BASIC DESIGN STUDY REPORT
ON
THE SEED PRODUCTION CENTER FOR FRESHWATER PRAWN
IN
THE SOCIALIST REPUBLIC OF THE UNION OF BURMA

AUG. 1983

JAPAN INTERNATIONAL COOPERATION AGENCY

PREFACE

In response to the request of the Government of the Socialist Republic of the Union of Burma, the Government of Japan decided to conduct a Basic Design Study on the Seed Production Center for Freshwater Prawn and entrusted the study to the Japan International Cooperation Agency (JICA). The JICA sent to Burma a study team headed by Mr. Tatsuhiko Iwasawa, Assistant Director, Oceanic Fishery Department, International Affairs Division, Fisheries Agency, from May 8 to May 27, 1983.

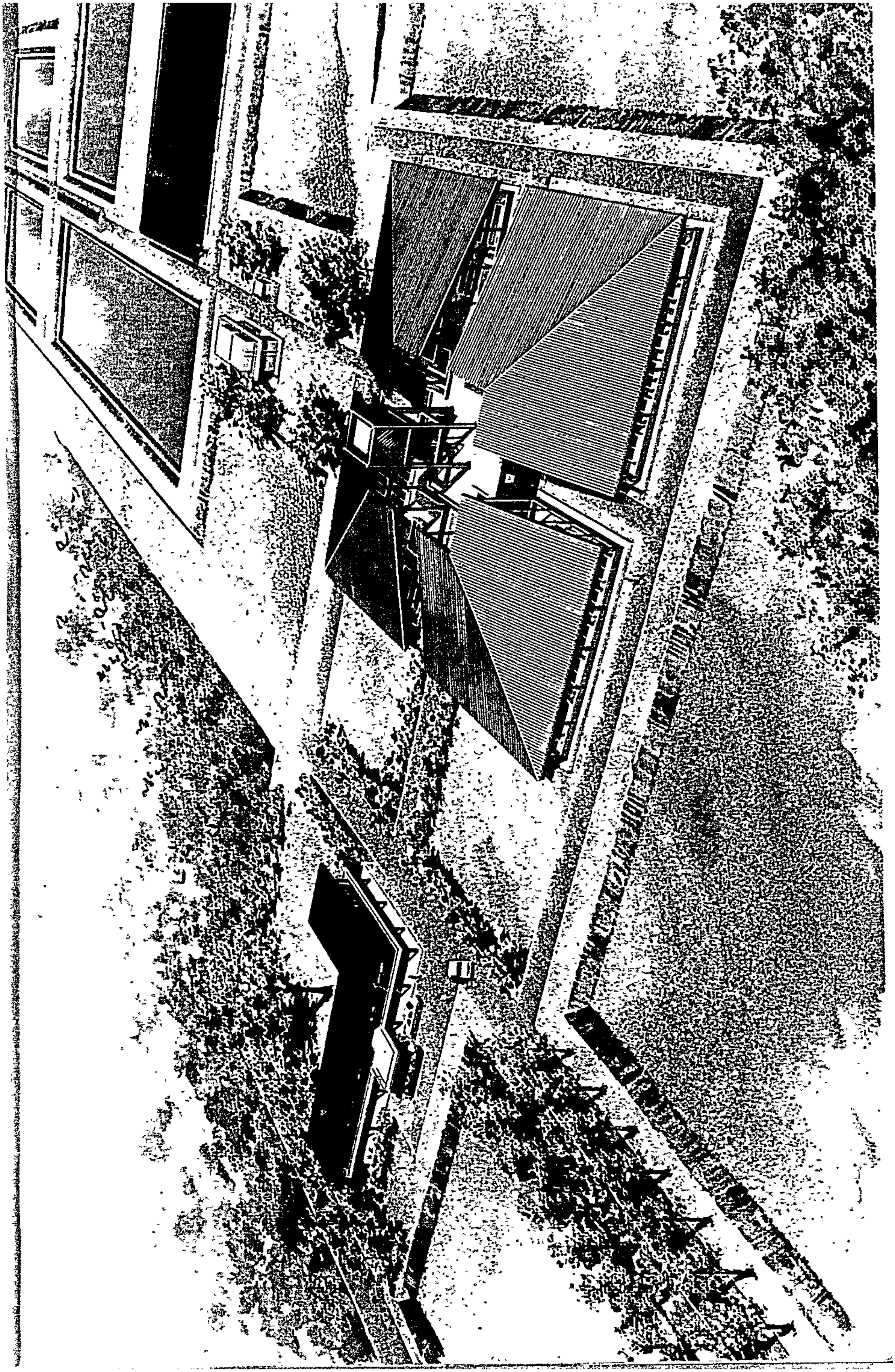
The team had discussions with the officials concerned of the Government of Burma and conducted a field survey in Kyauktan, Thaketa, Hmawbi and Thanatpin. After the team returned to Japan, further studies were made and the present report has been prepared.

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 the Socialist Republic of the Union of Burma for their close cooperation extended to the team.

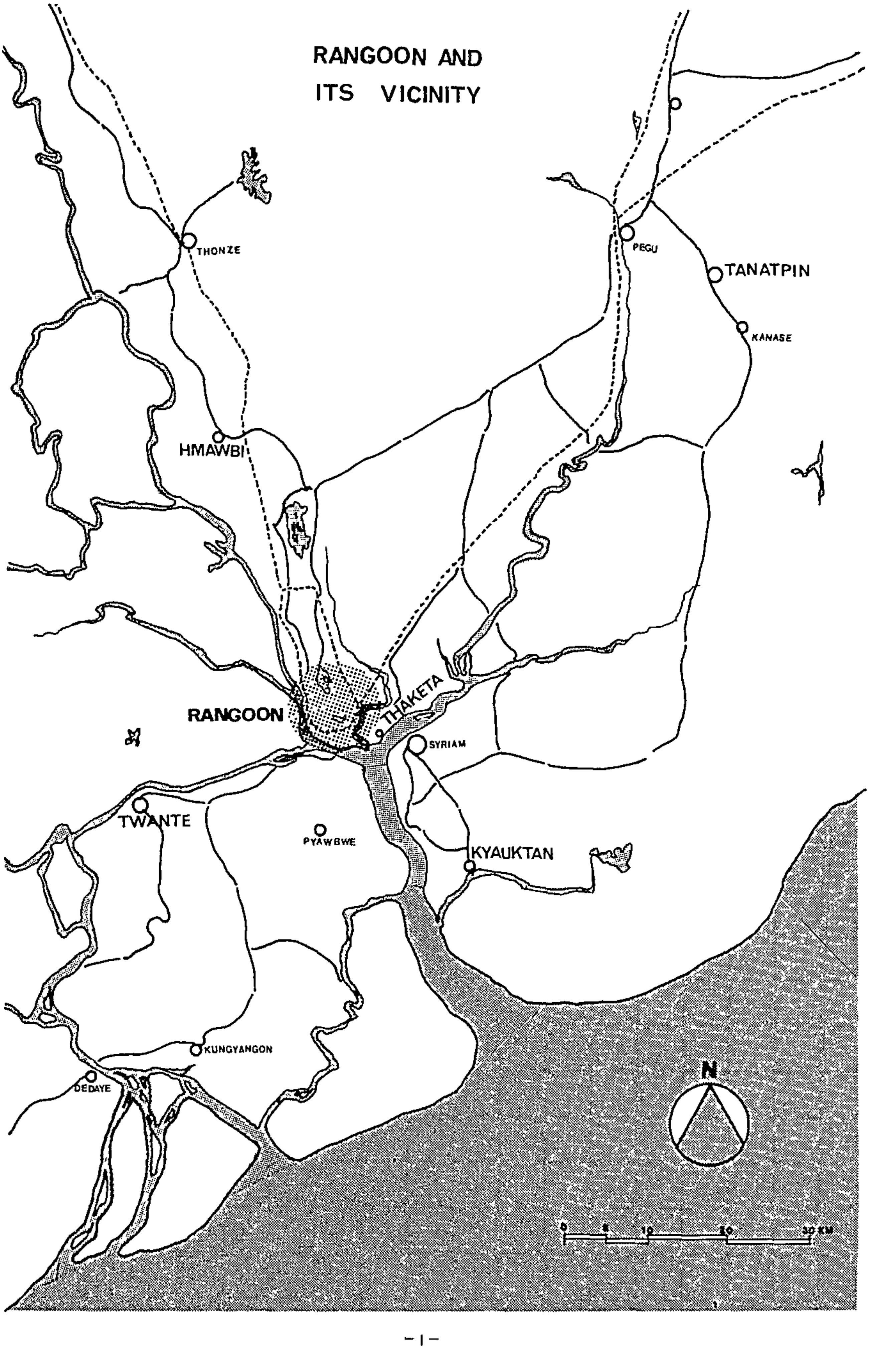
August, 1983

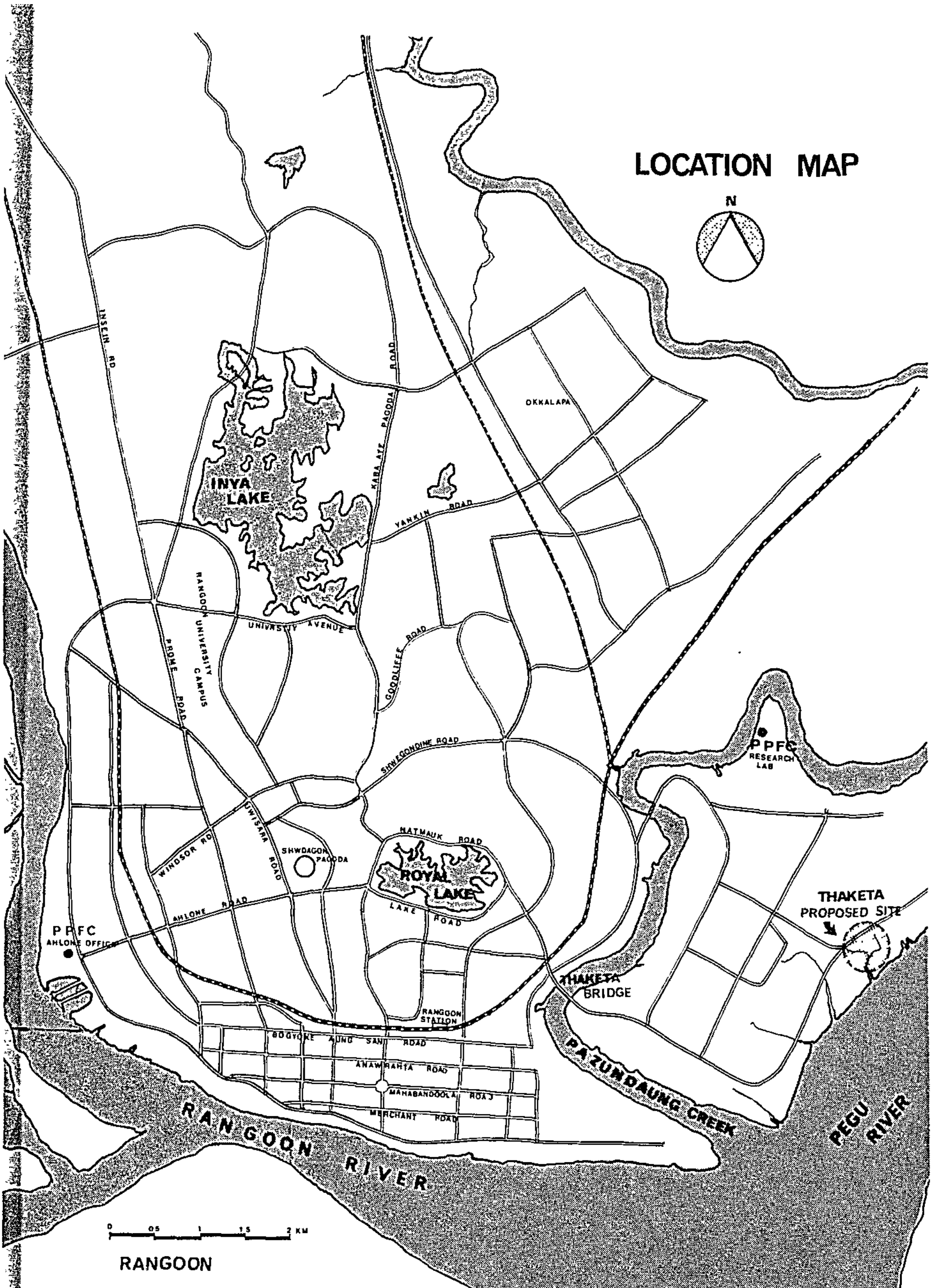
Keisuke Arita
President
Japan International Cooperation Agency



CONTENTS

List of Appendix


RANGOON AND
ITS VICINITY
THONZE
PEGU
TANATPIN
KANASE
HMAWBI
RANGOON
THAKETA
SYRIAM
TWANTE
PYAWBWE
KYAUKTAN
KUNGYANGON
DEDAYE
N
0 5 10 20 30 KM


LOCATION MAP
N
INSEIN RD
KABA AYE PAGODA ROAD
OKKALAPA
INYA LAKE
YANKIN ROAD
RANGOON UNIVERSITY CAMPUS
UNIVERSITY AVENUE
GOODLIFFE ROAD
PROME ROAD
SHWEGONDINE ROAD
PPFC
RESEARCH LAB
U WISARA ROAD
WINDSOR RD
SHWDAGON PAGODA
NATMAUK ROAD
ROYAL LAKE
LAKE ROAD
AHLONE ROAD
PPFC
AHLONE OFFICE
THAKETA
PROPOSED SITE
THAKETA BRIDGE
RANGOON STATION
BOGYOKE AUNG SAN ROAD
ANAWRAHTA ROAD
MAHABANDOOLA ROAD
MERCHANT ROAD
PAZUNDAUNG CREEK
RANGOON RIVER
PEGU RIVER
RANGOON

SUMMARY

The Socialist Republic of the Union of Burma, in the Fourth Four-Year Plan of its 20-year national development plan, has targeted a growth rate of 6% in the plan's first year (fiscal 1982/83) for the livestock and fishery sector. As a sector sharing responsibility for providing animal proteins to the Burmese people and one capable of producing high value-added products, the livestock and fisheries industries have been accorded a relatively high growth rate for a primary industry sector, vs. 5.2% for agriculture and 3.7% for forest products.

The Burmese Government looks upon fisheries as a sector offering a faster return on investment than livestock and so is actively making investments to expand the fishery production base. The country has funded the development of the fishery sector almost entirely from international organizations and through bilateral loans and has allocated these funds to various fishery development programs through the People's Pearl and Fishery Corporation (PPFC), an agency, under the control of the Ministry of Livestock Breeding and Fisheries, which is charged with production of onshore, offshore, and aquaculture fisheries.

The Burmese Government has sets export development as one of its basic goals in the 20-year national development plan. The PPFC, accepting this task, has developed a program for expanding production of prawn, which has a high value as an export commodity, through: expansion of the marine prawn fishery by building trawl vessels; improving distribution facilities for freshwater prawn and increasing the production of freshwater prawn.

The object species in the PPFC's Freshwater Prawn Culture Program is giant freshwater prawn (*Macrobrachium rosenbergii*), which is widely distributed throughout Burma's inland waters, primarily in the Irrawaddy Delta, and has traditionally provided the Burmese people with a source of both cash income and animal protein. In 1981, the Research and Development Branch of PPFC at Thaketa succeeded in seed production for

this species and, subsequently, at an experimental culture farm at Thanatpin, established the likelihood of obtaining ample economic yields by non-intensive culture method. In this way, the PPFC has given concrete substance to its aquaculture program for giant freshwater prawn.

The PPFC Freshwater Prawn Culture Program calls for the construction of four seed production centers capable of producing 10 million seed prawn per year and of six culture farms with a total pond area of 150 acres (almost 60 ha) each, geared to a combined annual production of 450 tons of giant freshwater prawn.

In order to implement this Program, a large and stable supply of seed must be maintained, while a certain level of aquaculture technology and facilities must be established for the grow-out of adult prawn of high commercial value. With regard to the grow-out stage itself, it will be a fairly simple matter to apply the existing technology of fish culture in pond widely developed in the country. But there is as yet no record of accomplishment in Burma with respect to the large-scale supply of seed for crustaceans.

Based on the recommendation made by the preliminary survey team sent to Burma in Jan. 1983, the Japan International Cooperation Agency (JICA) dispatched a Basic Design Study Team to Burma in May 1983 to establish the significance and appropriateness, in terms of promoting PPFC Program, of extending cooperation in the form of grant-in-aid for seed production facilities.

The PPFC, in accordance with the Program, has already started construction of prawn culture farms at two locations, Hmawbi and Thanatpin, and expects to complete 40 ha of culture ponds by March, 1984. With regard to the seed production center, the construction work is underway at Kyauktan for the facilities to produce 2.5 million seed a year--coprising 1/4 of the final production target--and is expected to complete by

March 1984. However, this production volume will not even satisfy the requirements of the above two culture farms, must less the distribution of seed to existing culture farms and cooperatives.

Based on the above, the Team developed a production plan and established an appropriate scale for facilities related to the following: the establishment at Thaketa, one of the sites designated under the PPFC Programe, of a seed production center, with a production capacity of 10 million seed prawn annually; to provide equipment that will help improve the efficiency of operations at the Hmawbi and Thanatpin culture farms as well as at the Kyauktan seed production center; and contribute to the development of an integrated production structure from seed production through harvest. (In this report, our plan is designated as the Plan for the Seed Production Center for Freshwater Prawn.)

The site selected for the seed production center at Thaketa is situated in the city suburbs, about 7 km east of the central district of Rangoon, on the banks of the Pegu River. In the seed production of giant freshwater prawn brackish water is required from the hatching to the post-larva stage. The brackish water available at Thaketa site has a salinity of 19 ppt so no practical problems will be encountered. During the high-water period throughout the rainy season, salinity drops sharply; thus, it will be necessary to prepare for this period by establishing a pond to serve as a reservoir for brackish water. Despite this problem, we feel that the proposed site will be quite advantageous for the production and distribution of seed, owing to the availability of commercial power, access roads, and the fact that the PPFC Research and Development Branch is located nearby. All of these conditions assure a good interflow of techniques and personnel in day-to-day operations at the Center.

In order to achieve a production level of 10 million seed per year, as targeted under the Plan, the following facilities will be required.

Outline of the Facility

Facility	Area/Size	Contents
1. Freshwater Reservoir	5,000 m^2	Earthen pond
2. Brackish Water Reservoir	5,000 m^2	Earthen pond
3. Concrete Reservoir	1,500 m^2	Covered concrete pond
4. Breeder Stock Pond	1,000 m^2 x 2	Earthen pond
5. Rearing Tank		7.5 tons concrete tank 128 pcs (Building; steel frame one story 3,280 m^2)
6. Water Intake and Distribution System		Pump, filter, elevated tank, pipe and ancillary equipment
7. Aeration System		Air blower and associated equipment
8. Water Recycling System		Pump, filter and other equipment
9. Administration/Lab Bldg.	341 m^2	Stee frame, one story
10. Aquaculture Equipment		Water wheels, aerators, feed preparation equipment, vehicles, environmental measuring equipment, pond maintenance equipment

The period of construction will cover 14 months, including the civil engineering portion, such as water intake and distribution facilities and pond constructions, where it is advisable to avoid the May-October rainy period. The progress plan should, accordingly, pay ample attention to the local climatic conditions.

In the Basic Design of the subject Seed Production Center, we have, to the maximum extent possible, made it a basic policy to adopt methods of production technology that are established and simple. For example, in the control system for the brackish/fresh water distribution, our design has avoided complex automated controls. Also, by dividing the seed production building into 4 units, we have avoided the possibility of accidents that could result in a total seed loss as a result of disease or mishandling of the equipment. We have thus given top priority to assuring a stable production of seed.

Based on an annual seed output of 10 million giant freshwater prawn, operating costs for the facility, including depreciation of the buildings and equipment, will be about 955,400 Kyat a year (about ¥ 28,662,000). On a per-seed basis, this works out to 9.55 Pyas (about 2.87 yen). Based on this seed cost, and assuming a cultivation period of 300 days, a harvest weight of 45 g/prawn and a projected yield of 50%, it is clear that non-intensive culture method should be economically viable even with a relatively small scale of operation.

The cost of seed produced in accordance with this Basic Design, seems appropriate in helping to achieve the planned increase in freshwater prawn production through aquaculture -- the ultimate objective of this Program. Furthermore, by levying a charge for the seed produced, by and distributed from this Center, it has been established that the facility is likely to be self-supporting.

In general, the production of crustacean seed is more difficult than that of fish species. Particularly in the case giant freshwater prawn given the fact that brackish water is required for seed production, it cannot be expected for the time being that each culture farm can become self-sufficient in terms of seed supply. Seed to be produced in the Center will also be distributed to the existing PPFC fish ponds as well as to ponds owned by cooperatives in the various divisions of the country. From the above standpoints, the benefits of implementing this Plan may be clearly seen.

Upon completion, the facility is to be operated by the PPFC. The 2 technicians required for seed production can be drawn from experienced senior staff members among the 13 technicians presently attached to the Research and Development Branch of the PPFC who are currently working on the freshwater prawn project. Thus, insofar as operation of the Center is concerned, there should be no problems with respect to technical personnel.

However, considering the planned expansion of the prawn culture farm and the need to provide technical advice to cooperatives, a large number of such technicians will eventually be required to support the overall development of Burma's freshwater prawn culture. We trust that a determined effort will be made to train such technicians along the lines of the advanced training course that the PPFC has recently instituted in giant freshwater prawn cultivation.

We offer the following advice with regard to implementation of the Plan for the Seed Production Center--

... First, it is vital to establish a year-round production system for seed based on self-sufficiency in the parent prawn. At the present time, adult prawn are being purchased from fishermen. Thus, during the 3 months (December - February), when egg-bearing prawn cannot be taken, seed production becomes impossible. If, through the breeder stock ponds incorporated in this facility, the artificial growth of female prawn can be encouraged to promote spawning activity, year-round seed production will become feasible.

... Secondly, there is a need to shorten the 50 days from hatching to post-larva stage. In Burma, where water is always available at the 28-29°C temperature level that is ideal for the production of giant freshwater prawn seed, if appropriate feeds can be developed, it should certainly be possible to shorten this period.

If these dual objectives can be attained, it would be possible to expand seed production from 10 million to 15 million per year, thereby raising the productivity of the facility and making it possible to greatly lower the unit cost of seed production.

SECTION 1 INTRODUCTION

The three river systems -- the Irrawaddy, the Sittang, and the Salween, together with their tributaries -- that traverse Burma from north to south provide grounds for the cultivation of useful marine products which constitute a source of proteins in the everyday diet of the Burmese people.

As a result, the culture of freshwater fish, mainly carp, has been relatively well developed in Burma for many years, while the techniques and facilities for seed production have also become established.

The giant freshwater prawn (Macrobrachium rosenbergii), a crustacean, requires brackish water for its larval stage, and so the Irrawaddy Delta area plays a major role in its reproduction.

The giant freshwater prawn is the largest variety among the family Palaemonidae. It is an omnivorous prawn distributed widely in the brackish and fresh waters of various countries, ranging from India and Sri Lanka to Indonesia and the Philippines. As a species living close to populated areas, it has, from earliest times, provided a supply of high quality edible protein. In recent years, as a result of the general upgrading of consumer tastes throughout the world, particularly in the advanced industrial countries, demand for prawn has greatly increased. In Burma too, the giant fresh-water prawn, which is taken from the expansive brackish and fresh-water areas, has long been an important source of food, reflecting the liking of the Burmese people for freshwater fish. At the same time, it has become increasingly important as an export product, providing Burma with valuable foreign exchange.

For the above reasons, aquaculture is being relied on as a means of increasing the production of giant freshwater prawn. Starting in 1980, research was begun in earnest on artificial seed production, the basic requirement for the cultivation of giant freshwater prawn. This research has been conducted mainly by the Research and Development Branch of the People's Pearl and Fishery Corporation (PPFC), which is charged with the overall execution of fishery development in the country.

After a relatively short period of experimentation and research, prospects have materialized for establishing a cultivation system permitting the mass production of 250,000 - 500,000 seed prawn per cycle and a harvest of some 100 - 125 g per square meter.

To accelerate the development of freshwater prawn culture, the PPFC, during the 1982/83 fiscal year, developed a plan for the construction of four seed production centers located in the suburbs of Rangoon with an annual production target of 10 million seed respectively, along with six culture farms with a combined water area of 60 ha (150 acres) each, with a planned production target of 450 tons of giant freshwater prawn per annum.

On the basis of these developments, the Government of Japan, for purposes of establishing the feasibility and appropriateness of a grant-in-aid cooperation program aimed at the provision of seed production facilities and supporting equipment, dispatched, through JICA (Japan International Cooperation Agency) a preliminary survey team, followed by a Basic Design Study Team. The latter, headed by Mr. Tatsuhiko Iwasawa, Assistant Director, Oceanic Fishery Department, International Affairs Division, Fisheries Agency of the Japanese Government, spent 20 days in Burma from May 8 - 27, 1983.

