مشروع تنمية الثروة السمكية

EGYPT AQUACULTURE PROJECT

For: The Ministry of Agriculture, A.R.E.
Sponsor: U.S. Agency for International Development

THE PROGRAM CONCEPT

February 5, 1980

KCM International Inc
Consulting Engineers, Architects, Applied Scientists
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in association with
PB SABBOUR
Cairo, Egypt

KCM International Inc

February 5, 1980 KCMI #270-03/AS

Mr. Salah Ezzat Zaalouk
First Undersecretary of Aquatic Resources
Ministry of Agriculture
Arab Republic of Egypt
No. 4 Tayaran Street
Nasr City
Cairo, Egypt

SUBJECT: **The Egypt Aquaculture Project (EAP)**
USAID/CAIRO Contract No. 263-0064

REFERENCE: **The Program Concept**

Dear Mr. Zaalouk:

Please find attached 45 copies of our submittal for the referenced report and the subject project.

The Program Concept represents the combined efforts expended during Phases B & C, The Data Gathering and Analysis and The Program and Concept Synthesis Phases, respectively, and, as such, we understand concludes that portion of contracted work.

The project team views this report as a positive instrument by which to establish mutual understanding and to form a basis for decision making in the subsequent phases of the project's development.

Inasmuch as the fundamental basis of the Program Concept has its roots in the origins of the combined MOA/USAID goals and objectives and in the interest of avoiding further delays, we feel confident in proceeding forthwith in Phase D: The Schematic Design Phase. To incorporate your comments effectively in the next phase of work, we are looking forward to your reply on this submittal by February 15, 1980. To minimize disruption of the schedule, it would be of utmost benefit that your final comments reflect accord mutual to both MOA and USAID; your coordination would reduce the likelihood of contradiction which might otherwise occur.

We are looking forward to submitting Phase D: The Schematic Design Phase for your review by the latter part of March.

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The International subsidiary of
Kramer, Chin and Mayo, Inc.
Consulting Engineers, Architects and Applied Scientists

On behalf of the KCMI/PBS project team, we would again like to reaffirm our continued interest in and support of The Egypt Aquaculture Project (EAP) and wish to express our utmost endeavor to meet its timely completion.

We hope this meets with your approval. Should you have any questions, please do not hesitate to contact us directly.

Sincerely,

KCM INTERNATIONAL INC

Ross F. Hart, ASLA
Project Manager

Luke K. Gjurasic, R.A.
Project Leader

cmw

cc: AID/Armstrong
AID/Ginnely
PBS/El Sadek
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Enc:

EXECUTIVE SUMMARY

This report is the conceptual and technical planning document for the Egypt Aquaculture Program developed by the Government of Egypt Ministry of Agriculture (MOA), and the United States Agency for International Development (USAID).

The report has been prepared for MOA by the staffs of KCM International (KCMI) of Seattle, Washington, USA, and P.B. Sabbour of Cairo, Egypt, under contract 263-0064 (USAID) between MOA and KCMI.

The concept is based on the best aquaculture technology currently available for large-scale production systems for fish, and respects other national priorities for the limited resources of water and agricultural land.

Specific goals and objectives within the concept are based on figures for production capacities and staffing developed by MOA and USAID, and subsequently finalized and approved through the response to the working paper submitted by KCMI in November 1979.

The focus of the program is the National Aquaculture Center (NAC) at El Abbasa. The NAC will include a complex of administrative and laboratory buildings, a hatchery for the production of carps, staff houses, accommodations for trainees and students, facilities for extension workers, and an extensive area of research and production ponds for work with carps, tilapias, and mullet. The NAC will cover an area of 200 feddans. Its production capacity will be 7.0 million fry of carp, 9.5 million young tilapia, and it will be able to accommodate distribution of 16 million young mullet. The probable cost of construction for this portion of work is estimated at US $ 11,635,000.

