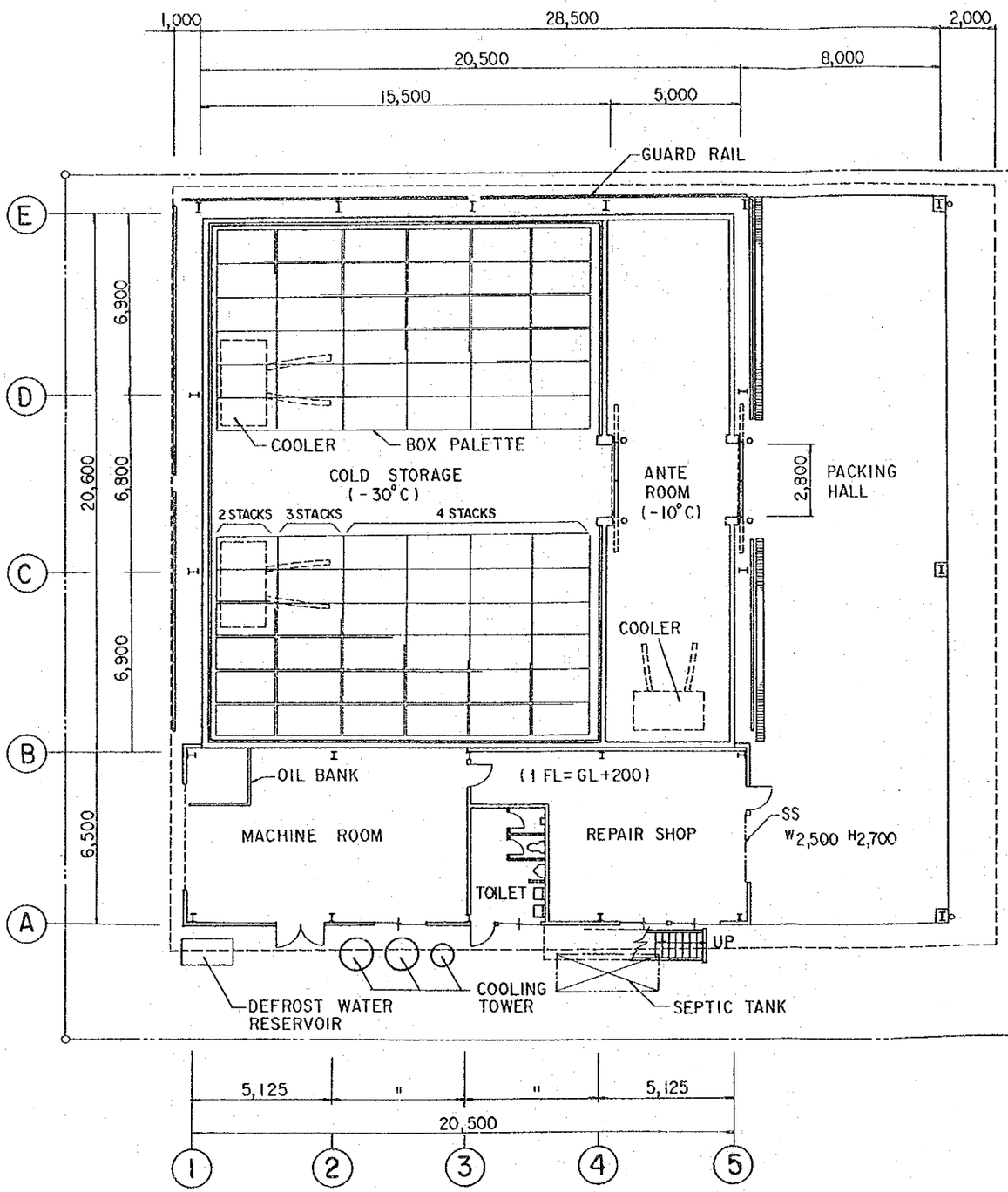
TYPICAL CROSS SECTION FOR DREDGING

UNIT : METER
SCALE : 1/600

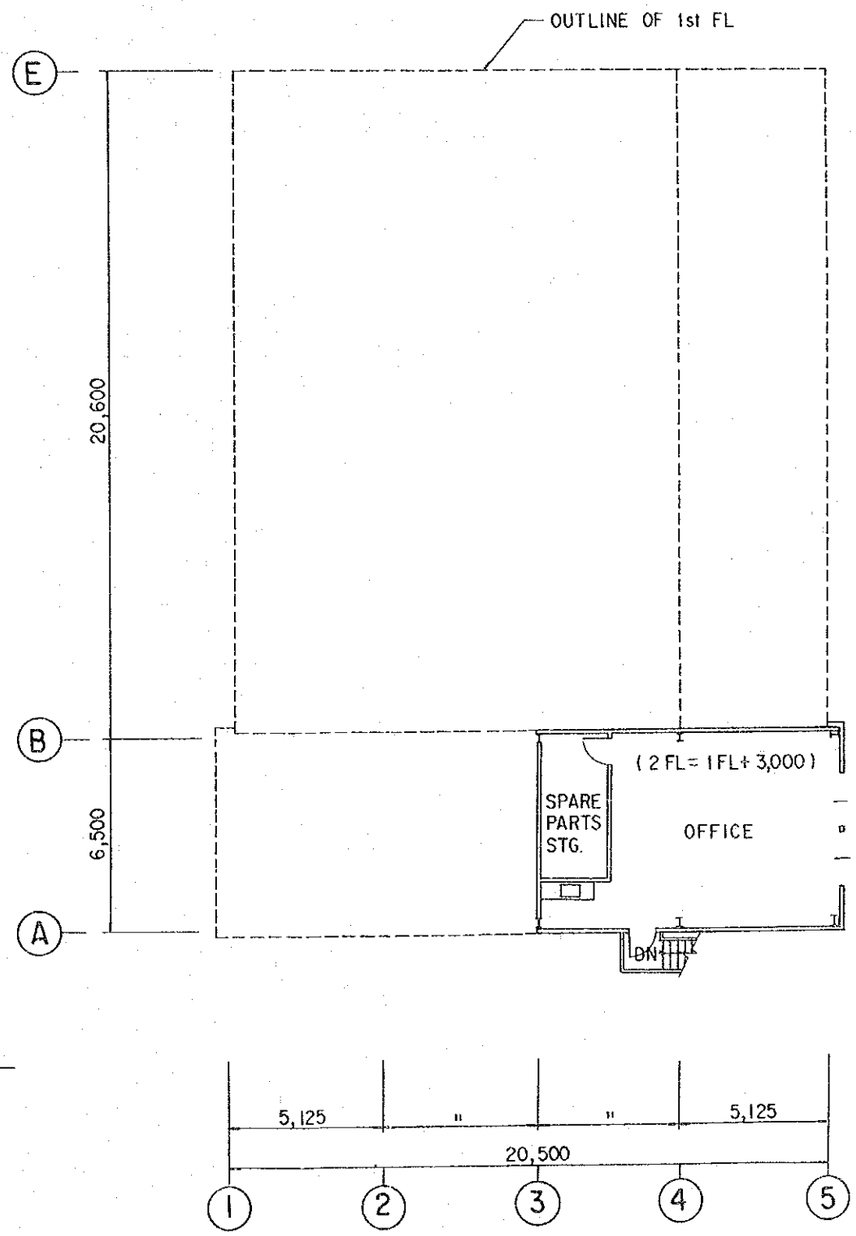