The objectives of the basic design study were:

1) to validate the contents and present status of the PPFC Program; and

2) to establish the scope and appropriateness of cooperation by Japan.

The survey team conducted on-the-spot surveys of the prawn culture farm sites at Hmawbi and Thanatpin, as well as the seed production sites at Kyauktan and Thaketa. In addition, the team held a series of discussions with Burmese discussants, mainly personnel of PPFC, regarding the scope of cooperation to be extended by Japan. A Results of Discussions, summarizing these findings was exchanged with the PPFC.

Following its return to Japan, the Team made a technnical analysis and evaluation of the current situation at the planned construction sites, the resources that would be required, and technological levels to validate the approrriateness of the program. On this basis, a basic design and construction plan was developed for the Seed Production Center for Freshwater Prawn, as presented in this report.

A copy of the Results of Discussions, a list of the team members, the survey itinerary, and the names of the Burmese discussants have been included as Appendices (i) - (iv), following the body of this report.

SECTION 2 BACKGROUND OF THE PROJECT

2-1 The Fourth Four-Year Plan

Burma has developed a long-term 20-Year Plan, running from 1974-1975 to 1993-1994, whose purpose is --

1) to double living standards from 1973/74; and

2) to move the economy from one based on agriculture to one based on the agricultural industry.

In order to achieve these goals, GNP must grow at an average annual rate of 5.7%. Looking at growth targets by sector, against 4.8% for agriculture, livestock, and forestry, 9.4% is targeted for manufacturing and power and 7.27% for transport, communications, and construction.

Goals under this long-term 20-Year Plan have been subdivided into 5 four-year plans. Owing to changes in plan length along the way, in 1981/82, the Third Four-Year Plan was completed, and the Fourth Four-Year Plan is now being implemented starting in April, 1982.

During the Third Four-Year Plan (1978/79 - 1981/82), Burma's economy maintained an expansionary flavor, with growth rates of 6.6%, in excess of the targeted 6%, as a result of an increase in rice production based on the introduction of high-yield varieties and the increased output of fertilizers and agricultural chemicals; an expansion of investment through the induction of foreign aid and the development of mining and manufacturing.

Under the subsequent Fourth Four-Year Plan, along with invigorating the domestic economy, in order to deal with a major increase in imports of capital goods and materials, the FFYP stresses the development of export industries making effective use of domestic materials.

80% of Burma's exports have traditionally been concentrated in fisheries in various ways. In addition to the Ministry of Planning and Finance, which has responsibility for tax collections, there is the Ministry of Cooperatives, which fosters fishery development through fishery cooperatives; and the Ministry of Livestock Breeding and Fisheries, under whose wing lies the Department of Fisheries, which has overall administrative control over fisheries; and the PPFC, which is the principle implementing arm for fishery production.

However, international rice prices, taking the Bangkok price of $367.51 in 1979 as 100, have fluctuated widely, falling to 90.9 in 1979, recovering to 118 in 1980, and 131.4 in 1981, then dropping to 79.8 in 1982. Prices have remained sluggish into 1983. Exports of teak woods too have shown sluggish growth owing to the deterioration of market conditions in Europe.

As a consequence, the country's balance of payments has deteriorated sharply since 1978/79. According to a report to the People's Congress, the deficit was 137 million Kyat in 1978/79, 150 million in 1979/80, 124 million in 1980/81, and 260 million in 1981/82. Meanwhile, the debt-service ratio had risen to 26.8% by 1981/82.

The Government of Burma has been taking various counter-measures, such as the diversion of domestic products to the export market, and has also been making a strenuous effort to develop exportable products, other than rice and wood, which utilize domestic resources.

2-2 The Fishery Development Plan

Among the long-term goals of Burma's fishery development plan are:

1) self-sufficiency in fish proteins; and

2) making the fishery sector a vital sector in the national economy.

Various plans have been developed for fisheries in advancement of these objections and the Burmese Government is involved directly in fisheries in various ways. In addition to the Ministry of Finance, which has responsibility for tax collections, there is the Ministry of Cooperatives, which fosters fishery development through fishery cooperatives the Department of Fisheries, which has overall administrative control over fisheries; and the Ministry of Livestock Breeding and Fisheries, under whose wing his the PPFC, which is the principle implementing arm for fishery production.

Fisheries in Burma are classified into freshwater and marine. Freshwater fisheries are broken down into: aquaculture, lease fisheries, and river, lake, and swamp fisheries. Marine fisheries are divided into three classifications: in-shore, on-shore, and off-shore.

The secotrs in which PPFC is most actively implementing its programs are: in marine fisheries -- onshore, offshore, and pearl culture; and in freshwater fisheries -- aquaculture and lease. But, in recent years, owing to the difficulties encountered in resource management in lease fisheries, weight has been shifted over to aquaculture.

With respect to marine fisheries, under aid from UNDP/FAO in 1979/80, resource studies based on acoustic method were carried out on a Norwegian research vessel. On the basis of this research, it was estimated that the stock of marine resources within Burma's economic zone totaled 1.7 - 1.9 million tons and that the sustainable production level was 700,000 - 960,000 tons a year.

When one considers the oceanic environment -- the nutrient salt from Burma's 3 major rivers; the coastal upwelling brought by the northeast monsoons; the current traversing the Bay of Bengal in a clockwise direction; the country's long 2,816 km coastline -- and the present catch level of 450,000 tons*1 for the nation's marine fisheries, it seems evident that there is still ample room for developing Burma's marine resources.

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*1 Notes on Fisheries in Burma, Min. of Agriculture and Forests, 1983 -- Catch of the Marine Fisheries in 1981/82.

Turning to freshwater fisheries, in view of the land and water environment, as evidenced by the developed river system, and the wide areas that are flooded during the rainy season caused by the monsoon climate, capture fisheries have been developed for many years.

However, in recent years, these traditional fishery catches have been severly restricted, owing to the construction of irrigation systems to build up agricultural production and the increased use of fertilizers and agricultural chemicals. From this, it has been determined that the future development of freshwater fisheries will lie mainly in aquaculture. Acuaculture development is expected to be based on pond culture technology using artificial seed production, which is already widely used in Burma in the cultivation of carp (Labeo rohita).

The Burmese Government had, at an early stage, established fishery development -- particularly of marine fisheries -- an industrial sector that promised a good return on investment and has been making various investments, mainly through the PPFC, to modernize fishery facilities. At present, the PPFC owns 85 vessels along with a 14,000 GT trawler. 34 of these vessels are shrimp trawlers with lengths of 11-19 m. To finance these vessels as well as the expansion of ice-making and refrigeration facilities, a series of 3 loans were obtained from the Asian Development Bank in 1974, 1978/79, and 1981/82, supplemented by other loans from the governments of Denmark and Norway and commercial loans from Australia and the United Kingdom -- totalling $120 million in all -- representing a very ambitious development plan. The immense interest of the Burmese Government in fisheries development is evidenced by the acceptance of 2 commercial loans, which usually carries severe restrictions in Burma, and the high priority accorded to shrimp fishery development, including the expansion of the collection system for and cultivation of freshwater prawn, which was the objective of the third Asian Development Bank loan.

The reasoning behind this plan was that, as an export product of high unit value, shrimp could earn valuable foreign exchange; that the resource was capable of further development; and that other fish species caught incidentally by shrimp trawlers could provide a source of animal proteins for the Burmese people.

Exports of prawn, fish, jelly fish, pearls, and other marine products are handled through the PPFC. Recent trends in volume and value are as follows:

Export of Marine Products

(Unit: Q'ty; ton, Value; 000 Kyat)

	78/79		79/80		80/81		81/82	
	Q'ty	Value	Q'ty	Value	Q'ty	Value	Q'ty	Value
Marine Fish	967.3	2,162.2	3,069.3	14,329.2	4,218	22,975.8	5,752	35,803.2
Prawn Freshwater / Marine	1,807.6	45,828.9	1,823.9	50,652.9	1,510 / 743	58,363.6	1,795 / 870	77,584.1
Jelly Fish	20.8	346.2	100	1,233.1	39.5	376.2	162.8	1,619.9
Others	49.8	418.3	160.2	1,715.4	-	19.9	37.5	790.3
Pearl*1	13,725	18,556.2	16,425	23,745	23,437.5	21,126.4	18,975	17,988.9

*1 Quantity of pearl is in gram and value is sales amount.

(Source: Notes on Fisheries in Burma, Min. of Agriculture and Forests, 1983, and others)

As this table shows, excluding pearls, prawn accounts for some 70% of fishery exports and, among shrimp exports, in terms of weight, freshwater prawn -- i.e., giant freshwater prawn -- are more than double those of marine prawn.

In order to further expand the exports of marine products and earn additional foreign exchange, the PPFC, starting in fiscal 1982/83, instituted a new basket sales system for customers who buy on annual contracts, with a view to promoting exports of all fishery products, particularly prawn. Under this system, sales are made in lots of 200 tons, representing a combination of: freshwater and marine prawn -- 130 tons (65%); hilsa (*Hilsa ilisha*) 50 tons (25%); other marine species -- 20 tons (10%). The 35% component of other fish products represent supplemental exports above the levels that would otherwise have obtained. The most important facet of this program will be how to expand the supply of exportable prawn so as to expand overall fishery exports.

With regard to the expansion of marine shrimp production, by means of the above-mentioned commercial loans from Australia and the United Kingdom, it was decided to introduce double-rig shrimp trawlers along with new ice-making and refrigeration facilities. In addition, 10 - 23m shrimp trawlers were added through the loans from the Norwegian government.

Although some confusion was anticipated in certain quarters as a result of the sudden and intensive expansion of the scale of land and vessel facilities over a short period of time, it was felt that, over the longer term, there would be a steady increase in the production of marine shrimp, based on this increased catch capability.

As to freshwater prawn which comprise the main share of prawn exports, at present, the natural catch from the Irrawaddy Delta is collected at 6 main and 12 sub-stations and brought to Rangoon for processing.

In order to clarify the size of the giant freshwater prawn resource, it will be necessary to conduct detailed resource studies. But, at the present stage, it is safe to say that, judging by the width of the distribution area of this species, there need be no apprehensions regarding resource volume. By expanding the present collection system for giant freshwater prawn through an increase in the number of collection stations, it is planned to increase the volume going into export distribution channels. This program is also one of the objectives of the third Asian Development Bank loan.

In order to increase the production of freshwater prawn, entirely apart from the above program is the plan to cultivate the giant freshwater prawn -- one which has become feasible thanks to the establishment of seed production technology.

The giant freshwater prawn lends itself relatively well non-intensive aquaculture method. The application of this system has the advantage of being simply an extension of the traditional fish cultivation techniques that have been long used in Burma.

In the case of the collection system being used in the Irrawaddy Delta area, in view of the absence of road or rail transport, a considerable period of time is required between catch and processing, due to the need to transport the prawn on refrigerated vessels. However, in the case of prawn culture, there are suitable areas right within the vicinity of the Rangoon district, while many existing fish culture farms can be converted to the raising of giant freshwater prawn. As a result, we believe it is possible to produce prawn with the characteristics of controlled production system, which will result in the shipment of products meeting market requirements.

With a view toward increasing production of the giant freshwater prawn, which is an important contributor to foreign exchange earnings, the PPFC is planning to rely on cultivation methods which present no future resource problems. To this end, it is planned to further develop the already established seed production technology and rapidly establish a system under which a large and stable supply of seed can be delivered at the required time.

2－3 Outline of the PPFC Aquaculture Program

In this section we shall discuss in outline form the PPFC Freshwater Prawn Culture Program and note the degree of progress that has been achieved as of May, 1983.

2－3－1 The Program Outline

(1) Objective:

The objective of this Program is to establish 4 seed production centers for giant freshwater prawn during the Fourth Four-Year Plan period along with 6 culture farms, with a view to promoting cultivation of this species and ultimately earning foreign exchange from exports of the cultivated product.

(2) Scale and Planned Locations:

Seed Production Centers:

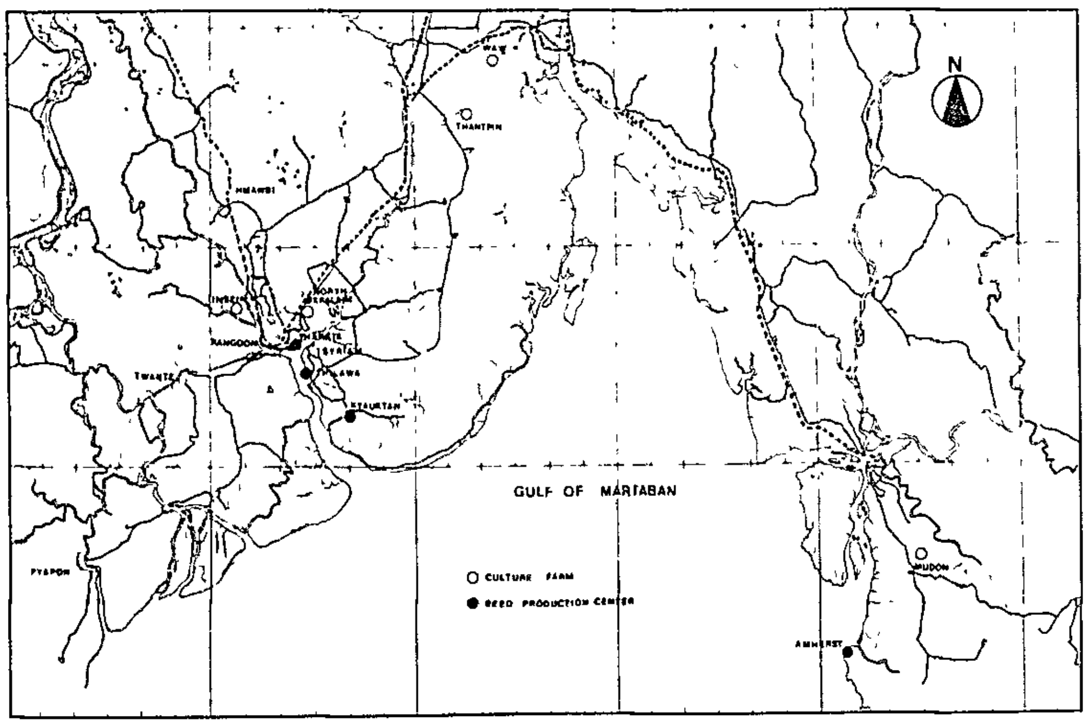
Each seed production center is to produce a total of 10 million seeds annually. The four locations selected, shown in order of construction priority, are as follows: Kyauktan, Thaketa, Thilawa, and Amherst.

Culture Farms:

Each of the culture farms will be comprised of 3 units of cultivation ponds (covering 60 ha), with each pond unit to be 20 ha (50 acres) in total area. Each farm will produce 75 tons of mature prawn per year. The farms are to be built at the following six locations and are expected to produce a combined 450 tons of giant freshwater prawn per year.

Thanatpin, Hmawbi, N. Okkalapa, Insein, Waw, and Mudon.

The locations of the above facilities are shown on the following map.



2-3-2 Current Status of the Program

(1) The Kyauktan Seed Production Center:

Kyauktan is reached by ferry from the central Rangoon pier to Syriam, following by a 30-minute drive of about 20 km. The site for the facility is about a 10-minute walk from the end of the paved road leaving Kyauktan to the south; it is about 6 ha, fronting on Hmaw-won Creek.

The main facilities are to include: 4 seed production buildings; one office/research bulding; reservoir ponds (of 0.2 ha each) for fresh and brackish water; a concrete pond, covered by a roof, as a storage area for brackish water (0.1 ha); a pond to breed adult prawn (0.2 ha); a dormitory, warehouse, generator, air blower and other facilities.

Of the above, as of mid May, 1983, excavation had been completed for one 0.2 ha pond, and basic materials (brick and steel bars) have been brought in for the construction of one seed production building (with a capacity of 2.5 million seed) and the office/ research building. Construction of these buildings is slated to start in mid-October after the end of the rainy season.

(2) The Hmawbi Culture Farm:

The Hmawbi culture farm is situated about 50 km by land north west of central Rangoon -- a bit over an hour's drive. The plan calls for the construction of 3 units in all. Each unit will consist of 18 culture ponds (of 1 ha each) and 9 intermediate culture ponds (0.5 ha each) for a total area of 22.5 ha (50 acres) per unit.

In March, 1983, construction was started on 5 of the 1 ha ponds and on 2 of these, excavation is almost completed. At present, the excavation work is being done almost all manually but, with the end of the rainy season, 3 large-size bulldozers and 1 scraper will be brought in and, with the exception of the water-gate works to be completed after next year's rainy season, the excavation work on one cultivation unit should be completed by March, 1984.

For freshwater supply, the facility will not rely on irrigation water, which is subject to pollution by agricultural chemicals and fertilizers, but will build a natural reservoir of about 6.5 ha for this purpose.

(3) The Thanatpin Culture Farm:

Thanatpin is located about 100 km by highway from Rangoon, just over 2 hours by car. The farm is in a low lying area, where large pools of water remain during the rainy season. Rice paddies in this area have low productivity and so have been converted to the new facility. Construction started in 1982 and already eight 0.25 acre ponds and three 0.5 acre ponds have been completed, with cultivation operations now underway on part of the facility.

Prior to the onset of the 1984 rainy season, it is planned to complete 11 1-ha ponds, 14 0.1-ha ponds, and four 0.2-ha ponds as well as the water channel from the Pegu-Sittang Canal. This construction is currently in progress.

In September, 1982, using rainwater, 18,800 juvenile prawn were released into three 0.1 ha ponds. This was followed by another 15,000 seed released in December. The prawn were fed a formula of 2-parts rice bran and 1 part groundnut cake once every 2-3 days. In May, the harvest taken from 1 pond was about 100 kg. (release density = 111,000 pc/ha ≑ 44,500 per acre; for a harvest of 100 g per m^2).

With respect to the remaining facilities, work is still progressing on site selection and land acquisition, but, at the present time, funding has not yet been provided for construction at any of these locations.

2-4 Environmental Conditions for the Cultivation of Giant Freshwater Prawn in Burma

In this section, we shall describe the environmental conditions in Burma affecting the cultivation of giant freshwater prawn as planned by the PPFC, from a discussion of the availability of suitable sites through distribution of the final product.

(1) Availability of Suitable Sites:

A water temperature of 25-30°C is required for the cultivation of giant freshwater prawn in freshwater. In the Rangoon area, during the months of lowest temperatures (December - January), water temperatures may fall somewhat below the 25°C level, but otherwise they are in a quite suitable range for the raising of this variety*1.

When water can be drawn directly from rivers and creeks, there is no problem obtaining the requisite amount of water, but, when reliance must be placed on rainwater, during the dry season from November through April inclusive, either the stocking density must be lowered and the cultivation done in stagnant water, or a reservoir must be built to maintain the required rate of flow during this dry season.

Even where using irrigation water, it is essential to continually verify the volume of water distribution during the dry season and pay special attention to the fact that crustaceans, unlike other fish species, are invertebrate and therefore vulnerable to the infiltration of agricultural chemcials.

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*1 Seasonal Variation on the Hydology of Fish Culture Pond and Ngamoeyeik River at Thaketa Research Station, PPFC Research Report No.6, 1981, Oceanography Research Symposium, Jan., 1982.

As of 1981/82, utilization patterns for Burma's total land area of 67,660,000 ha, were as follows: under cultivation -- 12.3%; lying fallow -- 2.6%; cultivable -- 12.6%; forest -- 47.4%; other uses -- 25.1%*1.

Since 1977/78, irrigated land area has been held at some 12% of total land under cultivation. And, in terms of the number of crops per year, most land is single cropped; double cropping occurs on only 15-18% of total land presently under cultivation. From the above, we can judge that the intensity of land utilization in Burma is proceeding at a relatively leisurely pace and that, consequently, there should be no difficulties in finding suitable sites for giant freshwater prawn culture farms from the land area now under cultivation (854,800 ha [12.6%] of the country's total land area.)

In most cases, sites suitable for freshwater fish culture are those of low agricultural productivity. Forthermore, since there are an estimated 15 million ha of ponds used for fish prawn farming in Burma, we can conclude that there is an ample supply of land suitable for the cultivation of giant freshwater prawn in the country.

(2) Feed:

Giant freshwater prawn have strong omnivorous characteristics so that traditionally available materials that have been used for fish culture, such as rice bran and groundnut cake, can be used as feed. While higher growth rates might naturally be expected from the use of mixed feeds with a higher protein content, since the giant freshwater prawn is a spunky creature and devour one-another, they tend to stay in a fixed territory. As a consequence, they do not lend themselves to intensive, high-density cultivation techniques and so there is little merit in cultivating prawn through the use of formula feeds

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*1 Report to the Pyithu Hluttaw 1982/83, Min. of Planning and Finance, 1982.

using high protein meal, which are scarcely produced in Burma at the present time.

With regard to the raising of giant freshwater prawn, when feeding them a blend of 3 parts rice bran and 1 part groundnut cake, based on experiments to date, a feed ratio of about 0.2 can be expected. Thus, the amount of feed required to cultivate 450 tons of freshwater prawn, as called for by the PPFC Program, may be estimated as:

450 tons ÷ 0.2 = 2,250 tons.

This means a new demand for about 1,690 tons of rice bran and 560 tons of groundnut cake.

Total domestic consumption of rice in Burma was 5,479,000 tons: in 1980/81 and 5,611,000 tons in 1981/82*1.

We may estimate this to be 9.13 million to 9.35 million tons of paddy equivalent. If we further assume that from one unit of paddy, 8% of rice bran can be extracted, we may conclude that the total production of rice bran within Burma is in the order of 700,000 tons annually.

The annual production of wheat in Burma is about 110,000 tons, but the mill by-product from this wheat has not been included in the calculations of feed supply for aquacultural purposes.

The total production of groundnut in Burma came to 430,000 tons in 1980/81 and 558,000 tons in 1981/82.

The amount of groundnut used to extract oil is not known but, if we assume that about 90% goes for this purpose, then the total amount of groundnut cake produced each year may be estimated at

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*1 Report to the Pyithu Hluttaw 1982/83, Min. of Planning and Finance, 1982.

between 120,000 - 150,000 tons. Other oil seeds produced in Burma include: sesame (167,000 in 1980/81), sunflower (450,000 tons), and cotton seed (107,000 tons), and the oil cake from these varieties too can probably be used as feed for the shrimp project.

In the future, there will of course be a need to conduct proper research on feeds for giant freshwater prawn cultivation that are richer in proteins and cheaper than those using locally available ingredients but, for the time being, there are no problems at least with regard to the supply of rice bran and groundnut cake, which are the prime target feed materials for the project.

(3) Aquaculture Technology:

The experimental cultivation of giant freshwater prawn on a commercial scale in Burma began during 1982. At 5 test ponds of 0.04 - 0.5 acre each, where the release density was 8.4 - 17.3 shrimp/m^2, the culture period covered 8 - 11 months, and the feed given was almost entirely rice bran, production of 20 - 140 g/m^2 was achieved, for an average of 78.7 g/m^2.

At 2 of the above 5 test ponds, predetors were observed in the ponds which resulted in extremely poor harvests. But, excluding these 2 ponds, the average at the other 3, where the release density was 16.24 shrimp/m^2 and the total culture period was 10.5 months (weighted average), a production volume of 132 g/m^2 was attained. From these results, it is clear that, notwithstanding the fact that there are many ways in which cultivation technology can be improved in the future, essentially production can be done with non-intensive culture method by applying to the culture of freshwater prawn the pond culture technology that has been widely used in Burma for carp cultivation.

Let us next compare, from the standpoint of land productivity, a harvest of 100 g/m^2 from the non-intensive cultivation of giant freshwater prawn over a 10-month period with that obtainable from rice cultivation. In fiscal 1980/81, the Government's buying price for rice was 10.6 kyat per basket (20.9 kg) for the first grade, while the average yield per acre for rice was 53.8 baskets. If we now on this basis, calculate the production value per m^2 of land, we obtain 0.142 kyat for rice cultivation.

In the case of freshwater prawn in the absence of a Government buying price, we may apply the present estimated buying price of 16 kyat per viss (1.633 kg) for medium-sized shrimp at the sub-stations under the collection system established for giant freshwater prawn in the Irrawaddy Delta area. Since a yield of 100g of prawn production per m^2 may be expected, the production value per m^2 comes to 0.737 kyat. Even assuming double cropping for rice, it is apparent that, on land suitable for both prawn cultivation and rice farming, the prawn operation represents a better return on land use.

From the above findings, we believe it would be best from the standpoint of both techniques and land productivity, to adopt the non-intensive culture method for the cultivation of giant fresh-water prawn in Burma. Accordingly, we can conclude that the existing techniques of fish farming can be applied to the prawn project.

(4) Seed Supply System:

The establishment of a supply of seed in large volume based on artificial seed production is a prerequisite for the development of prawn culture. In the case of carp culture, which is widely practiced throughout the country, some 7.5 million seeds, mainly of Indian carp, were being distributed in 1981/82*1.

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*1 Notes on Fisheries in Burma, Min. of Agriculture and Forests, 1983.