A Model Homestead Complex (MHC) of 1,200 feddans will be constructed adjacent to the NAC. The complex will consist of 79 individual farms of approximately 16 feddans each. A fish processing plant will be available for the farmers. Adjacent to the complex will be a small village, shops, and a mosque. The probable cost of construction for this portion of work is estimated to be US $ 21,620,000.

A new intensive production hatchery for carp will be built at the existing government fish farm at Serow. The hatchery will contain laboratory and administrative support facilities. The existing ponds will be refurbished and a number of new ponds constructed. The probable cost of construction for this portion of work is estimated to be US $ 1,804,000.

Two fish fry collecting stations, seasonally accommodating 30 million fry each, will be constructed on the Mediterranean coast to improve the survival of the natural resources of mullet in the region. Each collecting station will consist of raceways and a small building. The estimated cost of construction for this portion of work totals US $ 4,032,000.

A fish market will be constructed at Zagazig to provide a new outlet for the increased volume of fish produced by the program.

Operation and maintenance of all these facilities will require the employment of 216 personnel with a range of professional and artisan skills, and general laborers. Education and training for the majority of these personnel is planned during implementation of the second phase of the Egypt Aquaculture Program which will start in 1980, together with an extension program for farmers. The second phase will include a revolving credit and loan program. Construction of all facilities will be completed by June 1982.

The estimated total cost of the construction of all the facilities developed in the program is US $ 39,091,000. This cost does not include offsite improvements to existing irrigation canals and drains at NAC which must be reconditioned and maintained in their original state. Without the maximum capacity of water in these canals, the production objectives of the program as defined can not be fully met.

EGYPT AQUACULTURE PROJECT
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(separate volume)

ACKNOWLEDGMENTS

The following members have contributed significantly to the making of this report.

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SPONSOR: USAID

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EGYPT AQUACULTURE PROJECT
FOREWORD

Development of the Program Concept for the Egypt Aquaculture Project (EAP) began in September 1979 when the KCM International (KCMI) project team and their Egyptian counterparts, P.B. Sabbour, formally met with the Ministry of Agriculture (MOA), the client, and the U.S. Agency for International Development (USAID), the sponsoring agency. The meetings formally initiated the project and the development of the aquaculture program concept.

Prior to the September 1979 meeting, Mr. Ron Mayo and Dr. Colin Nash (KCMI) conferred in Egypt with Messrs. S. E. Zaalouk (MOA) and G. Armstrong (USAID) to do preliminary planning.

The Program Concept which has evolved since these meetings is presented in this report. It defines the project as a whole and is in part the foundation for all subsequent contracted portions of the project.

The report has been organized to reflect the fundamental makeup of the EAP and is divided into the following major sections.

- **National Aquaculture Center - El Abbasa (NAC)**
- **Model Homestead Complex - El Abbasa (MHC)**
- **Serow Fish Hatchery (SFH)**
- **Mullet Collecting Stations (MCS)**

The El Abbasa Way Road (AWR) project has been included as a subproject of the NAC, and the Zagazig Fish Market project will be addressed when the EAP has been developed to a level sufficient to ensure the market will be in context. For each of these major projects the following chapters define the basic biological, engineering, and architectural concepts.

General Project Profile - Outlines the nature and purpose of the project's major functional systems and shows how they relate and give rise to the building and site programs presented in subsequent chapters.

Biological Process Design - Defines the fish production goals and methods of achieving them, and establishes the initial biological criteria for subsequent engineering.

Project Site and Project Building - Establishes site and building needs based on biological and other functional requirements. Technological constraints, existing site conditions, and budgetary limitations are considered.

Engineering Systems - Presents preliminary engineering concepts for responding to biological requirements as well as to those needs generated as a result of the building and site programs.

Estimated Cost of Construction - Summary - Presents probable costs based on previously outlined goals, needs, and responses. Because the program concept does not present detailed designs, the costs are approximate and the level of accuracy can range from a minus 20 percent to a plus 30 percent. It is worthwhile to note that historically project costs tend to increase rather than decrease as subsequent phases of a project unfold.