SITE PLAN

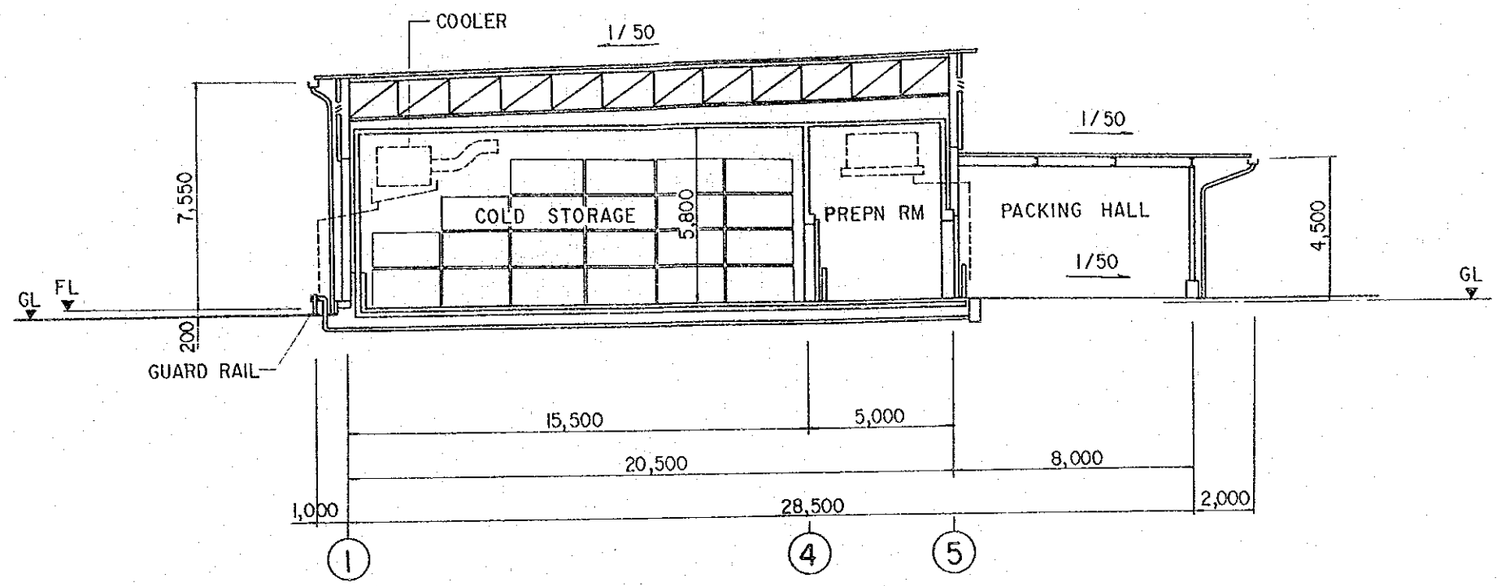
SCALE : 1/500



1st FLOOR PLAN



2nd FLOOR PLAN SCALE : 1/200



SECTION

SCALE : 1/200