The production of artificial seed for giant freshwater prawn culture was first successfully accomplished in Malaysia in 1962 and subsequently was extended to other parts of the world. In Burma, research was initiated in 1977 and, in 1980, the first commercial experiments were carried out by the Research Division of the PPFC which succeeded in producing 1,400 post-larvae in that year. Then, in 1981, using a 5-ton tank, about 190,000 post-larvae were produced, followed by 500,000 in 1982. Thus, within a short period of research activity, a reasonable level of seed production of giant freshwater prawn has been achieved.

Of course, many problems remain to be solved. For example, at the present time, seed production is relying on the supply of parent prawn bearing eyed egg from natural catch and so making it difficult to obtain supplies of parents during the December-February period, when spawning prawn cannot be taken in their natural habitats. Furthermore, the period through which the larvae metamorphose into post-larva stage is relatively long and the development of high nutrient feed becomes necessary. Nevertheless, it has been demonstrated that this variety of prawn has strong omnivorous characteristics and can easily be cultured and also lends itself well to non-intensive culture. Accordingly, the demand for seed for cultivation is increasing steadily, making it imperative that a structure be speedily established for the large volume supply of seed.

(5) Distribution of the Final Product

Giant freshwater prawn is widely distributed on the Burmese market. Since it is taken in freshwater areas, this variety of prawn, particularly in the Rangoon area, has become part of the diet of the general population and so has a firm demand base. In this respect, it may be said to have a slightly different market structure from that of the typical overseas market, where the product is distributed as a high-grade premium fish product.

Based on our inspection of the Rangoon fish market, the sale of sea-water shrimp is quite small; the overwhelming portion of the supply is the fresh-water variety.

Within the city of Rangoon, there is a central fish market called the Keighley Market, located in Keighly, supplemented by 4 smaller markets. Since data on the volume passing through these markets were not obtainable, accurate data on current distribution volume by species cannot be presented. However, based on 1975 data, distribution volume on these markets broke down as follows:

Freshwater fish	13,387 kg
Marine fish	7,161 kg
Crustaceans	10,523 kg
Total	31,071 kg

(Source: Notes on Fisheries in Burma, Ministry of Agriculture and Forests, 1983)

These data show the special characteristics of the Burmese retail fish market. We see that the volume of freshwater fish on the above market is about double that of marine species and that crustaceans comprise some 50% of the total volume of all fish.

As of May, 1983, retail prices for freshwater prawn were as follows: large size with a high degree of freshness -- 42 kyat per viss (1,633 kg); small size with a low degree of freshness -- 30 kyat per viss.

In marine shrimp, prices of small size white ran 34 kyat /viss; medium size black tiger shrimp 50 kyat . Thus, little difference is seen in the prices of freshwater and marine shrimp. However, it should be noted that, in the case of freshwater prawn , the March - June period -- the latter part of the dry season -- is traditionally a period of rapidly rising prices. (Our survey took place during this period.)

According to the PPFC Program, cultivated giant freshwater prawn are to be exported in frozen form. In 1980/81, the PPFC exported 1,510 tons of this variety; 1,795 tons in 1981/82, and 1,120 tons in 1982/83. Style of pack is not clear but, on a raw weight equivalent, product utilization may be postulated as follows:

... 10% with heads
45% headless with shells
5% meat only
5% heads only (for domestic distribution)
35% discards

From the above data, we may presume that 2,516 tons of raw material were processed in 1980/81, 2,991 tons in 1981/82, and 1,866 tons in 1982/83. These shrimp are processed in the PPFC plant in Rangoon but, at present, construction is proceeding on an ice making plant and a refrigerator with capacities of 50 tons and 600 tons respectively. Barring a sudden increase in culture production, the existing processing facilities can be used.

Export markets for giant freshwater prawn include: Thailand, Singapore, Hong Kong, with Singapore in particular assumed to be reexporting the prawn to markets in the U.S. and Europe. According to the PPFC, the FOB price for freshwater prawn (for export) in 1981/82 was U.S. $3,000-3,500/ton. As of March, 1982, the price of freshwater prawn on European markets (C & F Europe) was U.S. $3.20 per pound for 21/25 grade (medium size) headless, block; and $3.15 for 31/35 grade (smaller size).

On the U.S. market, prices C & F U.S.A. were: $3.25 for 21/25's and $2.45 for 31/40's *1.

*1 INFO Fish Trade News, INFO Fish, March 3, 1982.

Judging by the market price of $7,000/ton for medium-sized prawn and $5,400-6,900/ton for small, the FOB prices of the PPFC are seen to be close to the bottom end of the range.

From the above, we see that Burma has developed established sales channels for freshwater prawn for both the home and export markets. With particular reference to cultivated prawn, since the PPFC Program, in return for supplying seed, to buy back the grower's entire production and place this on the export market, it would seem that, so long as the share of this cultivated prawn remains at no more than 10-30% of the naturally caught product, there should be no problems with regard to product distribution.

SECTION 3 CONTENTS OF THE PLAN

3-1 The Plan and Japan's Cooperation

As shown in Section 2-4, it was made abundantly clear that the most urgent matter requiring solution for the proper development of the PPFC Program is the establishment of an adequate supply of seed.

For the interim, the PPFC is planning to construct at Kyauktau a seed production center with a capacity of 2.5 million post larvae. However, this volume will not even cover the requirements of the 40 ha shrimp cultivation facilities being built by the PPFC at Hmawbi and Thanatpin.

In addition to Kyauktan, the PPFC is planning to contruct seed production facilities at Thaketa, Thilawa, and Amherst. As of May, 1983, the construction site had been finalized at Thaketa, but, at the other two locations, a final site determination had not yet been made.

Thaketa is one of the 27 wards of the city of Rangoon and so power supply, access roads, communications, and other amenities are superior in many ways to those at Kyauktan. However, Thaketa is further from the sea than Kyauktan (42 km, as the crow flies, vs. 23 km.) And, in terms of the salinity of the brackish water required for seed production, a top value of 25ppt is available at Kyauktan, vs. only 19ppt at Thaketa. In the case of seed production for giant freshwater prawn, brackish water with a 10-12ppt saline density is sufficient for roughly 50 days from hatching to the post-larva stage. Thus, there are no technical problems involved in diluting the original brackish water with freshwater and establishing a reservoir matched to the density of the original brackish water.

With regard to the distribution of the seed produced at Thaketa, the transportation infrastructure is much superior to that at Kyauktan.

At present, PPFC is proceeding with the construction of the seed production center at Kyauktan as well as of the prawn culture facilities at Hmawbi and Thanatpin, and construction is expected to progress on schedule.

In order to produce a stable supply of high quality seed, it is essential, during the period from hatching to juvenile prawn, to provide equipment that will insure good water circulation and air supply so as to maintain high water quality. There is also a requirement for measuring equipment to monitor the health of the prawn and the environment of their habitat.

It may be assumed that, at the Hmawbi and Thanatpin facilities, a non-intensive culture system will be used in the early stages. However, if production efficiency is to be imporved in the future, there will be a need to conduct cultivation experiments and establish more effective cultivation methods through the use of pumps to insure a constant change of water, aerating facilities to increase dissolved oxygen, and equipment for the experimental production of food high in nutrition and low in cost.

But, since the PPFC would have to expend foreign currency for almost all of the above types of equipment needed to support a program of technical development and the creation of an adequate production structure, given the current critical state of the country's exchange reserves, it is hardly likely that such equipment could be provided at the required time.

In view of the above, Japan's cooperation in the form of grant aid to help develop the PPFC Program will include the construction of a seed production center at Thaketa and the provision of equipment for the facilities at Kyauktan, Hmawbi, and Thanatpin. The overall objectives of this cooperation -- viz., to increase the supply of seed in Burma and contribute to the future general upgrading of the cultivation system -- are deemed to be most appropriate.

3−2 Project Policy

3−2−1 Size of the Seed Production Facility

The scale of the seed production facility required to achieve the project objectives, as outlined in the previous section -- viz., an increase in seed supply -- will be established, based on the pond cultivation area that will be available for freshwater prawn cultivation starting in 1984.

The facilities in Burma which will be available for freshwater prawn cultivation include:

(1) the six culture farms (of 150 acres each) that are ultimately to be built specifically for prawn cultivation by the PPFC in various parts of the country;

(2) certain existing fish ponds of the PPFC that are to be shifted over to the cultivation of freshwater prawn;

(3) those ponds slated to receive seed distribution under the so-called 100 pond project -- i.e., involving the construction of 100 ponds of 1.25 acres each, which is being developed by cooperatives in the various Divisions.

(4) Other existing private facilities.

We will eliminate Group (4) from our calculations. These are facilities which are at present accorded a low priority and for which demand would be quite difficult to project. Our demand assessment will, therefore, be based on the facilities shown in Groups 1, 2, and 3.

1. The Freshwater Prawn Culture Farms of the PPFC

Among the 6 prawn culture farms being planned nationwide by the PPFC, construction is in progress at only two locations: Hmawbi and Thanatpin.

The size of facility at each of these locations will ultimately comprise 3 units totalling 150 acres (60 ha), with each unit comprising 50 acres (20 ha). At present, however, only 1 unit is being built at each site, and these will be available starting in about 1984. The pond areas for these facilities are as follows:

At Hmawbi ----	20 ha
At Thanatpin -	20 ha
Total	40 ha

2. Existing Fish Culture Ponds of the PPFC

The PPFC operates fish ponds spanning 518 acres (217 ha). At these facilities mainly Indian carps are raised. Most of these facilities are large in scale, such as the Twante facility, which contains 16 ponds of 18.5 acres (7.5 ha) each.

It is planned to shift a certain number of the above facilities over to the cultivation of freshwater prawn which offer higher returns than existing species. These are facilities relatively convenient to Rangoon in which pond size is small and easy to manage and so quite appropriate for prawn culture. The specific facilities are as follows:

Ma-u-bin, Irrawaddy Div.	9.3 ha
Insein, Rangoon Div.	13.9 ha
Amarapura, Mandalay Div.	32.4 ha
Total	55.6 ha

3. Ponds Belonging to Cooperatives:

This is a project being developed by the Ministry of Cooperative whereby aquaculture is to be introduced under the supervision of cooperative members via the construction of 100 ponds of 1.25 acres (0.5 ha) each.

The original objective of these ponds was to be fish culture but, using seed distributed by the Research and Development Branch of PPFC for the experimental cultivation of giant freshwater prawn, excellent results were obtained at ponds of the Latpandan Coop, and so a decision was made to shift over to prawn cultivation offering a higher return than fish species.

This project is now underway. If we confine our targets to those areas in which pond construction is being carried out by cooperatives with particular zeal, we have:

Letpadan, Pegu Div.	30 ha
Taungoo, Pegu Div.	30 ha
Total	60 ha

Combining the above three groups, the total pond area that can initially be potentially devoted to the cultivation of giant freshwater prawn comes to 155.6 ha. Since the relative densities presently being planned by the PPFC are in the order of 75,000 to 100,000 prawn per hectare (7.5 - 10 prawn/m^2), the seed requirements for this acreage work out to 11,150,000 - 15,400,000 seed. Estimating the cultivation period at 10 months, these estimates can, for the time being, be considered as the total annual seed requirements for the target areas.

The seed production capacity at Kyauktan that is being developed by the PPFC is 2.5 million prawn. This means that there will be a supply shortfall of some 9.0 million to 12.9 million prawn.

Seed production is quite different from that of industrial products. It is affected by many production variables which, pose both constraints and problems. As a consequence, some leeway is called for vis-a-vis production targets. In this report, we have provided for an annual production of 10 million prawn at the Thaketa seed production center, a very efficient production run for a single facility which will almost cover the seed production shortfall estimated above.

3-2-2 Method of Seed Production

The seed production of giant freshwater prawn may be divided into four stages:

(1) obtaining of parent shrimp; (2) raising of the shrimp in brackish water from hatching to post-larva stage; (3) raising in freshwater from post larva to seed size; and (4) seed harvest and distribution to culture ponds.

We shall now discuss the plan to produce 10 million seed a year in terms of these four stages. General life history of giant freshwater prawn is shown in Appendix (xiv) for reference purpose.

(1) Obtaining of Parent Shrimp:

Experimental aquaculture has already been carried out in the Thaketa area. Thus, a channel has been developed whereby the PPFC Research Station calls on fishermen to collect berried female prawn, and healthy female with eyed eggs are selected and purchased as parent prawn. Thus, there is no major problem in obtaining natural supplies of parent prawn in the required quantities. However, during the December - February period, since berried prawn cannot be caught, it is not possible to obtain parent prawn.

Natural prawn weighing over 50-60 g are selected as parents. From this size parent, 50,000-60,000 larvae can be hatched. Thus, the number of adult prawn required to produce 10 million seed, based on a 30 - 35% survival rate from hatching to seed size, would be 480 - 660. Dividing the production cycle into 2 periods (March - June and July - October) and, with a planned production of 5 million prawn during each period, a supply of 240 - 330 parent prawn in both March and July would be sufficient.

Considering the future possibility of a contraction in prawn supply in Burma, due to industrialization, the ecological impact of agricultural chemicals and industrial waste water, and the depletion of the resource due to over fishing, it will be vital to set up a system assuring self-sufficiency in parent prawn via the use of breeder stock ponds within the seed production facility. For this purpose, there will be a need for 2 breeder stock ponds, of 1,000 m^2 each with a water depth of 1 - 1.5 m. If 1,500 male and 4,500 females are continually raised in the two ponds combined, some 100 parent prawn can probably be secured per month.

Even during the December - February period, when a natural source of breeder cannot be expected, if a technology can be developed for producing parents artificially in breeder stock ponds, it will be possible to assure year-round seed production.

(2) Raising in Brackwish Water from Hatching to Post Larva:

The female prawn so secured are stored in brackish water adjusted to a salinity of 10 - 12 ppt. In the case of healthy female with eyed eggs, within 2 - 3 days larvae will be hatched. If the larvae are raised in brackish water of the above salinity, within about 30 days after hatching, they will start to metamorphose into the post-larva stage, and the entire post-larva process will be completed within about 50 days. During this period, daily supervision will be required -- feeding the nauplii of brine shrimp (Artemia salina) and formula feed, eliminating left-over feed, and changing the water.

To produce 5 million seed per cycle, a survival rate of 75% from post larva to seed size can be presumed. Thus, total of 6.7 million post-larvae must be produced. To attain this target, the following production method would, in our view, be most appropriate.

First, place 2 - 3 breeders in the rearing tank, filled with water 30 cm deep adjusted to a 10 - 12 ppt salinity; this will provide an average hatch of 120,000 larvae. While many sizes of rearing tank can be considered, given the increased efficiency that can be realized by conducting feeding operations from hatching through seed size in the same tank as well as the added convenience of one tank for feeding and cleaning, we feel a concrete tank 1.5 m wide, 5 m long, and 1.2 m deep would be most suitable.

From larva to post-larva, the yield, based on past achievements in Burma, should be about 44%; on this basis, in order to obtain 6 - 7 million post-larvae, 128 tanks of the above size would be required.

Up to the 9th day after hatching, if only left-over dirt is removed from the tanks without changing the water, then fresh brackish water must be introduced and the water level raised 5 cm per day. By the 9th day, the water depth will thereby reach 70 cm (5.25 tons per tank). From the 10th day on, water volume should not be further increased, and the water should be changed after removing the dirt. If the rate of water turnover is set at 10% per day, then, with a total water volume of 5.25 tons per tank, the required volume of brackish water becomes 0.525 tons/day; at 20%, 1.05 tons/day.

If the above breeding method is adopted, the total brackish water requirement through day 50 -- the period from the end of hatching to post-larva -- can be calculated as per the following table. Based on this table, for all of the 128 tanks, 6,180 tons of brackish water would be required at a 20% water turnover ratio. A 10% turnover rate is the absolute minimum; for a well-functioning seed production program, the higher the rate, the better.

Estimate / Volume of Brackish Water Required for Production of Giant Freshwater Prawn Seed

No. of day	Tank water depth (cm)	Rate of water change (%)	Daily amount required (tons/1 tank)	Total daily amount required (for per 128 tanks)	Accumulated volume (tons/128 tanks)
1 (hatching)		30	2.25	288	288
2		35	0.375	48	336
3		40	0.375	48	384
4		45	0.375	48	432
5		50	0.375	48	480
6		55	0.375	48	528
7		60	0.375	48	576
8		65	0.375	48	624
9		70	0.375	48	672
10	20 (10)	70	1.05 (0.525)	134.4 (67.2)	806.4 (739.2)
11	20 (10)	70	1.05 (0.525)	134.4 (67.2)	940.8 (806.4)
12	20 (10)	70	1.05 (0.525)	134.4 (67.2)	1,075.2 (873.6)
:	:	:	:	:	:
50	20 (10)	70	1.05 (0.525)	134.4 (67.2)	6,182.4 (3,427.2)

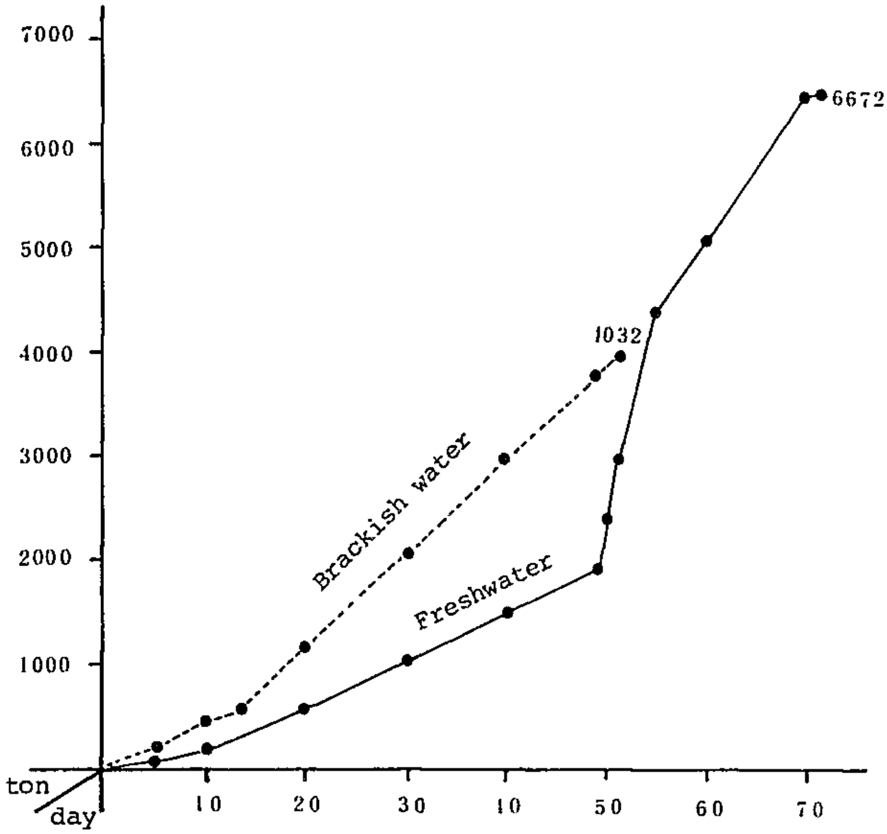
Note: Figures in ( ) show value based on a 10% water change.

The water in the Pegu River, on which the project site fronts, has a salinity of 10 ppt or less during the May - December period. During the June - October rainy season in particular, this value falls to almost zero. For this reason, we deem it vital, for purposes of rearing larvae, to siphon off brackish water during the January - April dry season for storage in a reservoir, to be drawn on during the rainy season.

Two reservoir ponds would have to be constructed for this purpose -- one open pond with a capacity of 7,500 tons or over and one roofed pond with a capacity of 2,500 tons or over. During the March - April period, the salinity of the water in the Pegu River rises to 19 ppt and, after introducing this water into the reservoirs and letting it lie stagnant for about 10 days to give the sediment a chance to settle, the clear top water is transferred to the concrete reservoir and kept there as a source of brackish water for production of seed during the rainy season.

When brackish water is again introduced into the exposed reservoir and the sand is allowed to settle, this is diluted to a suitable level of salinity for use in producing seed during the dry season. Under this reservoir plan, since 7,000 tons or more of brackish water can be used during the dry season, it is possible to increase water turnover to 20% or more.

In the rainy reason, on the other hand, the 2,500 tons of 19 ppt salinity brackish water stored in the roofed concrete reservoir is diluted 1.5 times, yielding 2,750 tons of brackish water. This insures at least a 10% water turnover ratio. But, to secure a higher ratio to guard against a deterioration in the health of the prawn or other unusual conditions, it would be desirable to recover breeding water that has been drained from the rearing tank, through filteration and water recycling system. Under this production method, the respective amounts of brackish and freshwater required for the production of 5 million prawn per cycle would be as shown in the following figure.



Since we can expect 10,000 post-larvae production per ton of breeding water, this works out to 52,500 larvae per tank and 6,720,000 larvae overall. In this instance, the survival rate from hatching to post-larva works out to 43.8%, a figure that is more than feasible under the present level of technology being used in Burma. If the above production pattern is repeated, the required post-larva production of 13,400,000 can be attained.

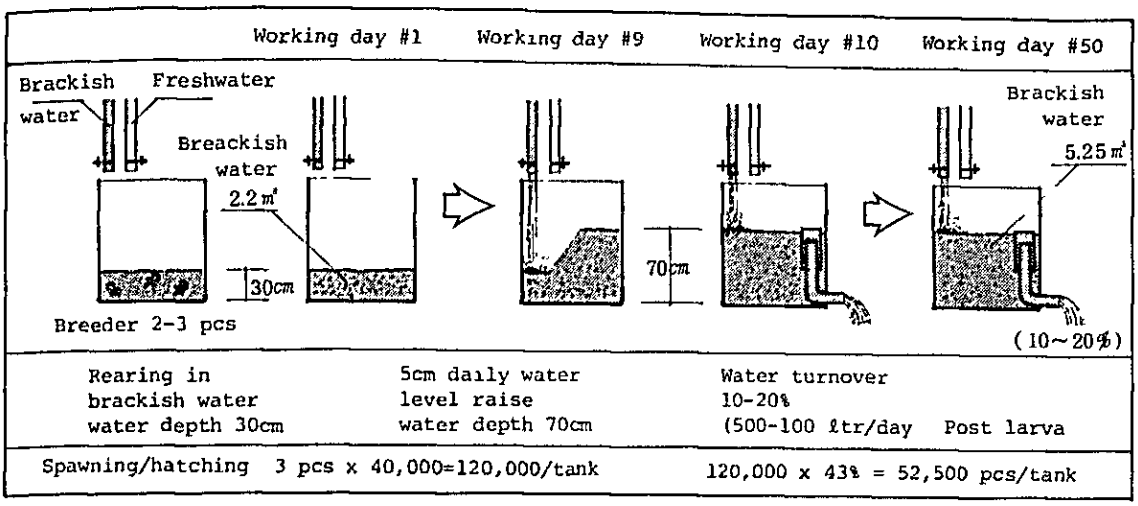
(3) Breeding in Freshwater from Post-Larva through Seed Size

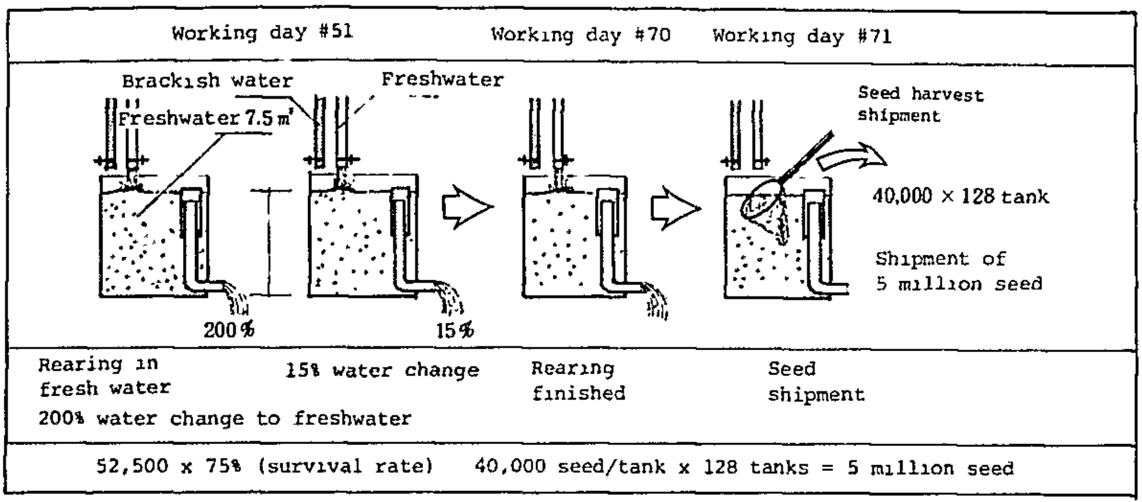
When the larva in the rearing tank have almost all become post-larva, this water should be gradually made fresh. At the same time, the depth and volume of the breeding water should be increased from 70 cm (5.25 tons) to 100 cm (7.5 tons), while breeding density should be lowered to 7,000 / ton. For the next 20 days, feed should be given, the dirt removed, and the water changed daily, thereby rearing the prawn to a seed size of 1.5 - 2.0 cm body length.

During the rainy season, freshwater can easily be taken in, obviating problems with respect to breeding during this period. However, during the dry season, freshwater cannot be taken in, so a freshwater reservoir is required. This should be an exposed earthen pond of 7,000-ton capacity. If this water is stored during October - November, when it can be obtained from the Pegu River, an adequate change of water will be possible during the dry season as well in the 128 7.5-ton tanks.

During the freshwater rearing period, the survival rate is about 75%. Since a production of 5,000 - 5,500 seed prawn per ton of breeding water is feasible, a production of 40,000 in each 7.5-ton tank can be achieved. In short, with 128 7.5-ton tanks, a production of 5 million or more is possible during both the dry and rainy seasons, permitting the annual production target of 10 million seed to be reached.

The following chart shows the breeding stage from hatching to seed size.





(4) Seed Harvest and Distribution to Culture Ponds

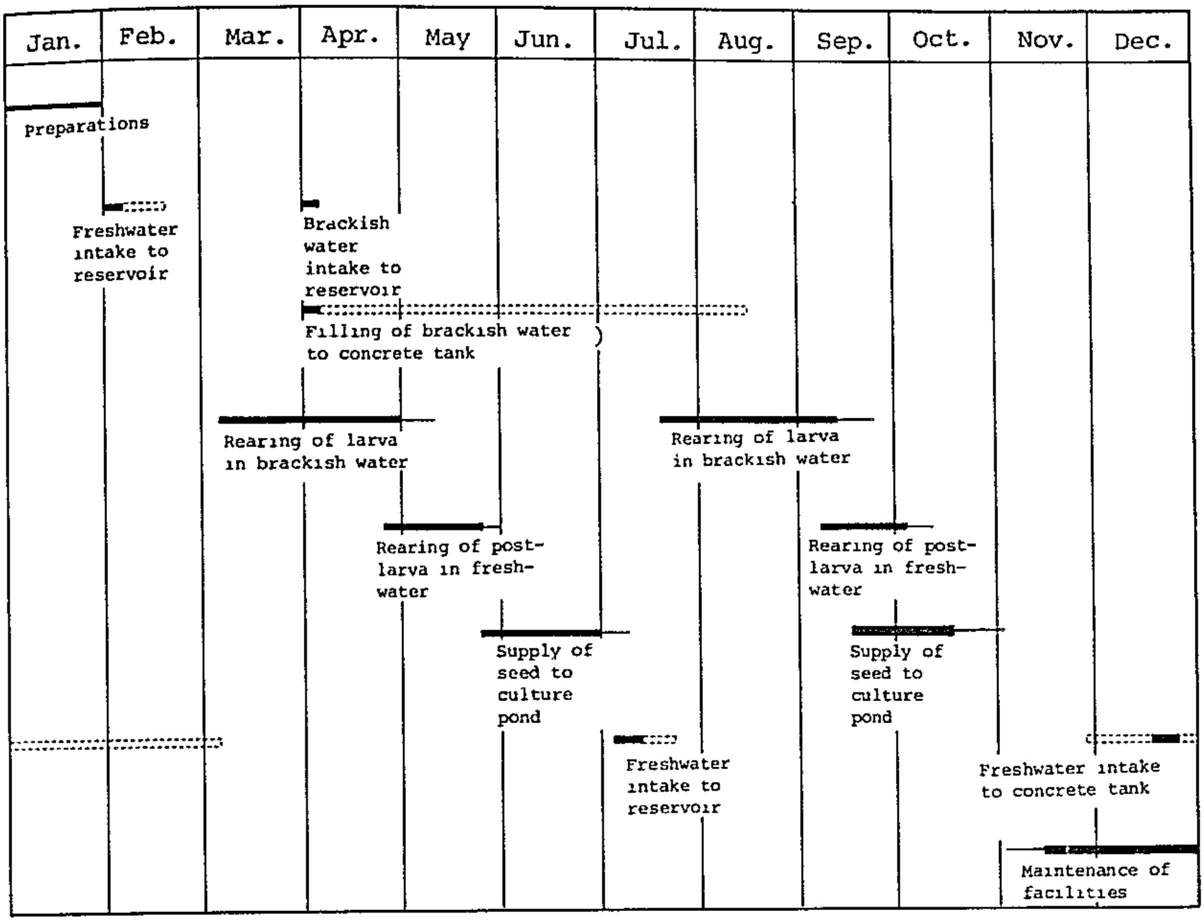
After the prawn have reached seed size, the volume of water in the breeding tank is reduced by means of a siphon or drainage pipes. The prawn are then recovered by a small scoop net. The prawn remaining in the tank can be recovered by applying a net through the drainage pipes while draining out the remaining water.

The harvested seed are sealed with water and oxygen gas in a vinyl bag or put into a live-fish transport tank capable of supplying oxygen gas and then distributed to the various culture ponds.

Under the former method, 100 - 300 seed prawn can be stored per liter of water, and they can be transported for up to 24 hours. Under the latter method, up to 300,000 seed prawn be stored per ton of water, and transport is possible for up to 6 - 7 hours.

Based on the above described seed production methods, we have developed an annual operating plan, as shown on the following page.

During January, preparations are made for the year's operations. During February - March, brackish water is taken in and stored for use during the rainy season. From the first part of March through the dry season, seed production begins on the first lot of 5 million, and distribution of these is virtually complete by June. Starting in early July, production begins on the second rainy-season cycle of 5 million seed, and distribution of these seed is completed by the end of October. November and December are a time for tidying up after the year's activities, storing freshwater for use during the coming year's dry season, and conducting maintenance checks on and making repairs to the facilities.



3-2-3 Feed for Seed Production

With respect to the feed used in the production of giant freshwater prawn seed, not only in Burma but in the world at large, technical skills can hardly be said to have reached their final levels. There are still many problems and areas that must be researched or developed. However, production is certainly possible even using the feed that is currently being fed in Burma. Thus, in the subject Plan, while production, during the initial stages, is undertaken with existing feeds, development and experimentation can start on new types of feed.

With respect to breeding during the hatching to post-larva period, the most important feed is the nauplii of brine shrimp (Artemia salina). To produce 13,400,000 post-larvae, some 70 kg of dried brine shrimp eggs would be required.

In addition to brine shrimp, another organism that can be immediately used is rotifer (Brachionus sp.), which, although not yet in use in Burma, has been successfully isolated and cultured by the PPFC research staff. And, in the future, water flea (Moina sp.), which has already been commercialized in Japan, can also be used in seed production.

To cultivate these feed organism, it would be convenient to provide a circular plastic tank of 500 ℓ. At present, apart from brine shrimp, the main feed materials being used in Burma during this stage are wheat flour, skim milk, and fish meal. Special formula feeds of these ingredients have been independently developed and are being used, supplemented by vitamins and minerals.

Judging by the amounts being currently used, almost 750 kg of formula feed would be required to produce 13,400 post-larvae.

For breeding from post-larva to seed size the feed currently being used is dried shrimp meal or dried fish meal. In our judgment, to achieve a production of 10 million seed, about 300 kg of these feeds would be required. To produce superior seed that is both larger and healthier, we would suggest the use of formula feed or the raw meat of fish and shellfish.

Required feed-related facilities would include: indoor concrete flooring capable of holding 24 circular plastic tanks of 500 ℓ each for use in the propagation of feed organisms; an airconditioned storage capable of storing brine shrimp eggs, ingredients for formula feed, manufactured formula feeds, and dried shrimp meal; a refrigerator for storing raw feeds; a feed preparation room for a feed mixer, a pellet maker, and drier; and a wet lab for experiments on the relative rates of growth based on the use of different feeds.

3-2-4 Seed Production Facility

From the above seed production plan, we may summarize, as follows the various facilities that will be required.

Seed Production Facility for 10 Million Seed

CATEGORY	SPECIFICATIONS AND NUMBER
1. Brackish water reservoir	Required volume 7500 tons, earthen, outdoor (1)
2. Concrete tank	" " 2500 " , concrete, roofed (1)
3. Freshwater reservoir	" " 7500 " , earthen, outdoor (1)
4. Breeding stock pond	1,000 m^2, depth-1.5 m, earthen, outdoor (2)
5. Elevated water tank	16-ton capacity for both fresh and brackish water; 2 tons for well water
6. Rearing tank	1.5m(W) x 5m(L) x 1.2m(D); concrete, with aeration, fresh/brackish water supply and discharge; 128 tanks, indoor
7. Mixing tank	50-ton in total capacity (2) -- for adjusting salinity
8. Filter tank	Overall filtering capacity of 25 tons/per hour or greater, with a filter size of 100μ, (2)
9. Microbe Culture tank	Fresh/brackish water supply/drainage (indoor)
10. Water recycling system	Filtering capacity of 100μ or larger, overall recycling capacity of 24 tons/hr or greater
11. Feed storage area	Air conditioned; 24 m^2
12. Refrigerator	Room temperature -5° --- +5°C; 10 m^3
13. Feed preparation room	Concrete floor; 32 m^2
14. Wet lab.	Concrete floor, with aeration; fresh/brackish water supply and drainage; 45 m^2
15. Equipment room	Air conditioned; 15 m^2
16. Deep well	2-inch, intake volume 3-4 tons / day (1)
17. Water intake facility	Water intake -- 11 tons/min.
18. Administration/ Lab building	341 m^2; director's room, office, library, other
19. Other related facilities	Water supply facilities (20 m^3/min); emergency geneator (75 KVA), others

3−3 Basic Design

3−3−1 Basic Policy

The basic design of the facility has been planned in accordance with the following basic policies:

(1) In determining the design, structure, and specifications of the overall plan and the individual facilities, we have given careful consideration to the natural and construction environment as well as to the local supply of materials.

(2) The plan is essentially in accord with the related laws and regulations, as presently in force in Burma.

(3) With regard to construction materials, since only a limited range of the materials are produced in Burma, with the bulk having to be imported, the main items will have to be sourced from Japan or a third country. We will, however, incorporate materials, such as timber and brick, which are produced locally in stable supply. We shall also integrate all materials with local construction methods.

(4) With regard to site utilization, we have planned this in such a way as to be able to respond suitably to future development.

(5) We have clearly set forth the functions of the various buildings and have provided the required space without waste and at the lowest possible construction cost.

(6) We have developed a plan of maximum simplicity for the related facilities -- one that lends itself to ease of operation and maintenance.

3-3-2 Functions and Size of the Facilities

(1) Functions

As shown in the seed production plan presented in the preceding section, the components of the various facilities may be broadly divided into the following 3 groups from the standpoint of facility planning:

1) Administration and Research:

This component is geared to management and operation of the overall facility as well as basic research and the storage of research equipment. The facilities include offices, conference room, wet lab, and library.

2) Seed Production

This component comprises the core of the operation, including: space for the hatching and rearing tanks to produce the seed; areas for the culture of feed organisms; a feed production room; and a refrigerator.

3) Water Supply and Distribution

This component will provide an adequate year-round supply of both brackish and fresh water. In order to accommodate the extremes in rainfall associated with dry and rainy seasons, we have provided reservoir ponds for both brackish and fresh water of an adequate storage capacity.

The water intake and distribution facilities comprise salinity adjustment tanks, freshwater and brackish water filters, and other water control facilities related to the above objectives as well as facilities for the intake of water from the Pegu River.

(2) Facility size

Based on the above functional group, we have set the following size or area for the each facility.

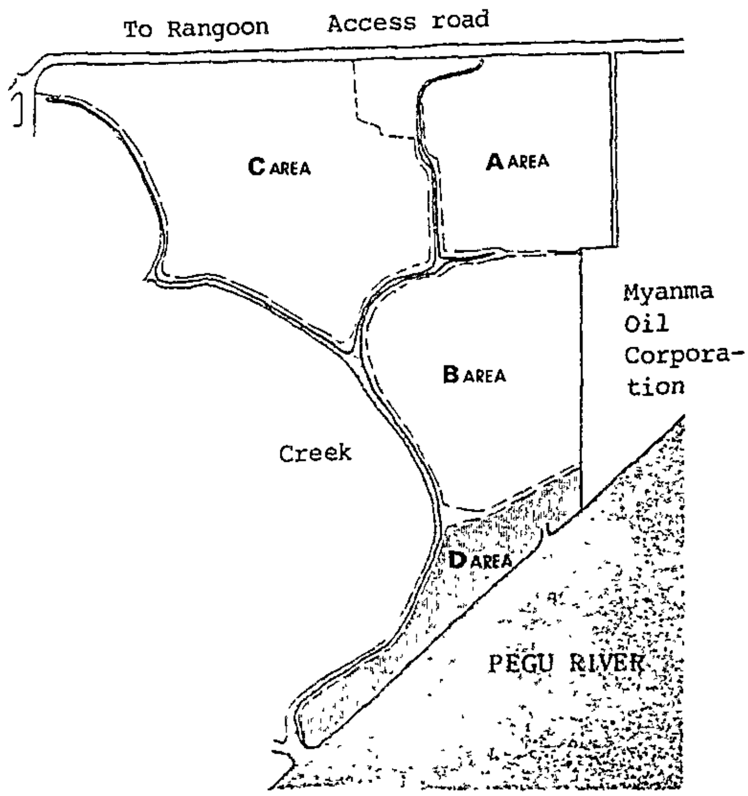
Facility/Room Designation	Floor Area (m^2)	Remarks
1) <u>Administration and Research</u>	(341.0)	
Office	40.0	
Director's office	20.0	
Toilet in Director's office	5.0	
Conference room	40.0	
Library	15.0	
Wet lab	45.0	
Equipment room	15.0	
Utility room	7.5	with air conditioning
Shower room	7.5	
Toilet	7.0	
Corridor, terrace	119.0	outdoor corridor
Stairway	20.0	
2) <u>Seed Production</u>		
Rearing tank rooms (including room for microbe culture tank)	2,880.0	recycled filtration system aeration equipment
Service space	271.0	
Office	20.0	
Feed preparation room	72.0	including refrigerator
Feed storage area	25.0	with air conditioning
Shower room	6.0	
Toilet	6.0	
Elevated tank	16 tons x (2)	to be installed above the utility core

Facility/Room Designation	Floor Area (m^2)	Remarks
3) Water Supply and Distribution		
Water intake gate and open channel	Water intake 11 m^3/min	Pit type
Backish water reservoir	Capacity 8,500 ton	Earthen pond
Concrete tank	Capacity 2,500 ton	Concrete tank w/roof
Freshwater reservoir	Capacity 10,000 ton	Earthen pond
Mixing tank	50 ton (2)	FRP
Fresh and brackish filter tank	15 m^2 (2)	Concrete tank
Generator room	12.0	
Pump room	6.0	
Well	2 inch	airlift pump for deep well
Elevated tank	2 inch	FRP
Breeder stock pond *1	1,800 ton (2)	2 Earthen ponds of 1000 m^2 each

*1: The breeder stock pond, from a functional standpoint, should be classified as part of the seed production facilities. However, in the construction plan, it is positioned the same as the freshwarter reservoir. In this plan, it has been treated, for convenience sake, as part of the water supply and distribution group of facilities.

3-3-3 Layout Plan

(1) Present Site Conditions

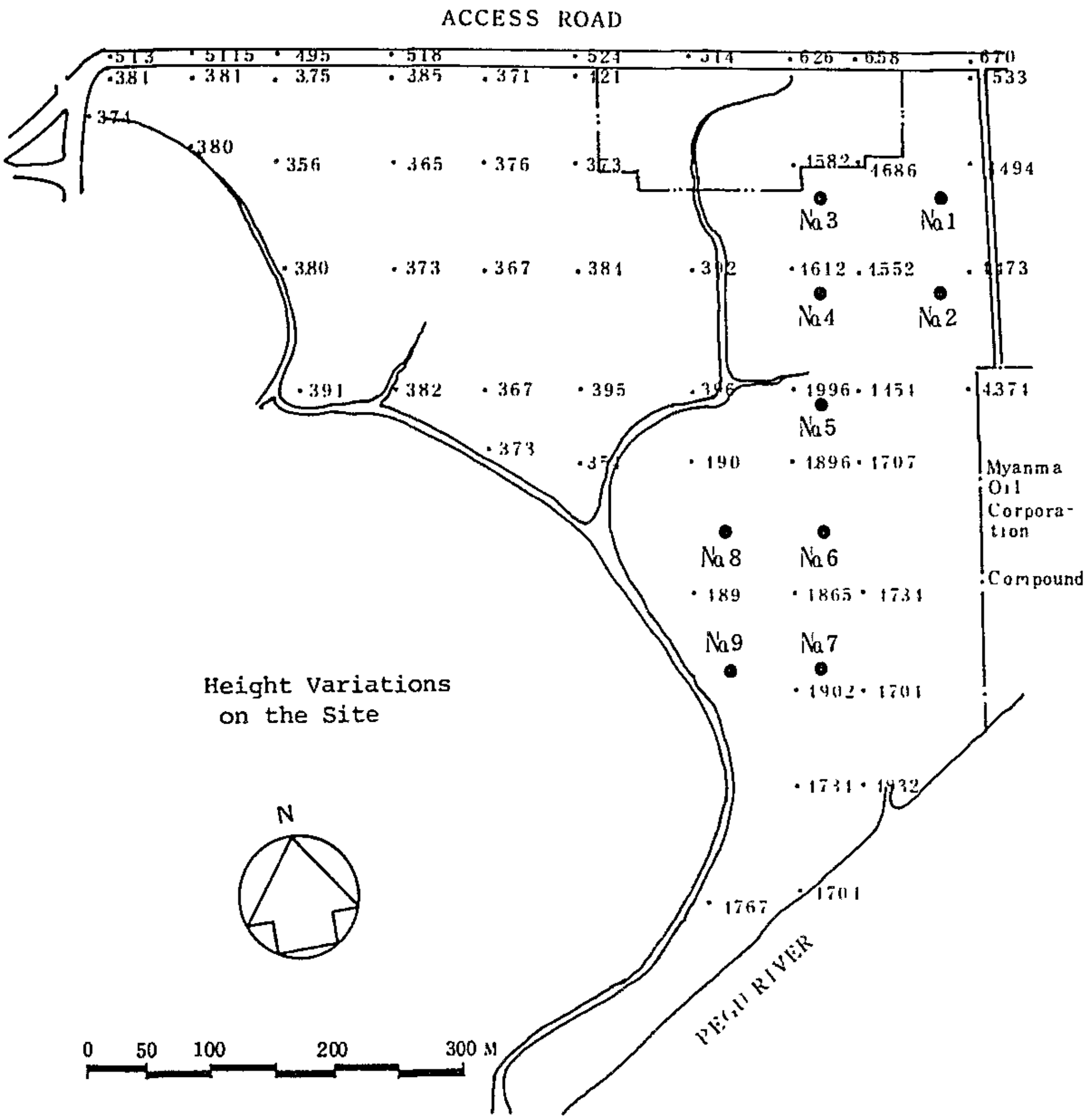


As shown above, the planned site for the subject facility is bounded by the Pegu River on the south, an access road on the north, a creek on the west, and compund of the Myanma Oil Corp. to the east. It is composed of 3 rice paddy areas (A,B,C) and riverbed, and is roughly divided by creeks running along and through the premises.

The land runs some 750 m north to south from the access road to the Pegu River and another 750 m from east to west along the access road, about 500 m in front of the Pegu River. The overall area is about 267,000 m^2.

The access road situated to the north is paved and has a width of 8.0 m. An average ground level of the site is about 2 m below the road surface.

This area is subject to flooding during the peak tides of the rainy season, and so the site targeted for construction of the facilities must be filled to a height of some 1.5 m. For the present site conditions, refer to the photographs in Appendix (v) and the detailed plan for site filling is shown in Appendix (vi).



(2) Basic Layout Policy

The layout plan has been developed in line with the following basic policy for site utilization --

1) As facilities that are linked in many respects to the

outside environment, the seed production component and the administration and research division should be located close to the road entering the premises from the north access road.

2) The water intake and distribution section should be located as close as possible to the Pegu River.

3) The "C" area has been reserved for future expansion of the overall facility or of particular segments (e.g., the development of a culture division).

4) With due consideration for the nature, functions, and logistics of the above facilities, the main activity flow has been oriented in a north-south direction, with facility groups for the various sections located along this axis.

5) We have designed a workable plan for facility arrangement, whereby the filling area has been held to a minimum.

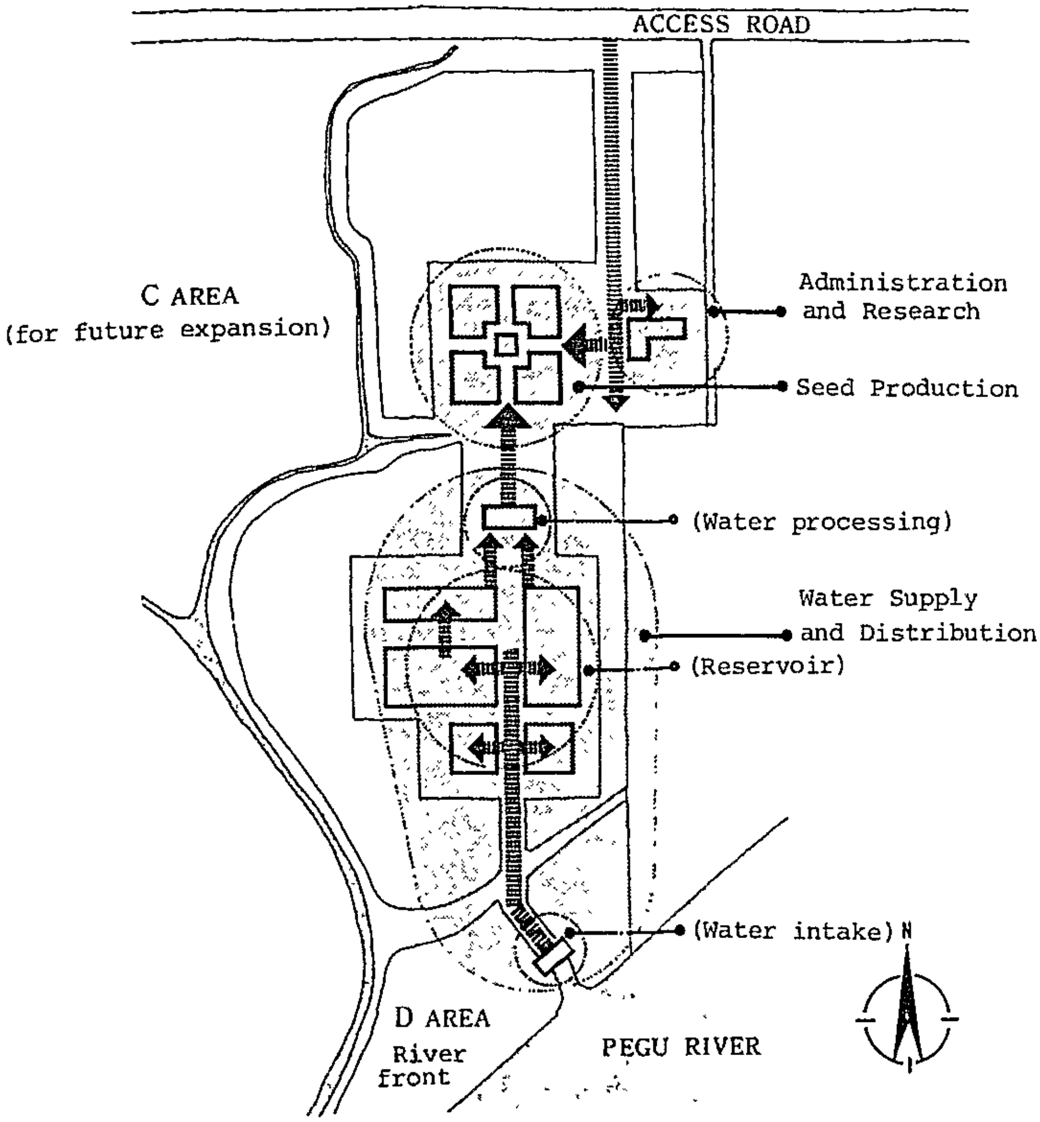
(3) The Layout Plan:

The two main arteries will be: 1) the road leading from the access road into the premises, which will be a key artery for shipping seed and receiving supplies; and 2) the water intake and reservoirs for brackish and fresh water, which support the production function together with the water distributor network leading from the water processing equipment to the rearing tanks.

The seed production division will be located astride those two arteries. To the east of the road leading into the site will be the administrative and research facilities.

On this basis, the overall appearance of the facility will show a primary cluster of buildings fronting on the north access road, in suitable contrast to the quiet area of the water division on the southern side of the site.

Layout Plan


ACCESS ROAD
C AREA
(for future expansion)
Administration
and Research
Seed Production
(Water processing)
Water Supply
and Distribution
(Reservoir)
(Water intake)
N
D AREA
River
front
PEGU RIVER

3-3-4 Construction Plan

(1) Floor Plan:

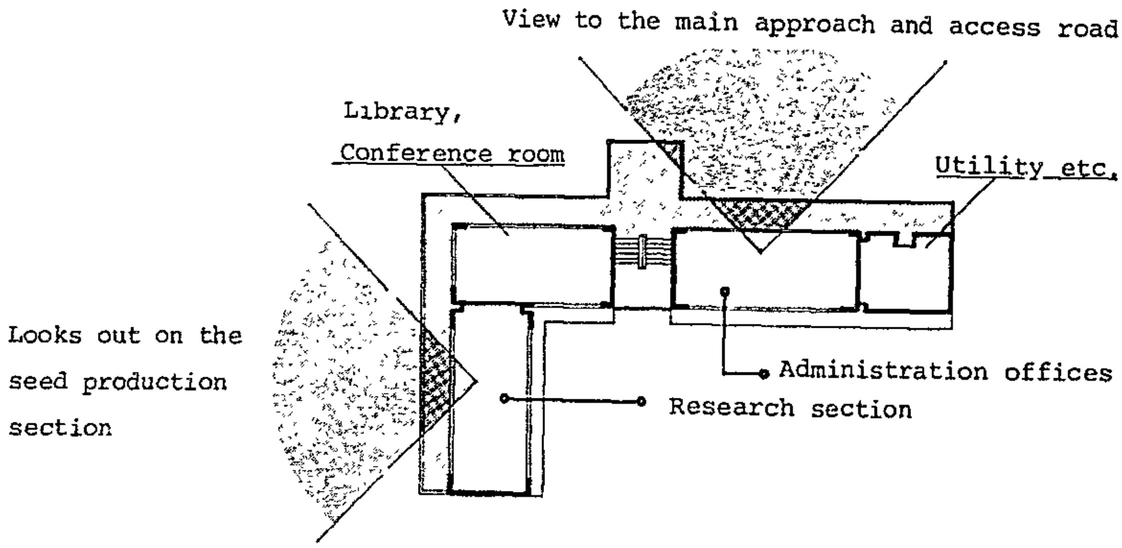
1) Administration and Research Division:

This section will have 3 functions: administration and operation of the planned facility; aquaculture research; and conference room and library areas common to these two functions. These functions will be consolidated into one structure.

The method of construction will incorporate pilotis, the traditional method used in Burma. Raising the perspective of the facility will also facilitate monitoring and management while lending a certain charm to the overall appearance.

The specific area layout will be as follows.

Plan and Diagram for Administration and Lab Building



2) Seed Production Section:

As shown in the seed production plan, there will be 128 hatching and rearing tanks -- the core portion of the facility with each tank 5 m long, 1.5 m wide, and 1.2 m deep.

For the following reasons, we have divided these into 4 units of 32 tanks each:

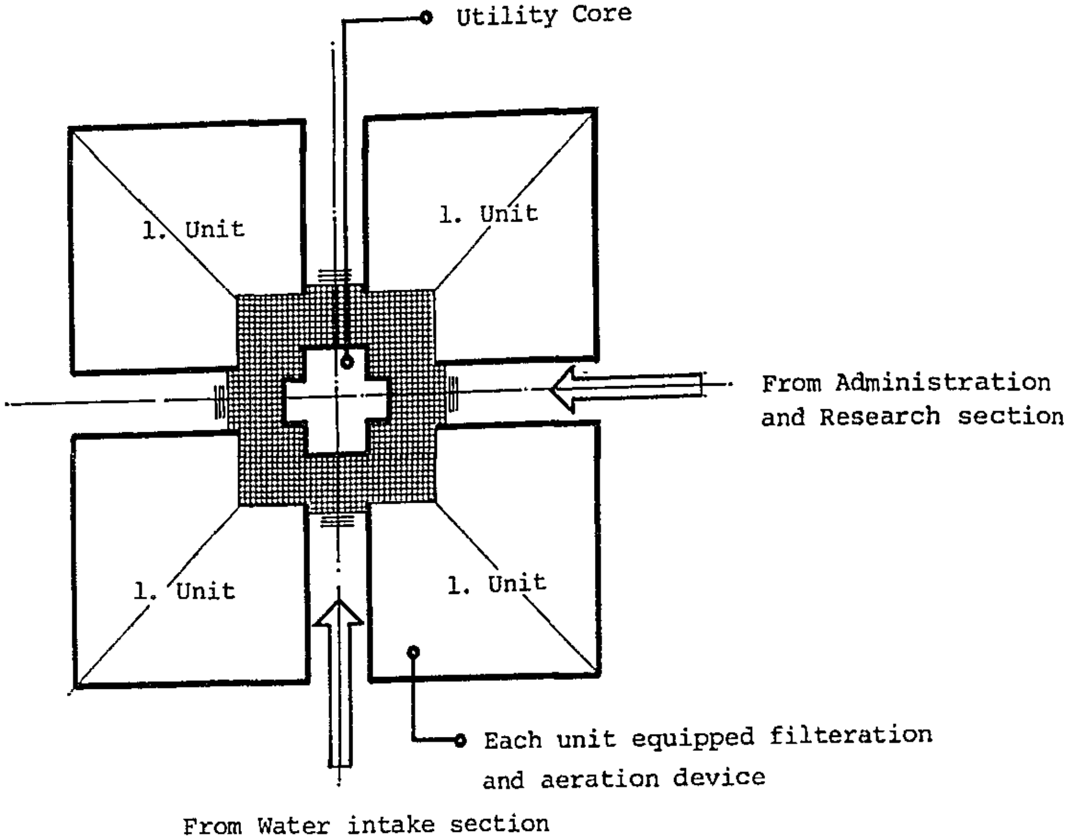
a) The division of the water distribution and drainage system into 4 units will facilitate water quality control and prevention of disease.

b) From an operating standpoint, 32 tanks (240 m^2) is probably the maximum number that can be worked together.

c) If all 128 tanks are grouped into 1 building, the scale of the structure becomes too large, introducing unnecessary complications in the management and maintenance of the construction program and of the building itself.

The detailed space layout is as shown below. We have located the service area in the center as a common facility, including the feed preparation room and storage, office, and shower room. Above this area, we have placed elevated water tanks for distributing water to the various tanks.

Around this central utility core area in the mid-section of the building, we have provided 4 seed production units, each housing 32 hatching and rearing tanks. Between the units, we have established a multi-purpose area for the smooth conduct of day-to-day operations, such as feeding and harvesting.



(2) Number and Height of Floors:

The number and height of the building floors have been established as follows:

1) Administration and Lab Building --

This will be a 2-story building, with the first floor pilotis and all of the main rooms located on the first floor.

In a tropical climate like Burma's, with average annual temperatures of close to 30°C, ordinarily the comfort level of a building tends to improve, the higher the ceilings. Taking into consideration the balance between room size and construction cost, and based on a comparative evaluation of similar facilities, we have set the standard ceiling height at 3.0 m and the height of story at 3.5 m.

The height of pilotis floor will be kept at a minimum of 2.5 m.

2) The Seed Production Building:

This facility will not have any ceilings and the height of the eaves will be 3.0 m with the roof at a 1/3 pitch. The height of the section on the building, to which elevated tanks is to be affixed, will be about 8.5 m.

(3) Component Plan for the Buildings:

With regard to the component plan for the buildings, we have made the following basic adjustments based on a consideration of the natural and social environment:

... A long continuous period of high temperature and high humidity.

... Based on climatic conditions, we assume there will be large amounts of rainfall in very short periods of time

... A chronic shortage of essential materials and a limited construction season.

Based on the above considerations, we have prepared a construction plan, as follows, for the various construction components.

1) Roofing:

In the field survey, we saw very few flat roof styles; most of the roofs were high pitched gable or hipped roofs. Roofing materials were of 3 types: palm-leaf roofs, as used in many private homes; corrugated asbestos slate, as seen in many other kinds of buildings; and corrugated steel sheet, common to both types of structures. During the British colonial rule, tile was used in both ordinary and high grade buildings but, at present, its production appears to have stopped.

Ranking the above 4 materials in terms of their suitability to the natural environment, palm-leaf roof and tile are the most suitable, followed by corrugated asbestos slate, and corrugated steel sheet respectively. Based on cost and supply, steel sheet was found to be the principal type.

In the subject facility, considering heat resistance and durability, in the Administration and Lab Building we have used an asbestos type of roofing material developed in Japan; and, in the Seed Production Building, insulated steel sheet roofing. It will also be necessary to give consideration in design to air circulation under the roofs.

2) Exteriors:

The most common exterior material used in Burma is brick, which is both well suited to natural conditions and in good supply. We have, therefore, liberally incorporated this material in our Plan.

3) Window and Door Openings:

Forms for windows and door openings in Burma are mostly wood. Based on observations during our field survey, product standards are not uniform. In addition, we could see, in private homes, bamboo doors and, in large structures, steel sashes.

In the subject facility, however, based on a calculation of construction efficiency and cost, we have specified aluminum sash for windows and wooden or metal doors.

With regard to the design of windows and door openings, special consideration should be given to making the eaves quite deep so as to shield the buildings from sunlight. In this way, the openings can be given maximum protection against direct sunlight.

We have considered the height of the sun by season so as to develop a suitable shielding plan. Data on the solar height table in Rangoon is given in Appendix (vii).

4) Flooring:

Based on the examples seen in our filed survey, most floor finishes use mortar steel trowel plus a certain amount of cast-in terrazzo. In this Plan, we have selected mortar trowel finish for the Seed Production Building and other general facilities, and cast-in terrazzo for the Administration and Lab Building.

5) Interior Finish

The following interior finishes are planned for the Administration and Lab Building:

Ceilings: Standard acoustical board to afford effective sound proofing and insulation or painted plywood. One or the other of these two types of finish will be used, depending on the intended room.

Interiors: Both painted mortar finish and painted plywood.

(4) Structural Plan

1) Superstructural Plan

From the above construction plan, and considering the uses and ease of construction of the various buildings, the following superstructural systems will be employed:

... in the Administration and Lab Building ---
steel frame, using economical 5 - 6 m spans and ordinary grade rigid frame.

... in the Seed Production Building ---
steel frame, in the outside portions, column with economical spans; in the inside,rigid frame structures with extended spans.

... in the utility core ---
concrete construction;
rigid frame construction using brick walls.

... in the covered concrete reservoir ---
inside the tanks, columns will be built to support the upper-level roof structure.

... in the machine house ---
concrete; rigid frame construction, with brick walls.

2) Structural Design:

a) Applicable Standards:

In Burma, there are no specific structural standards other than those covering anti-earthquake design. In general, the country follows British standards, but these are no compulsory. The applicable standards in this plan have been left to our responsibility and judgment.

As a result, in this Plan, we have, in principle, used Japanese standards governing design methods and load factors. Specifications for construction materials follow, for the most part, British standards. Concrete stress tests, in particularly, are generally 180 kg/cm^2, with 28-day strength; the 210 kg/cm^2 standard is only rarely used. The Construction Corporation has established the following basic values for long-term tolerance:

Compressive unit stress in bending	750 psi (54.0kg/cm^2)
Compressive unit stress	570 psi (41.0kg/cm^2)
Shearing unit stress	75 psi (5.4kg/cm^2)
Average bond unit stress	90 psi (6.5kg/cm^2)
Local bond unit stress	135 psi (9.7kg/cm^2)

b) Earthquake Intensity:

International standards are only now being developed in Burma for seismology and earthquake resistance. In 1970, as a result of a major earthquake in the Rangoon area, which caused extensive damage, the Burmese Government asked the Government of Japan to dispatch experts in seismology and earthquake resistance. In response to this request, a Japanese seismological mission was sent, which produced a report designed to encourage the development of earthquake science in Burma. But the fact remains that governing standards have not yet been established on a national basis.

We feel it would be most appropriate for earthquake design for the subject facility to follow the anti-earthquake standards laid down in the report by the 1970 Japanese mission. This report may be summarized as follows:

Draft Earthquake Standards for Burma (Extract)

Anti-earthquake design coefficient (design earthquake intensity)

1. Horizontal design earthquake intensity is determined by the following formula:

$$KH = n_1 \cdot n_2 \cdot n_3 \cdot k$$

where:

KH = design earthquake intensity

n_1 = earthquake area coefficient (shown in the area on the following chart)

n_2 = basic type coefficient (as shown in the following table)

n_3 = weight (use) coefficient (cf. table)

k = standard design earthquake intensity (= 0.1)

2. Generally, vertical earthquake intensity can be ignored.

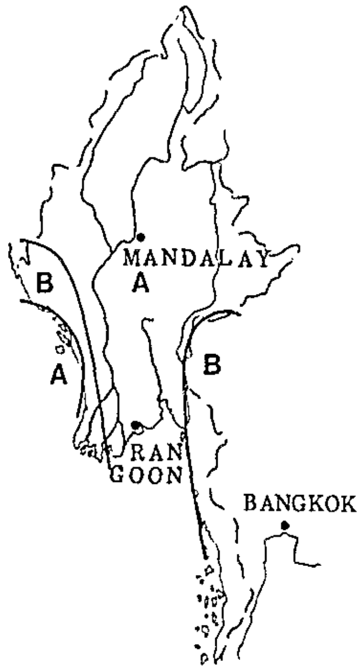
Coefficient by Foundation

Classification	Condition of Foundation	n_2
1	(1) Tertiary or older stratum (stone foundation) (2) Oiluvium of 10m or less thickness over rock base	0.9
2	(1) Oiluvium of 10m or over thickness over rock base (2) Alluvium of 10m or less thickness over rock base	1.0
3	Alluvium of a thickness of 10m or less	1.1
4	Other stratum	1.2

Earthquake coefficient by sector

Sector	n_1
A	1.0
B	0.7

Earthquake area breakdown



Coefficient of Importance

Type of Structure		n_3
Public buildings		1.5
	Reinforced concrete	1.0
	Brick structure	0.5
	Wood structure	0
Dams		1.5
Bridges		1.0
Port and harbor structures		1.0

The design earthquake intensity for the subject facility may be derived from the above formula.

With n_1 = 1.0 (Section A)

n_2 = 1.2 (Group 4)

n_3 = 1.3 (Public buildings)

$KH = n_1 \times n_2 \times n_3 \times k$

$= 1.0 \times 1.2 \times 1.3 \times 0.1 = 0.15$

Thus, the design earthquake intensity = 0.15

c) Soil Bearing Capacity:

Based on building scale, we can estimate the spread foundation for the facility. In our field survey, we conducted temporary soil bearing capacity tests using a penetrometer at 9 points, as shown in the chart on page 45.

Based on these tests, we obtained values ranging from a minimum of 11 tons to a maximum of 24 tons per square meter for designed foundation level that is likely to be 1.0 - 1.5 m below the existing ground level.[*1] Apart from these tests, a supplementary survey is to be carried out by the PPFC as well, based on undisturbed soil testing. But, we feel that our own survey results are more than ample for the Basic Design. Accordingly, our Plan establishes the soil bearing capacity at 10 tons/m^2.

3-3-5 Water Intake and Distribution Plan

(1) Facility Use and Construction Method:

In this section, we shall consider the various water intake and reservoir facilities connected with the water intake and distribution segment together with the construction and civil engineering plan for the breeder stock pond.

Factors for determining water quality for breeding use include water temperature, salinity, dissolved oxygen, suspended material and other minute components. Among these factors, salinity will be one of the constraints to be considered in terms of pond design due to seasonal difficulties in obtaining brackish water.

As significant influences from the natural environment on salinity in the reservoir, we should consider principally elements in the intake and outflow of water, such as evaporation, rainfall, and water seepage, both direct and reverse, through the pond walls.

In order to maintain reservoir salinity over a fixed time period and prevent a decline in reservoir salinity, it is essential to eliminate the influence of both rainfall, which increases the volume of water and thereby causes overflowing,

* For details refer to Appendix (viii).

and of underground water seeping through the pond walls.

From the above considerations, we have provided in the subject Plan a roofed concrete tank for brackish water for long-term use, two earthen ponds for storing brackish and fresh water, and two earthen breeder stock ponds.

(2) Ground Preparation Plan for the Reservoirs:

1) Exposed Pond Excavation:

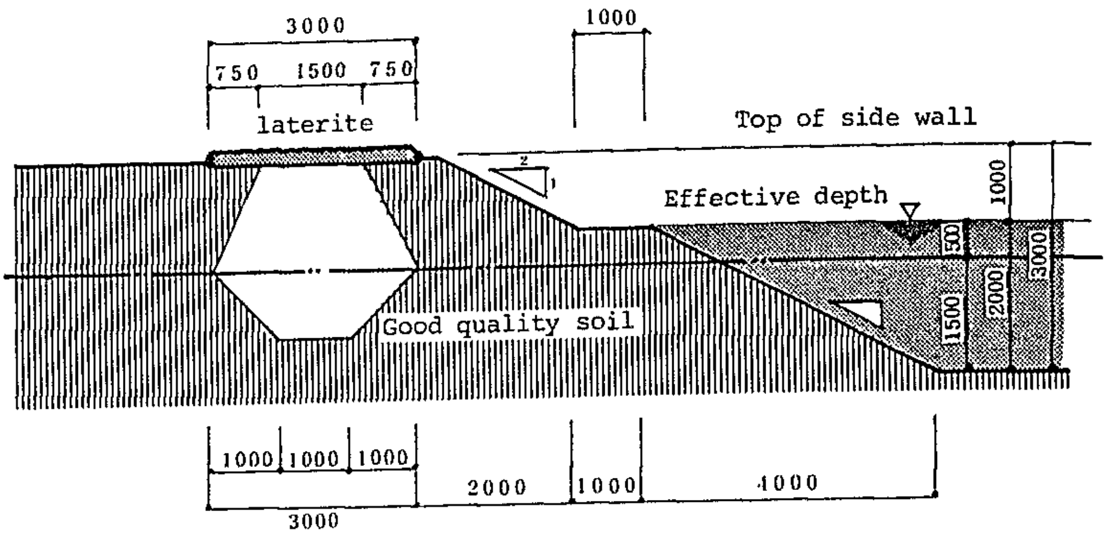
a) Structural Plan:

The Structural Plan for the earthen pond is as follows:

Generally, with respect to the pond bottom, in order to reduce soil seepage loss, it is necessary to improve the soil quality of the pond bottom or to dig down to level of the underground water table. The soil quality in the subject area is relatively good, and the underground water table, at 1 - 1.5 m, is relatively close to the surface. Thus, we have established an excavation depth of 1.5 m, from the existing ground level for the pond foundation.

The height of the bank top will be +1.5 m from the ground level and the bank slope will be 1:2. Accordingly, the bank top will be 3.0 m from the pond bottom. In a horizontal direction, as compared with a vertical, a particularly certain amount of water seepage may be expected especially from the upper portion of the bank. Thus, the core portion of the bank will be built with good quality soil so as to reduce water seepage. The construction of the exposed earthen pond is shown in the following chart:

Structural chart for fresh and brackish water reservoir



b) Reservoir Size in Relation to Facility Scale:

The volume of water to be stored in each reservoir will be the total amount of planned water usage plus increases and decreases from rainfall, evaporation*1, and soil seepage.

Average monthly rainfall in the Rangoon area from 1960 - 1979, as measured by the Meteorological Observatory, is about 800 mm during the 6-month dry season from November - April and as high as 2,500 mm during the 6-month rainy season from May - November.

Observed values for evaporation at the Observatory in the Rangoon area averaged 2,194 mm/year over the 1970 - 1979 decade.

For detailed data on soil seepage, we shall have to await the findings of the soil tests at the proposed building site but, considering the fact that the soil here has a silt/clay basis, we can estimate seepage as being generally 1 - 3 mm/day. And, given the fact that the surrounding area is low land with a high ground water table, we have tentatively applied a value of 2 mm/day.

*1 For details refer to Appendix (ix).

Considering the above adjustments in the balance of water intake and outflow, we have set the size of the reservoirs and breeder stock ponds as follows

As shown on page 74, the required volume of freshwater and brackish water per cycle were calculated at 6,672 m^3 and 4,032 m^3, respectively. For ease of pond construction and operation, the dimensions of the earthen pond will be 5,000 m^2 (50 m wide x 100 m long), and then an effective water depth will be determined.

However, since it is hardly desirable for a high seepage to occur from the bank above the existing ground level, we have set the allowable effective water depth at + 2.0 m.

Freshwater Reservoir:

During the July - October period, losses from soil seepage and evaporation can be recovered by taking in water from the Pegu River. However, during the January - May period, freshwater cannot be supplemented from the river. During this time, therefore, in addition to rainfall, it is planned to supplement supplies at the end of February from the 2,500 m^3 in the covered concrete tank into which freshwater had been originally introduced during November and December. In this way, the balance of water intake and outflow over the January - May period becomes:

$(2,500\ m^3 \div 5,000\ m^2)$ m + 0.336 m - 1.167 m -
(supplemented from the concrete tank) (rainfall) (evaporation)

0.002 m x 150 days = - 0.631 m
(see page)

The required water depth H, then, is derived as follows:

$$H \geqq (6,672 \div 5,000) + 0.631 = 1.965\text{m}$$

With a built-in margin for error, the effective water depth can be set at 2 m. This will not exceed the allowable effective depth.

From the above, we can set the planned size of the freshwater reservoir at -- 50 m(W) x 100 m(L) x 2.0 m (D).

Brackish Water Reservoir:

In exact opposition to the freshwater situation, it is the May - December period when it will be difficult to supplement the supply of brackish water from the Pegu. Thus, during the March - April period, when high salinity brackish water cannot be obtained, it will be necessary to provide supplies of brackish water that are adequate to meet the needs of 2 seed production cycles a year.

The amount of brackish water to be used per year will be:

$$4,032 \times 2 = 8,064\ m^3$$

Of this total, 2,500 m^3 can be stored in the covered concrete tank, thus the required volume to be stored in the brackish water reservoir is 8,064 - 2,500 = 5,564 m^3.

Based on a tentative calculation of freshwater intake and outflow as a result of rainfall and evaporation between March and September, it is unlikely that overflow from the pond will occur during this period, so we do not anticipate a change in overall salinity of the brackish water. At times, the dilution ratio for the brackish water may have to be changed but, this will present no problem. Accordingly, if we estimate the brackish water supply and demand balance during this period, giving consideration only to soil seepage, we can determine the effective water depth as follows:

$$\text{Seepage} = 0.002/\text{m/d} \times 210 \text{ days} = -\ 0.42 \text{ m}$$

Thus, the effective depth (H) becomes:

$$H \geqq (5{,}564 \text{ m}^3 \div 5{,}000 \text{ m}^2) + 0.42 \doteqdot 1.533 \text{ m}$$

We have set an effective depth in this plan at 1.7 m, which is within the allowable effective water depth. On this basis, the planned size of the brackish water reservoir is,

50 m (W) x 100 m (L) x 1.7 m (D)

Ordinarily, in the case of both fresh and brackish water, even if the water level of the reservoir exceeds the designed level, there is no need for a drainage operation. However, to guard against an abnormal increase in the water level due to heavy rainfall or a deterioration of water quality, we shall use a drainage outlet and a concrete pipe buried in the ground, on the basis of which we will be able to adjust maximum water levels, with excess water being drained off into the creeks in the site.

Breeder Stock Pond:

From the standpoint of ease of harvesting operations and maintenance of the facility, the size of the pond will be 32 m x 32 m.

If we assume that January - March will be a difficult period for supplementing the supply of breeding water (freshwater), the supply/demand balance, as in the case of the freshwater pond, becomes:

$$\underset{\text{(rainfall)}}{0.336 \text{ m}} - \underset{\text{(evaporation)}}{1.167 \text{ m}} - \underset{\text{(seepage)}}{0.002 \text{ m} \times 150 \text{ days}}$$

Setting the normal water depth at 1.5 m and the minimum allowable depth at 0.6 m, the planned water depth (H) becomes:

$$H \geqq \underset{\text{(Minimum allowable depth)}}{0.6} + 1.131 = 1.731 \text{ m}$$

The effective water depth, including a safety margin, has been set at 1.8 m, which is within the allowable effective water depth.

From the above, the size of the breeder stock pond becomes:

32 m x 32 m x 1.8 m (D)

As in the case of both the freshwater and brackish water ponds, a drainage facility will be built for excess water in the breeder stock pond.

2) Covered Concrete Tank:

During the period from the end of March to mid-October, brackish water will be stored in the roofed concrete water tank; from then until the following March, freshwater will be stored. The required amounts of freshwater and brackish water to be stored will be 2,500 m^3, respectively.

Since the brackish water storage period, includes the rainy season, it must be anticipated that, in the case of outdoor ponds, there will be some decline in salinity owing to overflow due to rain water. And, allowing also for the effect of seepage, we have decided to construct a roofed concrete pond. The area of the tank, in the interest of ease of construction and maintenance, will be 20 m(W) and 80 m(L).

With this type of construction, there should be no variation in water balance owing to rainfall or seepage. With regard to evaporation, even if some occurs in the case of the brackish water, there should be no change in the total saline content, and so it will be possible to maintain a fixed level of salinity by adding freshwater. And, in the case of freshwater, storage period is short, and, thanks to the roof covering, the evaporation coefficient will be very small. For these reasons, such influences can be ignored in designing the size of the storage tank.

The effective water depth (H) for a required water volume of 2,500 m^3, will be:

$$H = \frac{2,500}{20 \times 80} \doteqdot 1.6 \text{ m}$$

Adding a safety margin, we have set the depth at 2.0 m.

From the above, the size of the covered concrete tank becomes:

20 m(W) x 80 m(L) x 2 m(D)

Short colums will be arranged in 2.5 m grid in the tank to provide support for the truss structure of the roof.

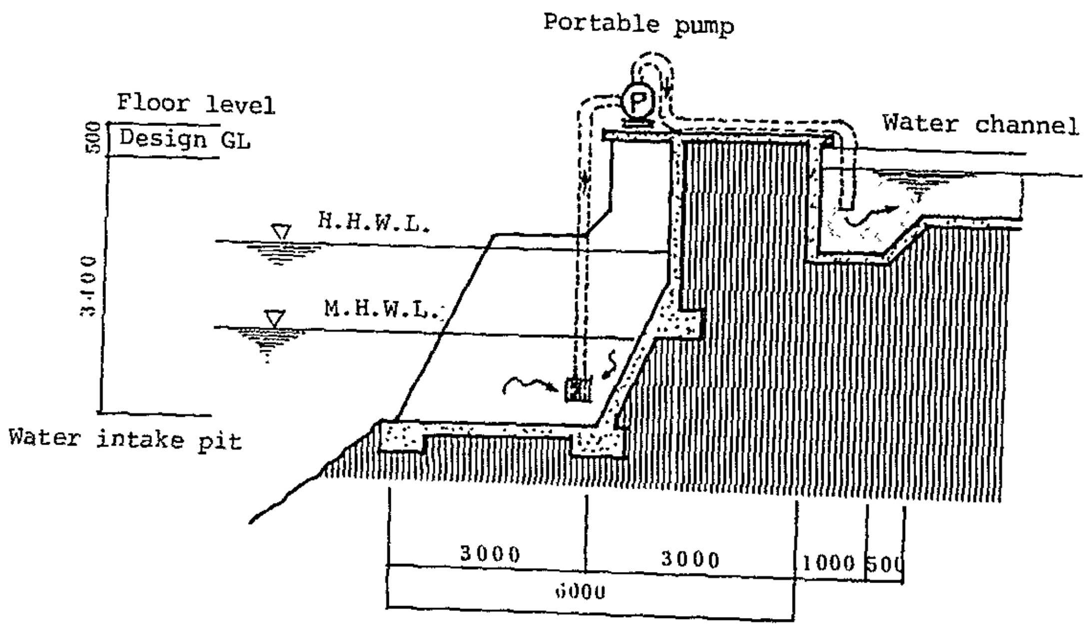
3) Water Intake Pit and Water Channel

In principle, intake of brackish water will occur twice during March and that of freshwater will take place 2 - 3 times between June and December.

Each intake operation will involve a volume of 8,500 - 10,000 m^3 and all intake operations will extend over about a one-week period during peak tide, when water quality is stable, via water intake pumps.

Since, based on the observed values, there is no marked difference in the quality of river water by the location, we have provided for water intake through natural basin on the river bank at the eastern edge of the site.

Since no protection facilities for the river bank have been seen in the planned area, the riverside line may be unstable owing to erosion. If the water intake facilities are to be permanent, major construction effort would be required, including the walling of the river bank in the area, and this would not serve the purposes of the Plan. For this reason, in order to facilitate a change in the water intake pit or in the intake location in the event that the permanent shoring protection is undertaken in the future, we have decided to use simplified structure. Water intake will be accomplished by the reinforced concrete pit, as shown in the following diagram:



To permit easy maintenance against the bottom sediment, we will use open channels of concrete construction.

We have determined the cross-section of the open channel and its slope as follows:

... the amount of water to be carried per hour is set at $11.1\ m^3/min = 0.185\ m^3/sec$ or more.
(Refer to section 3-3-6, g).

The rate of flow, in the case on concrete waterway, should be set at a maximum tolerable speed of 3 m/sec in order to protect materials. But here, in consideration of resistance in the waterway, we have established a value on the conservative side of 0.5 m/sec.

The cross-section area (A) of the channel is:

$$A = \frac{Q}{V} = \frac{0.185}{0.5} = 0.37\ m^2$$

where Q = rate of flow
V = flow velocity

If we set the width at 0.8 m, the required wall height may be calculated at 0.463 m.

The slope of the channel may now be derived through the Bazin's Formula;

$$V = C\sqrt{RI}$$

in which: C = flow coefficient
R = hydraulic radius; a constant derived from channel depth and width (in this case: 0.209)
V = flow velocity (0.5 m/sec)
I = slope

The flow coefficient is derived from the following formula:

$$C = \frac{87}{1 + \frac{r}{\sqrt{R}}}$$

(r: Bazin's roughness factor, r = 0.06)

Thus, $C \fallingdotseq 76.923$

Hence, channel slope is calculated at:

$$I = \frac{1}{R}\left(\frac{r}{C}\right)^2 \fallingdotseq 2 \times 10^{-4} \geqq \frac{1}{5,000}$$

With a built-in safety factor, the specifications for the open channel are established as follows:

1 m (W) x 0.7 m (D)

Slope $\frac{1}{1,000}$ or greater

3-3-6 Building Services Plan

(1) Design Policy

The building services plan divides into 3 parts: those for water supply and drainage; air supply; and electrical equipment. These facilities are a key element in the project, with a direct bearing on the success or failure of the seed production activity.

Facilities are required that will insure a good quality source of water, the establishment of an effective network for water intake, storage, distribution, and drainage, and, from an operational standpoint, simple yet effective facilities that will minimize operational loss. In order to rear water organisms, all of the equipment impacting directly on water and air supply must be designed with the assurance that the alternative equipment will be readily available.

We have used standard items whereever possible, and our design has centered on materials and equipment that are relatively widely used in Burma and easy to obtain. We have also given consideration in their selection to possible future expansion or changes in the utilization plan. In addition, to assure that the facilities can be adequately run by unskilled workers, we have avoided equipment requiring complex, delicate handling or maintenance.

(2) Water Supply and Drainage:

1) Water Supply:

In the subject facility, the principal source of water for seed production will be the Pegu River, which runs along the southern edge of the site. Potable water, water for washing equipment, and for sanitary purposes will be obtained from deep well to be built within the site.

As already explained, freshwater for seed production can be obtained from the river in June and July, and brackish water between January and mid-May.

Brackish water is brought into the reservoir and left for 10 days. After the sediment from the silt and clay has been allowed to settle, the water is transferred to the roofed concrete storage tank. Then, it is pumped up and moved into a mixing tank, then transferred to a filter tank by means of gravity method. The mixed and filtered water for seed production is lifted into the elevated tank for final distribution to the various terminals.

In similar fashion, freshwater is brought into a reservoir. From there, one of 2 piping channels can be used. It may be pumped up into a mixing tank, blended with the brackish water, and distributed through the filter tank by gravity method. Or without mixing, it may be used directly through the filter tanks.

Drinking water is to be supplied by the well via an air lift pump to the elevated tank, and then distributed by gravity method to the various terminals. The results of water quality analysis for the well water being used at Thaketa Research Station are shown in Appendix (x).

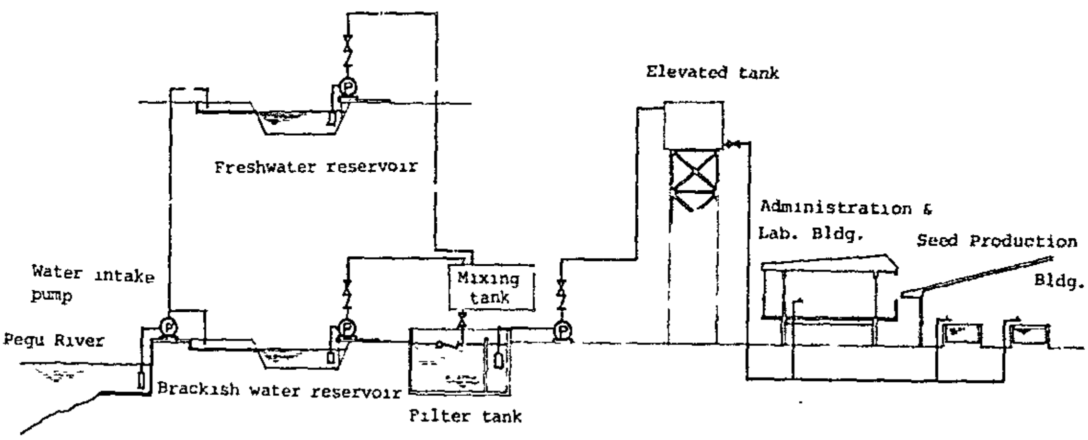
Pipes and valves used to distribute water for seed production will, in principle, be made of either rigid pvc or polyethylene. However, in the case of the exterior piping, in order to prevent softening due to temperature rise or quality deterioration due to direct sunlight, we will, as a general rule, use underground piping. Exposed sections will be protected by insulation.

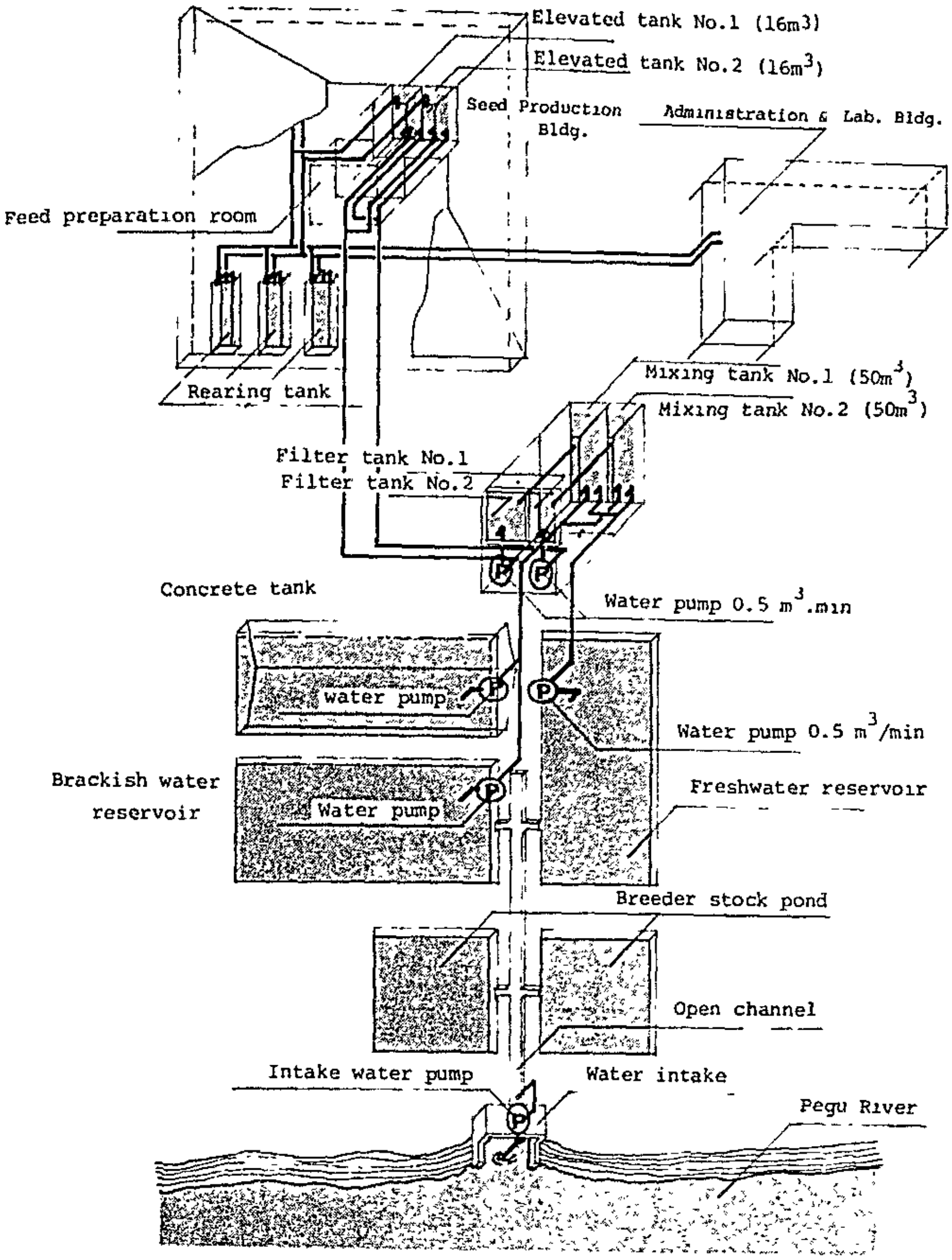
Water for Seed Production

a) The Distribution System:

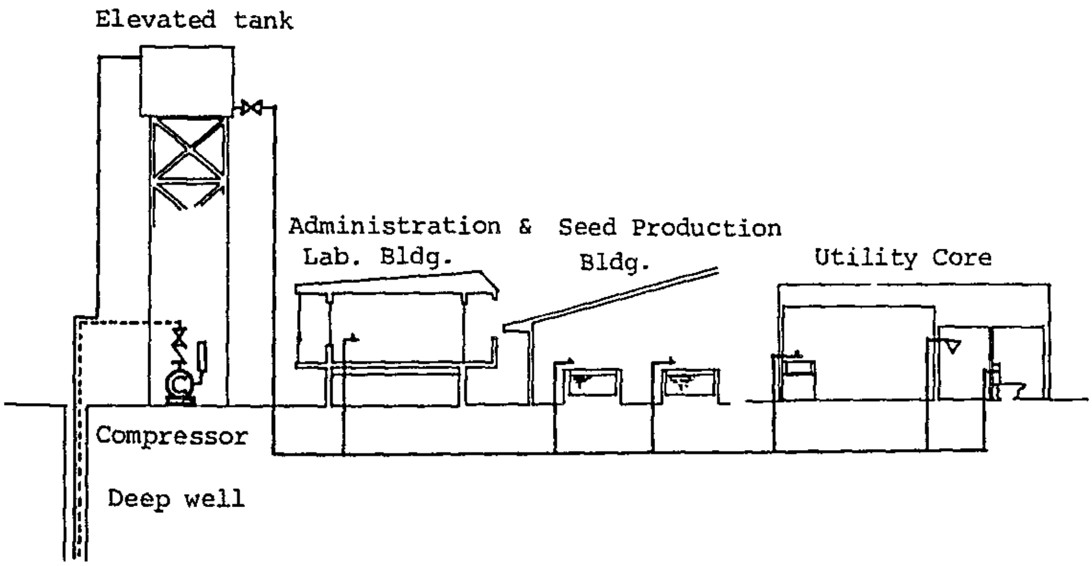
The following chart shows the general distribution system for the water to be used for seed production.

Fresh and Brackish Water Supply System Diagram



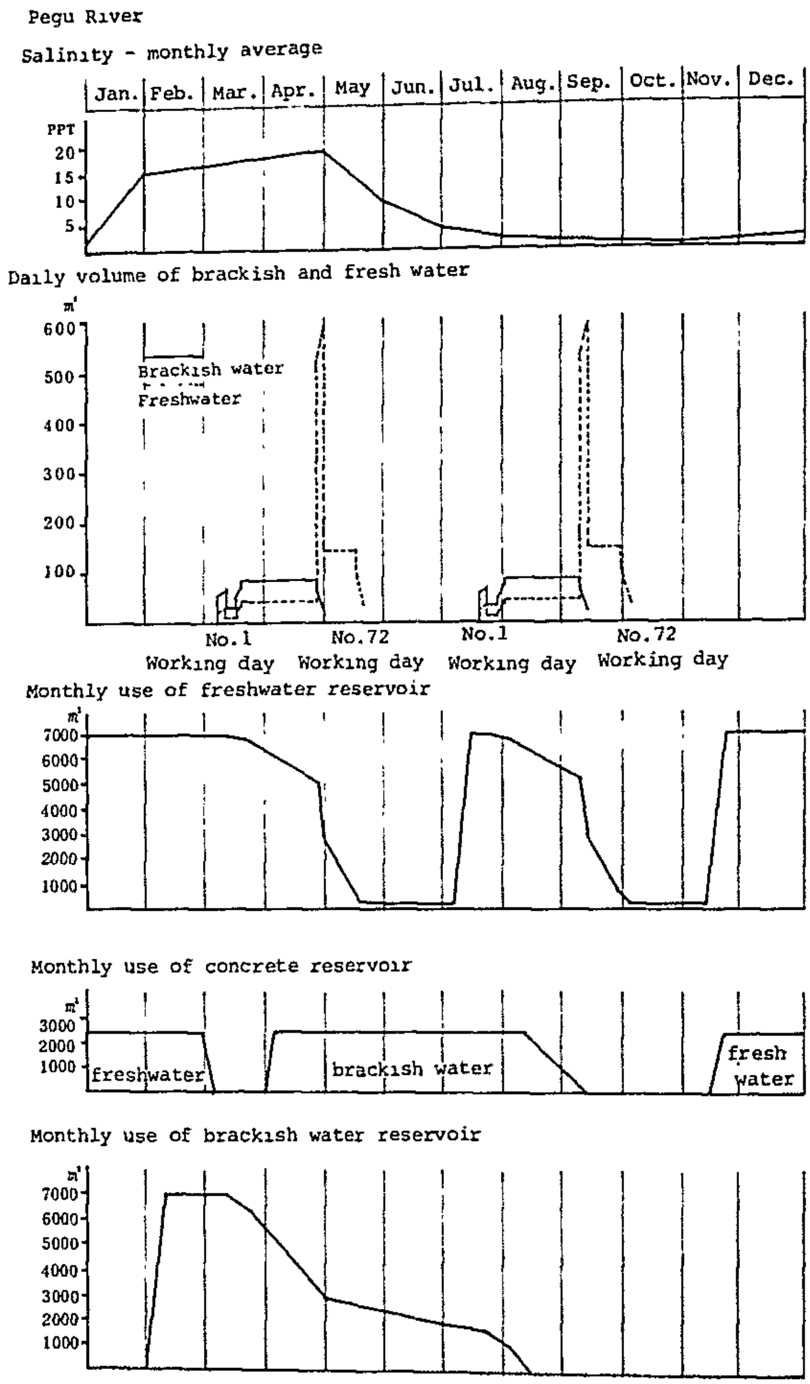


Well Water Supply System Diagram



b) Volume of Water to be Used:

The projected volume of water to be used in the seed production per year is as shown in the following chart.



In accordance with the water supply diagram to the hatching / rearing tanks, as shown in the seed production plan, we can estimate the maximum amount of water that will be used per hour for the various phases from the first working day to day 74. In making these estimates, we have established the following conditions:

... Since it would be difficult to deliver in one day all of the breeder prawn to 128 tanks, we have divided the total into 4 groups of 32 tanks each, to distribute gradually over a 4-day period from Day 1-4.

... The water exchange rate for the tanks has been set at 20% between Day 10 - 50 and at 15% from Day 51 onward.

... We have assumed a net working hour of 6 hours per day. However, for the acclimatization process to freshwater, during Day 50 - 53, in order to avoid a sudden infusion of freshwater, the operation will be carried out around the clock, with 15% of the turnover achieved during the regular 6-hour working day and 185% during the remaining 18 hours (e.g., at night).

... The required average salinity for the breeding water is 12 ppt. If the value of the original brackish water is assumed to be 19 ppt, the freshwater mixture becomes about 0.5 part freshwater to 1 part brackish water.

The process flow is shown in the following table.

Per Hour Usage of Breeding Water (m^3/hr)

Tank group / Working day	#1 Group tank 1-32	#2 Group tank 33-64	#3 Group tank 65-96	#4 Group tank 97-128	Brackish water usage hr/day	Mixture ratio: Freshwater 1 hr/day	Mixture ratio: Brackish 2 hr/day	Freshwater usage hr/day
1	30 ※1 / 12 ※2	0 / 0	0 / 0	0 / 0	12 / 72	4 / 24	8 / 48	0
2	35 / 2 ※3	30 / 12	0 / 0	0 / 0	14 / 84	4.67 / 28	9.33 / 56	0
3	40 / 2	35 / 2	30 / 12	0 / 0	16 / 96	5.33 / 32	1066 / 64	0
4	45 / 2	40 / 2	35 / 2	30 / 12	18 / 108	6 / 36	12 / 72	0
5~9	50~70 / 2	45 / 2	40 / 2	35 / 2	8 / 48 x 5day	26 / 16 x 5day	54 / 32 x 5day	0
10	70 / 56 ※4	70 / 2	65 / 2	60 / 2	116 / 696	3.8 / 232	7.7 / 46.4	0
11	70 / 56	70 / 5.6	70 / 2	65 / 2	152 / 91.2	5.0 / 304	102 / 60.8	0
12	70 / 56	70 / 56	70 / 56	70 / 2	188 / 1128	6.4 / 37.6	12.4 / 75.2	0
13~49	70 / 56	70 / 56	70 / 56	70 / 5.6	22.4 / 134.4 x 37day	7.4 / 44.8x37day	150 / 89.6x37day	0
50	6 100 / (247) ※5	70 / 56	70 / 56	70 / 56	16.8 / 100.8	56 / 336	11.2 / 672	6 (247) / 480
51	100 / 6 ※6	6 100 / (247) ※5	70 / 56	70 / 56	112 / 67.2	3.7 / 224	73 / 44.8	12 (24.7) / 516
52	100 / 6	100 / 6	6 100 / (247)	70 / 56	5.6 / 336	1.8 / 112	38 / 22.4	18 (24.7) / 552
53	100 / 6	100 / 6	100 / 6	6 100 / (247)	0	0	0	24 (247) / 588
54~69	100 / 6	100 / 6	100 / 6	100 / 6	0	0	0	24 / 144
70	Seed harvest shipment	100 / 6	100 / 6	100 / 6	0	0	0	18 / 108
71		Seed harvest & shipment	100 / 6	100 / 6	0	0	0	12 / 72
72			Seed harvest & shipment	100 / 6	0	0	0	6 / 36
—				Seed harvest & shipment				
—								
			Usage per cycle (m^3)		6,048	2,016	4,032	46.56

*1 Shows water depth

*2 Amount of water to increase depth 30cm/day 7.5 x 32 x 0.3 ÷ 6hr = $12m^3/hr$

*3 Amount of water to raise depth 5 cm/day 7.5 x 32 x 0.05 ÷ 6hr = $2m^3/hr$

*4 Amount of water for a 20% turnover at 70cm depth 7.5 x 32 x 0.7 x 0.2 ÷ 6 = $5.6m^3/hr$

*5 Amount of water for a 15% turnover at 100cm depth and 185% turnover (18 hrs operation) 7.5 x 32 x 1 x 1.85 ÷ 18hr = $24.7m^3/hr$

*6 Amount of water for a 15% turnover at 100cm depth 7.5 x 32 x 0.15 ÷ 6 = $6m^3/hr$

From the above, the maximum amount of water required is 22.4 m^3/hour for mixed brackish water on Day 13 and 24.7 m^3/hour for freshwater from Day 50 onward. With a safety margin built in, we can set the maximum volume for both mixed brackish and freshwater at 25 m^3/hour each.

Next, based on a maximum usage rate of 25 m^3/hour, we can estimate the scale required for the water supply and distribution facilities from the tanks to water intake pump.

c) Elevated Tanks and Pump

Over Day 1 - 52, a maximum of 22.4 m^3/hour of mixed brackish water is to be supplied from the elevated tank, via gravity method, to the various tanks.

For 3 days (day 50 - 52), both the mixed brackish water and freshwater systems will be simultaneously operated. As a result, two elevated tanks will be required, one for the mixed brackish water and the other for the freshwater. The elevated tank can also be used as a holding tank for back washing of the filter.

i) Elevated Tank

The volume of the elevated tank is calculated by the following formula:

$$V_E = (Q_p - Q_{pu})\ T_3 + Q_{pu}T_4$$

where: V_E = effective capacity of the elevated tank (ltr)

Q_p = maximum expected supply of water at any one time (ltr/min)

Q_{pu} = amount of water to be lifted by the pump (in this design, this is set at the same level as maximum volume)

T_3 = maximum consecutive hours of pump operation at full capacity. (in this design -- set at 1 hour)

T_4 = shortest operating interval for the pump (in this design, set at 30 minutes)

From the above, taking the maximum water usage per hour at 25 m^3/hour $\doteqdot$ 417 ltr/min:

$$Q_p = 417 \text{ ltr/min}$$
$$Q_{pu} = 417 \text{ ltr/min}$$
$$T_3 = 60 \text{ minutes}$$
$$T_4 = 30 \text{ minutes}$$
$$V_E = (Q_p - Q_{pu})\ T_3 + Q_{pu} \cdot T_4$$
$$= (417 - 417)\ 60 + 417 \times 30$$
$$= 12{,}510 \text{ ltr.}$$

Allowing a 30% safety margin, the capacity of the elevated tank works out to 2,510 ltr x 1.3 = 16,263 ltr $\doteqdot$ 16 m^3.

ii) Pump for the Elevated Tank

The capacity of the water pump, with a suitable allowance for intra-pipe loss, comes to:

$$Q_{mp} = 417 \text{ ltr/min} \times 1.2 \doteqdot 500 \text{ ltr/min}$$

d) Filter Tank

In Japan, at the present time, various filteration materials are being used -- ceramic, chemical fiber, gravel, and sand. Making an overall determination, based on ease of obtaining the material, effectiveness, and maintenance, we feel it would be best to use gravel and sand, which are easy to obtain in Burma and can be expected to be reasonably effective.

The items to be filtered are trash and excess plankton, which are to be eliminated up to 100 microns.

The maximum volume of water to be filtered is 25 m^3/hour, for both mixed brackish and freshwater. On two occasions a year, there will be simultaneous use of mixed brackish and freshwater -- over the roughly 8 days period between Day 54 and 57.

On this basis, we have provided 2 filter tanks with processing capacity of 25 m^3/hour. At times other than between Days 54 - 57, one filter can serve as a reserve tank during back washing, but, normally, the tanks will be used on an alternating basis.

The area of the filter tanks is determined via the following formula:

$$A = Q/V$$

where A : filteration area

Q : amount of water to be filtered (m^3/hr.)

V : speed of filteration (m/hr.)

When conducting filteration operation of about 100 microns, the filtration speed (V) will normally be set at 2 - 3 m/hr., with the filter medium thickness set at about 2 m.

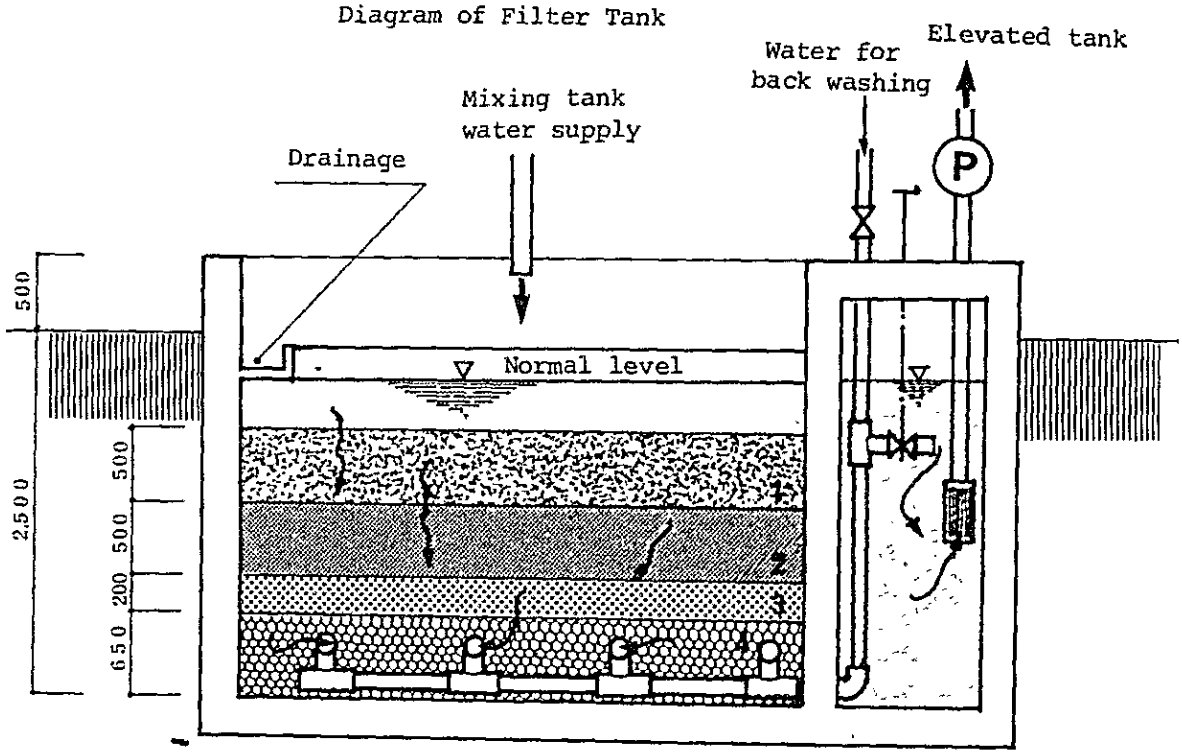
Assuming $V = 2.5$ m/hr.,

$$A = 25/2.5 = 10 \text{ m}^2$$

Allowing for intra-tank losses, we have set the area of the filter tank at 15 m^2 x 2 units.

With regard to the back washing method a bypass will be installed, from the elevated tank to the bottom of the filter. Without using a pump, water from the elevated tank and the reserve filter tank will be supplied through valve operations, together with compressed air. Thus, the gravel and sand layers can be cleaned. Used back washing water is collected via the collecting channel and then drained off. The filter construction outline is as shown in the following figure.

Diagram of Filter Tank



1. Anthracite 400mm
2. Sand 400 mm
3. Gravel 8 - 12 ø
4. Gravel 20 - 30 ø

e) Mixing Tank and Pump

By means of a mixed tank, fresh and brackish water will be mixed and the salinity is adjusted. Since the salinity of the brackish water will vary slightly depending on the time of intake and length of storage, a mixing adjustment will be necessary. While such adjustment can, technically, be accomplished automatically, this would not, in our view, be appropriate to the local conditions. Thus, in this Plan, we have chosen a method whereby, following the introduction of brackish water and during the introduction of the freshwater, salinity is measured and the mixing adjustment made manually.

The maximum use volume of mixed brackish water is 25 m^3/hr., but, in consideration of working hours and efficiency, it would be appropriate to install 2 tanks, capable of mixing and storing 2 hours' volume of water, to be operated alternately. From Day 54 - 57, there will be simultaneous operation of the mixed brackish water and freshwater systems and so, during this period, the two tanks will be separately used.

Tank capacity $\geqq$ 25 m^3/hr. x 2 hrs. = 50 m^3

On this basis, we have set the capacity of the mixing tanks at 50 m^3 and have specified 2 tanks. The routing of water from mixing tanks to filter tank will be accomplished by gravity method, using a float control.

The capacity of the pump to be used can be determined on the basis of the time required to fill the mixing tank. In this Plan, based on a 2-hour capacity of the mixing tank and alternating operation, the time required to fill the tank, allowing for valve and salinity adjustment, will be about one hour. Thus, the capacity of the pump can be calculated at:

$$Q \geqq 50{,}000 \text{ ltr} \div 60 \text{ min} = 834 \text{ ltr/min}$$

This calculated value is the combined capacity of both brackish and freshwater. The maximum mixing proportions can be set so as not to exceed 0 - 100% in brackish water and 0 - 33% in freshwater.
Thus:

Brackish water pump capacity

$$Q_{bp} \geqq 834 \text{ ltr/min} \times 100\% = 834 \text{ ltr/min}$$

Freshwater pump capacity

$$Q_{fp1} \geqq 834 \text{ ltr/min} \times 33\% = 275 \text{ ℓtr/min.}$$

After an allowance for intra-pipe loss, we can set:

$$Q_{bp} = 834 \text{ ltr/min} \times 1.2 \doteqdot 1{,}000 \text{ ltr/min}$$

$$Q_{fp1} = 275 \text{ ltr/min} \times 1.2 \doteqdot 330 \text{ ltr/min}$$

However, this freshwater pump continues to be used even after the 57th working day. We have, therefore, set a capacity value for the freshwater pump at either of a higher value of Q_{fp1} or capacity required after Day 57

(Q_{fp_2}).

From the first through the 53rd day, only mixed brackish water is supplied, but, from Day 54 - 57, both mixed brackish water and freshwater are simultaneously supplied. After Day 57, only freshwater supplied to the tanks. The freshwater that starts to be used after Day 57 is sent to the filter tank only bypassing the mixing tank. From the fact that the required capacity of the freshwater pump used at this stage is 25 m^2/hr, $Q_{fp_2} \geqq 416$ ltr/min; and, with an allowance for anticipated intra-pipe loss, Q_{fp_2} = 500 ltr/min and $Q_{fp_1} < Q_{fp_2}$. Thus, the freshwater pump capacity (Q_{fp}) may be set at 500 ltr/min.

f) Reservoirs:

The required capacity for the freshwater and brackish water reservoirs has been set as follows.

freshwater exposed pond	=	10,000 m^3
brackish water " "	=	8,500 m^3
covered concrete tank	=	2,500 m^3

Freshwater will be taken from the Pegu River, between June and October, while brackish water will be taken during February and March. The water will be distributed in accordance with the water use Plan. As the river water contains much silt and clay, heavy sedimentation in the waterway may be expected. To faculitate easy maintenance, the type of the waterway will be the open cut channel.

g) Water Intake Pit:

Since water quality will be stable at peak tides, both in fresh and brackish water, the water intake should take place at such times during March - June and September -

October, over the span of about 1 week, for 2 - 3 hours during day time.

The pump for water intake will therefore, be operated only a few days a year. In this type of facility, the pump is a very important equipment in transferring water between the ponds and for drainage operations at times of unusual flooding.

Considering an effective use during non-operating periods, and possibility of change in the location of the water intake pit due to riverside erosion, it would appropriate to employ portable, engine operated pumps for water intake use.

The required pump capacity will be 8,500 m^3/per operation for freshwater and 10,000 m^3/operation for brackish water. However, the water intake period will be different, between brackish and freshwater so the intake will never take place at the same time. Thus, the required pumping capacity must be sufficient to take in the required amount of water within 3 hours at the peak tide over the 5 - 10 days. Accordingly, the pump capacity (Q) may be derived as follows:

$$Q \geqq 10{,}000\ m^3 \div 180\ min \div 5 \sim 10\ days = 11.1\ m^3/min -- 5.5\ m^3/min$$

Assuming that the capacity of one pump will be 2 m^3/min, then 3 - 6 units will be required.

Potable Water:

In the Thaketa area, there are still no water main facilities. Drinking water will be supplied from a common well in the immediate area. A new well of 200 - 250 feet will be dug on the project site for obtaining water for human consumption in the

Administration and Lab. Building, the Seed Production Building, and the Machine House.

a) Water Usage:

With regard to the volume of water used per hour, excluding the seed production building, virtually all buildings will be operating on 6 hours a day. In the case of the seed production building, even allowing for concentrated usage when washing the tank, the working hour can be set at 4 hours.

Research Room:

1 (room) x 3 m^3 = 3 m^3/day (6 hrs.)
(estimated water usage per day) = 0.5 m^3/hr.

Office:

20 (persons) x 0.2 m^3 = 4 m^3/day (6 hrs.)
(water consumption per day) = 0.7 m^3/hr.

Machine House/
Feed Preparation Room:

6 (taps) x 0.5 = 3 m^3/day (6 hrs.)
(estimated water usage per day) = 0.5 m^3/hr.

Seed Production Building:

4 (building units) x 4 (taps) x 0.5 m^3/day
(estimated water usage)
= 8 m^3/day (4 hrs.)
= 2 m^3/hr.

Total: 3.7 m^3/hr.

b) Pump Capacity and Elevated Tanks:

The pump capacity, based on water usage per hour, after an allowance for losses, will be:

$$3.7\ m^3/hr. \doteqdot 62\ ltr/min. \rightarrow\ 65\ ltr/min.$$

The pump will be an air-life type, incorporating a compressor, widely used in the country.

The interior capacity (V) of the elevated tank is derived as follows:

$$V = Q_{pu} \times T = 65\ ltr/min. \times 30\ min. = 1,950\ ltr.$$

where:

Q_{pu}: pump capacity --- 65 ltr/min.

T: shortest operating interval of the pump (in this case, the compressor) -- set at 30 min.

Thus, the interior capacity of the elevated tank becomes $2\ m^3$.

2) Draining Facilities:

The drainage facilities may be divided into 3 categories, as shown in the following chart: storm water, waste water, and soil water.

a) Storm water, breeding water:

... to be discharged into creeks on the site by drain channel and gutter.

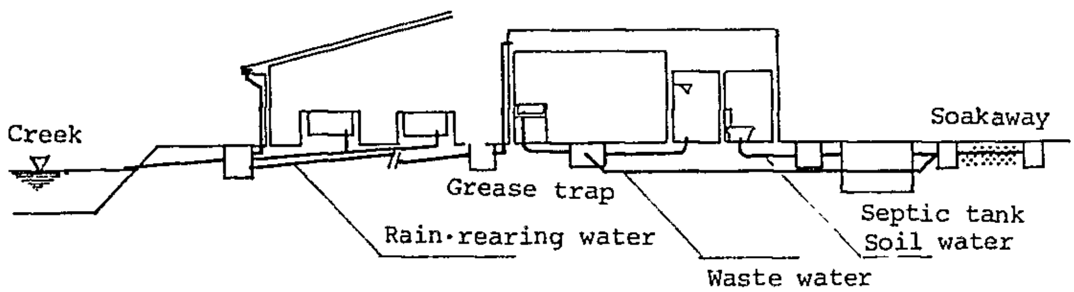
b) Waste water:

... drainage from the feed preparation room, after passing through a grease trap and catch basin, evaporates and soaks away.

c) Soil water:

... after being processed in a septic tank, the drainage evaporates and soaks away. To be based on WHO standards.

Drainage System Diagram



3) Water Recycling Equipment:

To guard against an emergency in the main water supply line, owing to contamination of the main water source, inadequate supply of breeding water, or equipment breakdown, we have provided a facility capable of recycling and filtering about 15% (24 m^3/day) of the entire volume of breeding water.

We have also specified an underground water tank, a filtering tank, a recycling pump, and a distribution tank in the seed production building along with distribution pipes for collecting and distributing water.

(3) Air Supply System:

Air supply to the rearing tanks is essential. By air supply, we mean such operations as:

1) speeding up the dissolving of oxygen in the water by aeration;

2) improving the breeding environment by providing continual movement and flow to the water.

In the blower, which provides aerating pressures, two methods are available: 1) using a turbo-blower with a low exhaust pressures; and 2) using a compressor with high exhaust pressure. If the compressor method is used, it carries the disadvantage of a low blow volume relative to the required power. On the other hand, the turbo-blower method has the advantage of a high blow volume but a low exhaust pressure. Since the maximum depth of the rearing tanks is as shallow as 1.0 m, we have selected the turbo-blower method.

Air is supplied to the rearing tanks in the seed production building and the research room in the administration and lab. building, using air blowers installed in the machine house. If we set the required air volume at 1 m^3/hr per one cubic meter of water, the total required capacity of the air blower may be calculated from the following equation:

$$(V) = (\underbrace{7.5}_{\text{(rearing tanks)}} \times 128 \text{ tanks} + \underbrace{0.5 \times 10 \text{ tanks}}_{\text{(Artemia hatching tanks)}} + \underbrace{2}_{\text{(no. of research rooms)}}) \ / \ m^3/\text{hr.}$$

$$\approx 967 \ m^3/\text{hr.} \rightarrow 16.1 \ m^3/\text{min.}$$

With a suitable margin, we have set the required volume at 20 m^3/min. The air pressure, after giving due consideration to intra-pipe loss and rearing tank depth, is set at 0.2 kg/cm^2.

So as to be able to cope with changes in water volume in response to the particular rearing stage, it is desirable to use an alternative operating system, based on multiple blower units having a capacity of about 5 m^3/min. We have provided 6 blowers, including back-up units.

The air supply pipes will be of 2 types: rigid PVC for distribution from the machine house to the rearing tanks; and soft PVC for branch piping within the tanks.

We have summarized, in the following table, the specifications and design quantities of the above facilities for water supply, drainage and air supply.

Water Distribution and Air Supply Facilities

	Equipment	To be distributed	Outline Specifications	Q'ty
Water Intake Pit	Portable Pump	Brackish water Freshwater	2,000ℓ/mm x 10mH Engine powered	6
Mixing Tank	Water Pump	Brackish water	1,000ℓ/mm x 10mH (3.7kW)	4
		Freshwater	500ℓ/mm x 10mH (1.5kW)	2
	Mixing Tank	Mixed water Freshwater	FRP tank, 50 t	2
Filteration System	Filter Tank	Mixed water Freshwater	Concrete tank, 15 m^2	3
Elevated Tank	Water Pump	Mixed water Freshwater	500ℓ/mm x 15mH (1.5kW)	3
	Elevated Tank	Mixed water Freshwater	FRP tank, 16 t	2
Water Recycling System	Water Pump	Freshwater	100ℓ/mm x 5mH (0.75kW)	8
	Elevated Tank	Freshwater	Steel plated, 1 m^3	4
	Filter Tank	Freshwater Mixed water	Concrete tank, 6 m^2	4
Deep Well	Air Lift Pump	Freshwater	65ℓ/mm x 15mH (0.75 kW)	2
	Elevated Tank	Freshwater	FRP tank, 2 t	1
Air Supply System	Air Blower	Air	5 m^3/mm (3.75 kW)	6

(4) Rearing Tanks:

A continuous series of production operations are undertaken in these tanks from hatching to rearing of seed size. Mixed brackish and fresh water supply, drainage, overflow, and air supply are necessary functions of each tank. We now consider the piping facilities needed to handle these various functions.

1) Water supply pipes:

Water is to be supplied via gravity method from elevated tanks of a hight of about 10 m. The maximum supply per unit hour of mixed brackish water and freshwater in each tank is determined on the basis of the time required to fill the tank. In this Design, we have set the required filling time, in accordance with the work plan, at 30 minutes. The maximum supply then, based on a maximum water usage in each rearing tank of 7.5 m^3, comes to 7,500 ltr ÷ 30 min = 250 ltr/min.

Setting intra-pipe velocity at not more than 2 m/sec, we can estimate the approximate diameters of the main water supply pipes as follows:

The allowable head loss (i) is determined from the following equation:

$$i = \frac{(H - H') - H_l}{L + L'} \times 1{,}000$$

where:

H (hydrostatic head) = 1.0 m (water surface height of the elevated tank)

H' (height of water tap) = set at 1.2 m

H_1 (height equivalent to the required water supply pressure) = 3 m (0.3 kg/cm^2)

L (pipe length) = 100 m (estimated value)

L' (equivalent pipe length
of joints and valves) = 50 m (estimated value)

From this:

$$i \doteqdot 40 \text{ mm Ag/m}$$

Based on the above, the pipe diameter, if derived from the data in Appendix (xi), becomes ø 65 mm. Adding an appropriate safety allowance, we have set this at ø 75 mm.

2) Drain Pipes:

Drainage from the bottom is accomplished through valve adjustment. If, based on the work plan, we set the drainage period for the entire $7.5m^3$ volum in each water tank at 30 minutes, the cross section (A) of the drainage pipes is derived from the following equation:

$$t = \frac{2F}{CA\sqrt{2g}} h_1^{\frac{1}{2}}$$

where:

t : drainage time (30 min x 60 seconds)
F : tank area ($7.5\ m^2$)
C : flow coefficient (0.62)
h_1: hydrostatic head (1 m)
g : gravity acceleration ($9.8\ m/sec.^2$)

Thus:

$$A \doteqdot 0.00303\ m^2$$

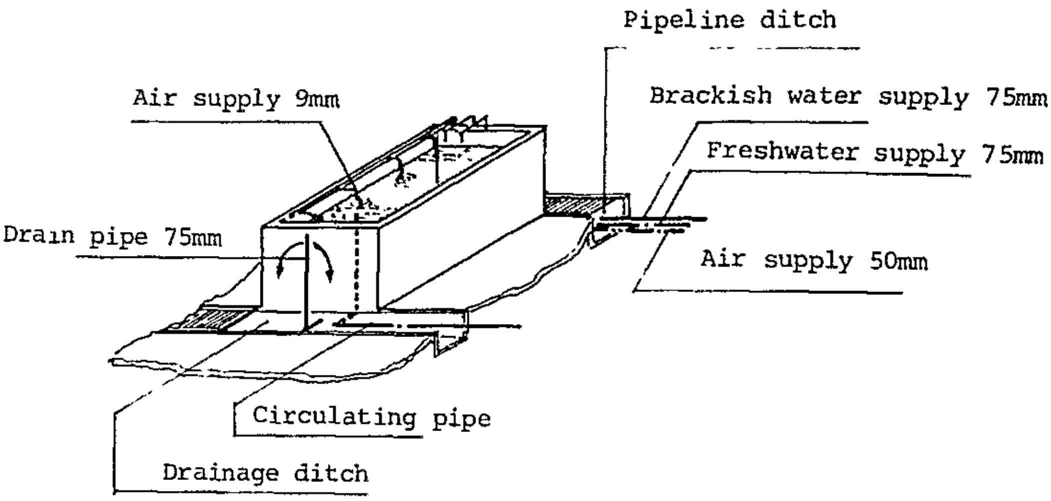
From the above, the required drainage pipe diameter becomes ø 62 mm, which we have increased to ø 75 mm to allow for valve and elbow loss.

Attaching to the drain of the tank, a standing pipe is is stalled to adjust the water level in accordance with the required surface height via overflow.

3) Air pipes:

In the various tanks, a maximum of 1 m^3 per hour of air must be supplied for every cubic meter of tank water. With air supply nozzles of 9 mm set at 4 locations in each tank, at intervals of about 1.2 m, the air is supplied through soft PVC pipes. Air stones are used at each terminal.

Diagram of Piping System for Rearing Tank



(5) Electrical Equipment

1) Power Supply Facilities:

The Rangoon Power Corp. runs overhead high-voltage power distribution lines into an area adjacent to the planned site from which power can be received. Electric poles will be built to carry power onto the site. Voltage will be dropped, via pole-mount transformers, from the 6.6 kV 50 Hz, as received, and distributed to the power distribution board within the facility.

The voltage to be used will be:

3 ϕ 400 V and 1 ϕ 230 V.

The power requirements for the various facilities are estimated as follows:

a) Lighting equipment, and outlets: 18 kW

Lighting	10 kW
Outlets	5 kW
Equipment	3 kW

b) Power facilities --
blowers, water pumps; compressors, etc. 28.55 kW

Blowers	14.4 kW
Water pump	7.4 kW
" "	3.0 kW
"	3.75 kW

c) Power for air conditioning and ventilating equipment 26 kW

Air conditioner	12 kW
Ventilating fan	10 kW
Ceiling fan	4 kW

d) Equipment for research use 10 kW

e) Other equipment 16 kW

Drying machine for feed processing	5 kW
Mixer	1 kW
Refrigerator, other	10 kW

Total: 98.55 kW

On the basis of the above, we can set the load power capacity, after providing an appropriate margin of safety, at 100 kW. We have considered that this level is acceptable by local power supply conditions.

2) In-house Generator:

Power stoppages are particularly frequent during the rainy season. In the subject facility, where living marine organisms are to be continually raised, an in-house generator is an absolute necessity.

The generator is to be provided with an engine permitting continuous operation. Facilities which will receive power from the generator will include: water and air supply facilities, research equipment, refrigerator, air conditioning equipment, and emergency lighting facilities. The generator will be an automatic-starting type; thus, when regular power is cut off, power will automatically be fed from the generator to the target facilities.

Generator capacity has been set as follows, based on the following list of the power consumption of the various facilities to be served by the generator:

1.	Air-lift pump	0.75 kW
2.	Water pumps	7.4 kW
3.	Air blowers	1.5 kW
		3.0 kW
		14.8 kW
4.	Refrigerator	3 kW
5.	Air conditioner	12 kW
6.	Research equipment	3 kW
7.	Emergency lighting	3 kW
	Total:	47.45 kW

Generator capacity is set at the highest value among the following computed capacities:

a) PG_1: Capacity derived on the basis of the generating load under regular operating conditions

$$PG_1 = \frac{0.75}{0.85 \times 0.85} + \frac{11.9}{0.92 \times 0.85} + \frac{14.8}{0.85 \times 0.85} + \frac{3+12}{0.75 \times 0.85} + \frac{3+2}{0.8} = 66.52 \text{ kVA} \quad \text{..........} \ (1)$$

b) PG_2: Capacity determined on the basis of the momentary voltage drop of the generator at the time the most powerful motor is started --

The capacity (kVA) at the time of starting up the most powerful motor

$= \sqrt{3} \times 230 \text{ V} \times 100 \text{ A} \times 0.67 \times 10^{-3} = 26.5 \text{ kVA}$

$$PG_2 + \frac{Xd\ (1 - \Delta E)}{\Delta E} \times \text{capacity at time of start of operation}$$

$$\frac{0.21\ (1 - 0.3)}{0.3} \times 66.52 = 32.6\ \text{kVA} \quad \ldots\ldots\ldots\ (2)$$

c) PG_3 : Capacity as determined from the transit maximum load of the generator when the biggest load comes on last.

$$PG_3 = \frac{Xd\ (1 - \Delta E)}{\Delta E} \times \text{(total of loads during periods of regular operations load of the most powerful motor during regular operating periods + load at the time of starting up the largest motor)}$$

$$= \frac{0.21\ (1 - 0.3)}{0.3} \times (66.52 - 20.48 + 26.5)$$

$$= 35.55\ \text{kVA} \quad \ldots\ldots\ldots\ (3)$$

Comparing the 3 values obtained:

$$PG_1 < PG_3 < PG_2$$

On this basis, we shall require a generating capacity of at least 66.52 kVA.

3) Trunk Line Facilities:

Power for the various pieces of equipment will be distributed via control panels. The trunk line facilities from the power distribution board to the control panels will be of the burried pipe distribution type, with some section overhead lines. Exposed piping sections will use pipes of rigid PVC.

4) Lighting Equipment:

For ease of maintenance and handling, it would be desirable to use fluorescent lighting equipment, for which tubes are obtainable locally. Incandescent lighting fixtures will also be used, as necessary.

Illuminance is set as follows for the various rooms.

General office	300 LX
Research area, library	400 LX
Conference room	300 LX
Seed production area	150 LX
Warehouse, machine house, lavatories, corridors	100 LX

5) Outlets:

Outlet circuits will be separately provided for general use and for use with research equipment, ceiling fans, and ventilating fans. In areas using water, outlet circuits will all use short-circuit breakers.

6) Control and Alarm Facilities:

Use of control and alarm system for the various facility groups will, in principle, be held to the minimum necessary level, considering for maintenance. Overspecification will be avoided.

The control and monitoring system for this facility is established as follows:

The water pump is automatically controlled by the electrode installed in the elevated tank. The air blower will have an automatic turnoff based on a built-in pressure switch. Air conditions, coolers, ceiling fans and ventilating fans will all be manually operated.

An alarm system will be connected to the water level in the elevated tanks, the various pumps and the air blowers. When there is an emergency in any of these equipment, an alarm will be sounded so as to maintain a safe environment for prawn seed and to protect various items of equipment.

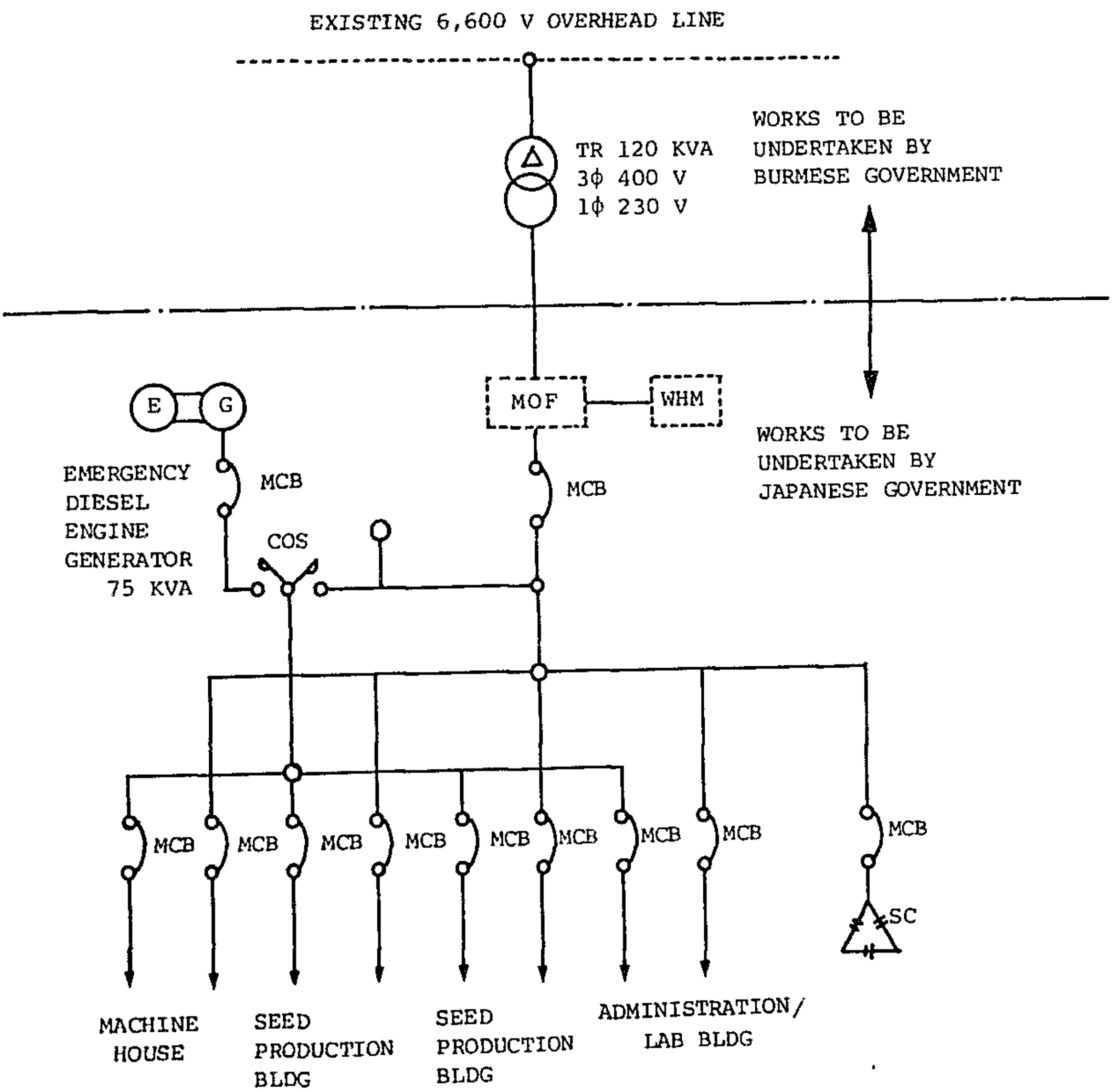
7) Manually Operated Fire-alarm Equipment --

Fire alarm equipment, activated by push buttons, will be installed for emergency use in the administration lab building, the machine house, and the seed production building.

8) Power Diagram --

The power diagram is shown in the following chart:

Power Diagram



(6) Communication and Broadcast Facilities:

1) Interphone and telephone equipment:

To permit inter-office telephone communication within the subject facility, an inter-com system will be installed in rooms requiring this service.

The bringing in of outside telephone lines is the responsibility of the Burmese side, but distribution conduit for wires are included in the scope of the construction plan.

(7) Air Conditioning and Ventilating Equipment:

1) Air Conditioning --

Air conditioning is not widespread in Burma. Even within the city of Rangoon, it is used only to a limited extent. In the subject facility, natural ventilation will, as a general principle, be relied on, supplemented by ceiling and other types of fans.

However, in the equipment room, where precision instruments are to be installed and testing chemicals are to be stored, and in the room where feed materials are to be stored, the temperature and humidity will be controlled by air conditioning equipment.

2) Ventilating Equipment:

Forced ventilating equipment will be installed in the research room, the feed preparation room, the generator room, the dark room, and lavatories.

(8) Lightning Rods:

Particularly during the rainy season, there is frequent thundercloud formation, and so considerable damage is caused by lightning. We noted that existing facilities above a certain size in Rangoon area were equipped with lightning rods. In the subject facility, rods will be placed on the buildings and elevated tanks.

3-3-7 Aquaculture Equipment

In this section, we shall cover the selection and quantities of the aquaculture equipment and materials included in this Plan. These items comprise: equipment for measuring environment; research equipment; and production materials.

The four facilities for which these items are intended include: the Thaketa Seed Production Center, which is to be built under this Plan; the Kyauktan Seed Production Center currently being built by the PPFC; and the culture farms at Thanatpin and Hmawbi.

With regard to the power distribution for Thaketa Center, plans call for distribution of 3-phase 400 V and single-phase 230 V., 50 Hz. Water supply can be accomplished by an on-site well.

Power is also available at the Kyauktan facility, but, under present conditions, for only 6 hours a day. Water supply is expected from wells in the immediate vicinity.

No power facilities exist at either the Thanatpin and Hmawbi culture farms.

Gas cylinders are not expected to be available at any of the four facilities.

Given the conditions prevailing at the above four facilities, we have established the following selection criteria for equipment and materials:

... Taking into account basic functions, amenities, and production scale at the various facilities, we will select types and quantities of equipment and materials fully compatible with these conditions.

... Selection of research equipment will, as a basic rule, give priority to practical equipment. This equipment will be limited to items used in feed development, disease prevention, and technical development.

... Selection of materials will be weighted to model equipment that will be effective in raising productivity and fostering technical development.

... As a basic principle, the equipment will comprise items that do not require a high degree of technical know-how for maintenance or repairs.

... It would be desirable to avoid the use of any equipment requiring replacement parts or disposable supplies that are difficult to obtain in Burma.

In addition, we have established the following individual selection criteria for the each facility:

Thaketa Seed Production Center
(Subject facility in this Plan)

As a specialized facility dedicated to the hatching and rearing of seed prawn, this center will require the largest production capability of any such operation in Burma.

We anticipate that there will be many technical problems that will require solution, and so we will put major emphasis on research instruments and equipment that can deal with such problems. Environmental measuring equipment and production materials of a certain level will also be incorporated.

Kyauktan Seed Production Center:

Since this is a facility now under construction, selection will focus on materials which would otherwise have to be purchased with foreign exchange -- primarily environmental measuring instruments and production materials.

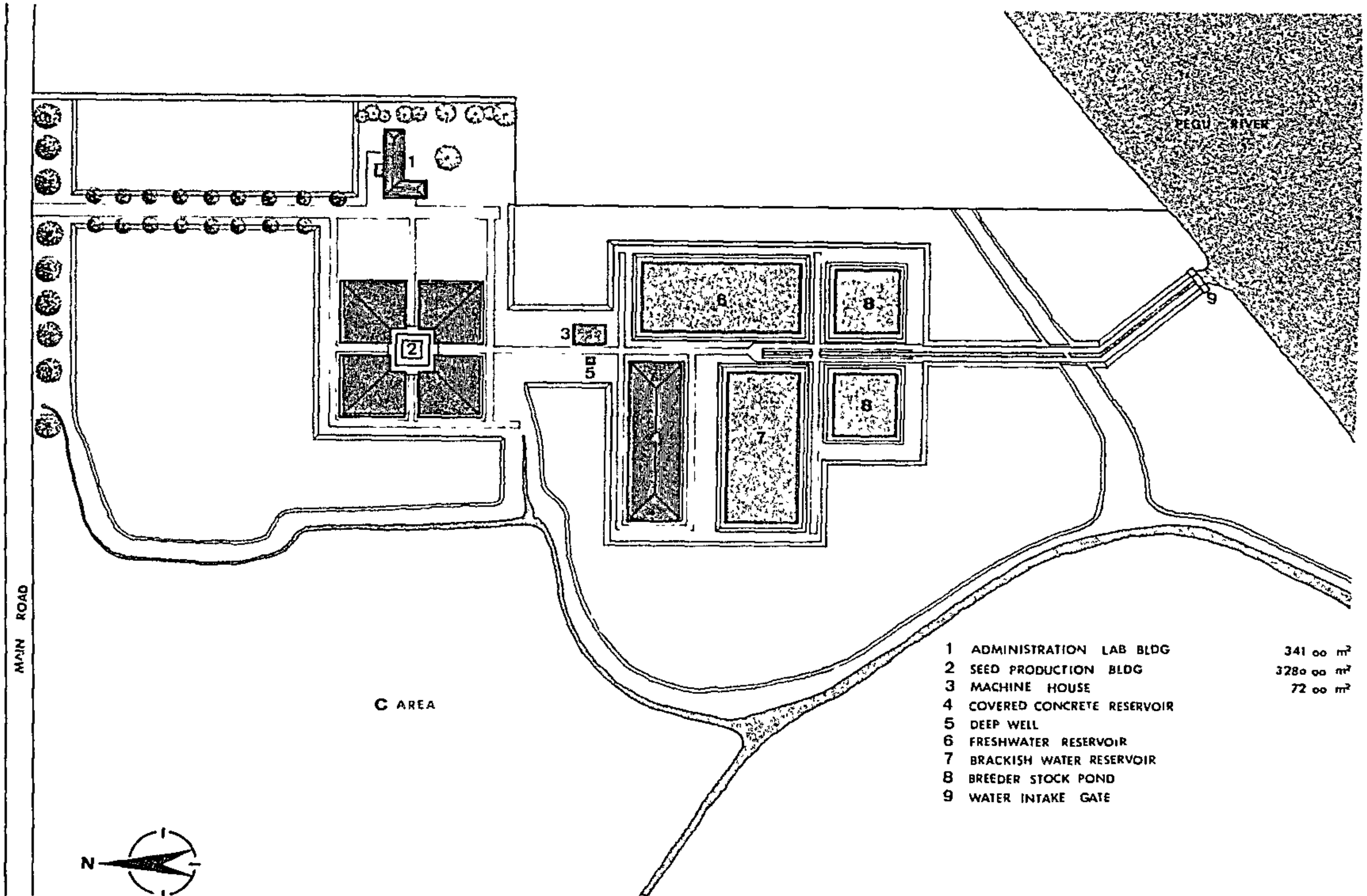
Culture Farms at Thanatpin and Hmawbi:

Items will be limited to production and other materials required for local operations. We will consider also furnishing work vehicles for culture ponds to improve the efficiency of production activity as well as civil engineering equipment for use in pond maintenance.

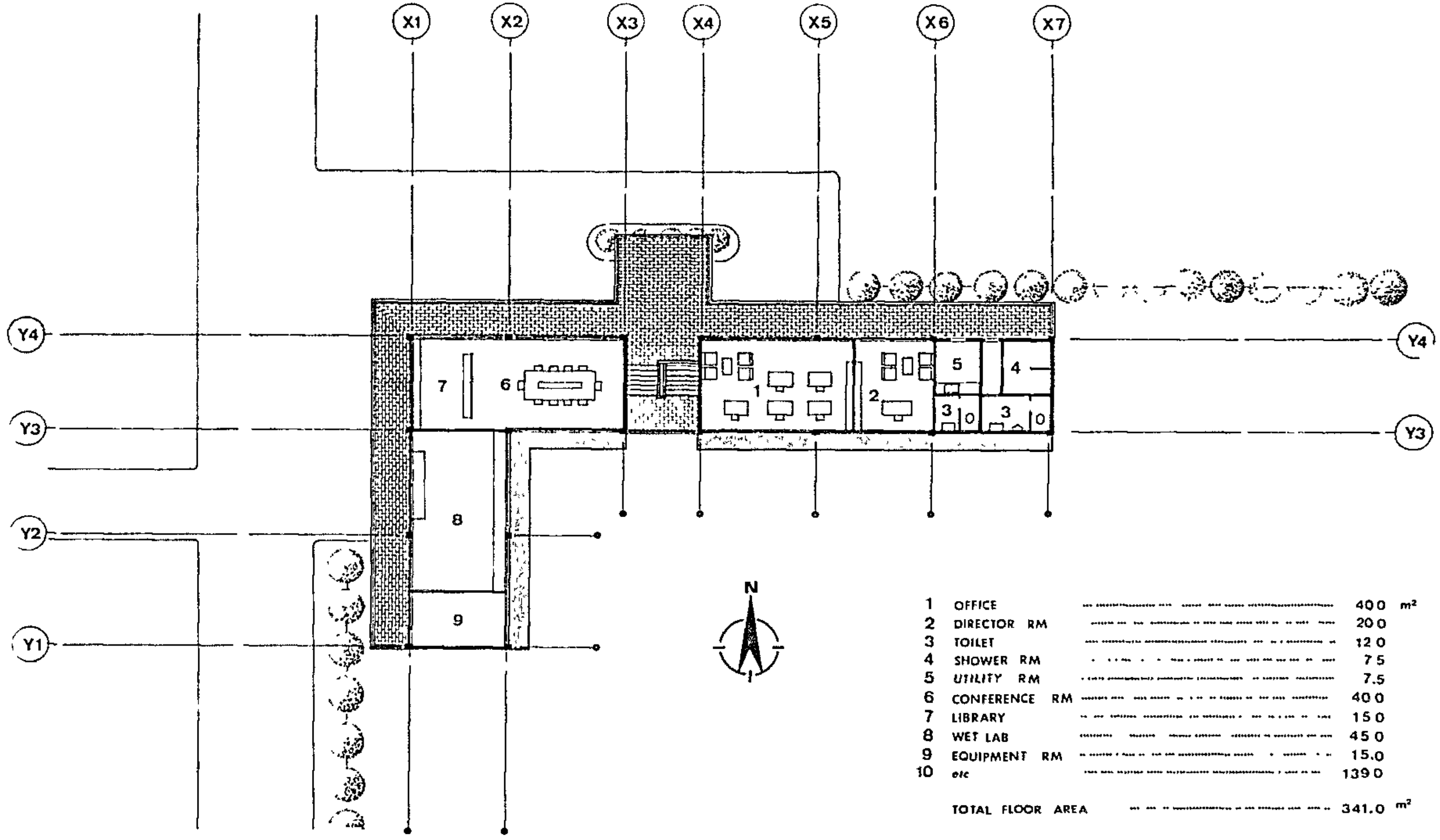
We have listed, in Appendix (xii), the specifications and quantities for the aquaculture equipment and materials that have been selected on the basis of the above criteria.

3－4 Basic Design Drawings

The Basic Design Drawings for the Seed Production Center is shown on the following pages.

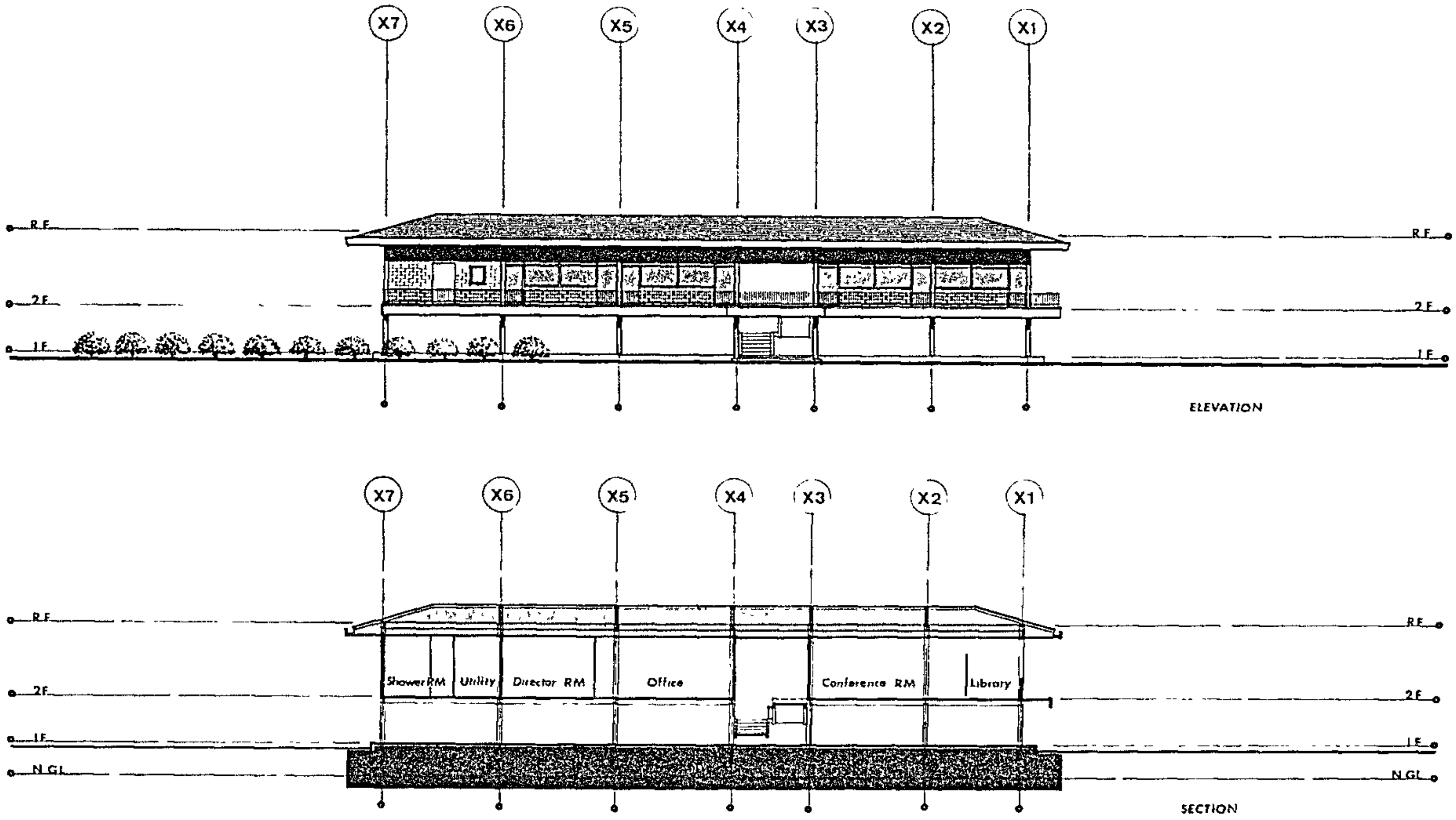


LOCATION PLAN

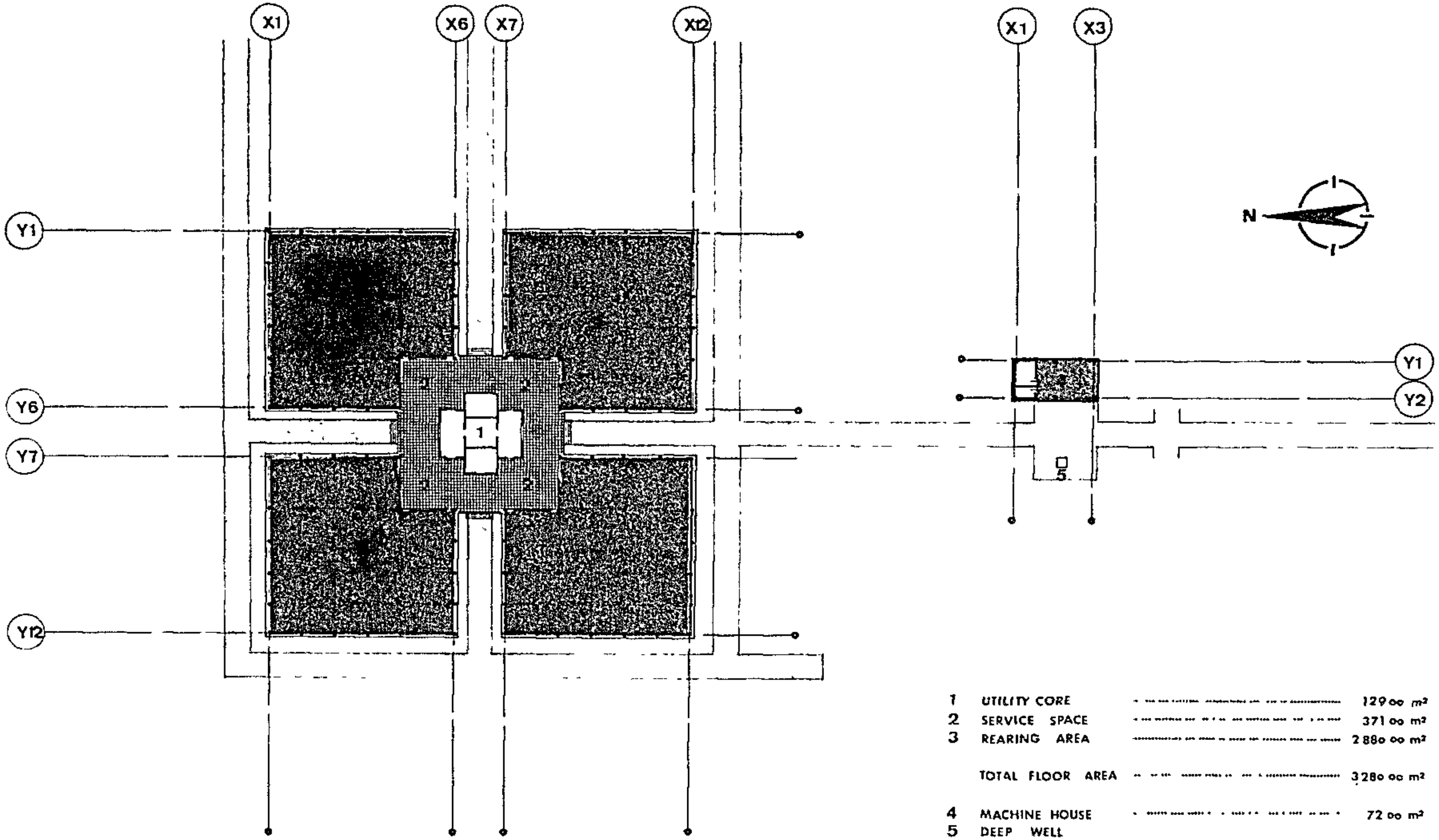


1	OFFICE	40.0 m²
2	DIRECTOR RM	20.0
3	TOILET	12.0
4	SHOWER RM	7.5
5	UTILITY RM	7.5
6	CONFERENCE RM	40.0
7	LIBRARY	15.0
8	WET LAB	45.0
9	EQUIPMENT RM	15.0
10	etc	139.0
	TOTAL FLOOR AREA	341.0 m²

ADMINISTRATION / LAB BLDG 1-ST FLOOR PLAN



ADMINISTRATION / LAB BLDG ELEVATION & SECTION



1 UTILITY CORE .... 129.00 m²
2 SERVICE SPACE .... 371.00 m²
3 REARING AREA .... 2 880.00 m²

TOTAL FLOOR AREA .... 3280.00 m²

4 MACHINE HOUSE .... 72.00 m²
5 DEEP WELL

SEED PRODUCTION BLDG GROUND FLOOR PLAN

0 10 20 30m