Background information for the program concept is presented in a separate volume, The Program Concept - Appendices, and includes back-up data on such subjects as climate, soils, and costs.

In determining the recommended goals, programs, and systems, the design team considered a range of alternatives. However, this report presents only those concepts considered most appropriate for the project.

The recommendations are based on reports and facts available to date. In instances where reliable data were not available, professional judgment was exercised. The goal of this phase of the EAP was to define, in a comprehensive manner, a project scope which would best benefit the Arab Republic of Egypt.

EGYPT AQUACULTURE PROJECT
INTRODUCTION, BACKGROUND, AND MASTER CONCEPT

Egypt is typical of many countries that have a firm use for aquaculture but only a small and predominantly empirical fish farming industry. These countries are presently unable to make the major transition of a rudimentary rural practice into a well-structured and economic industry because they lack the organization, the trained manpower, and the institutional base on which to establish the bridgehead.

The establishment of a national effort by the Government of Egypt to make that bridgehead has been developed over a period of five years. A preliminary fisheries survey was made by a team from the U.S. Agency for International Development (USAID) in 1976 in response to a request for technical assistance by the government. Fish farming, or aquaculture, was identified by the team as a future industry with good potential for supporting the national goal of increasing fish production.

In 1977, the Food and Agriculture Organization (FAO) of the United Nations conducted an aquaculture mission in Egypt and reinforced the earlier findings of the USAID survey. The mission's report went further and recommended an investment of LE 23.5 million over a five-year period to accelerate an effort to increase fish production in the country. FAO followed this up by supporting a one-year project to assist the government to develop a pilot farm facility.

The World Bank (International Bank for Reconstruction and Development (IBRD)) supported a second mission by an FAO team to conduct a preloan study for implementing a development program. Since then, the IBRD has conducted surveys and appraisals for the design and construction of fish farms on the Nile Delta region totalling 2,100 hectares and prepared the way for a major aquaculture development loan to the country.

Other independent development studies for fish farming in the region were conducted by teams from Germany, France, and Canada, and reported favorably on the potential for such a national program.

At the end of 1977, USAID supported another visit by a team to study the feasibility of a specific farm development program and to identify the nontechnical inputs required to expand and maintain a viable fish farming industry. The feasibility study report was followed by individual specifications for the technical background to the program.

As a result of these individual and interrelated efforts by the development banks and bilateral funding organizations, Egypt stands on the threshold of a decade of intensive effort and vitalization of an aquaculture industry. Present plans by the government call for an increase in inland fish ponds over the next five years to a total of over 50,000 feddans. There are already in existance about 10,000 feddans of fish ponds. The bulk of the development will be achieved by the IBRD project to establish eventually 30,000 feddans of new fish ponds in the Nile Delta region. In addition, USAID is developing a new 5,000-feddan complex around the region of El Abbasa. The goal of the Government of Egypt in terms of providing the necessary farming area will be substantially met by the end of 1984.

The construction of fish ponds per se will not achieve the government's goal in terms of production of food without an associated increase in infrastructural support at the national level. Aquaculture programs require the same support that is essential for efficient production of cereals and animal protein in agricultural development programs. They require good administration, education and training of scientific and technical personnel, extension services, financial credit and loan programs, processing and marketing systems, resources of seed, and last but not least, modern and efficient research and development facilities.

USAID has assisted the Government of Egypt to develop a total aquaculture program which, in a period of five years, will establish the focal point and firm foundation for a strong aquaculture industry in the country. The total program, which is to be implemented in phases, considers all the vital elements that will allow the future industry to expand and maintain itself.

The Ministry of Agriculture (MOA) has contracted KCM International Inc, the international subsidiary of Kramer, Chin & Mayo, Inc., engineers, architects, applied scientists of Seattle, Washington, U.S.A., and P.B. Sabbour of Egypt, to design and structure certain new aquaculture facilities, and to upgrade and refurbish several existing fish farming facilities in the Nile Delta region for the first phase of the program. The facilities, which are to be built as part of the first phase and completed in 1980 - 1981, are as follows:

- The National Aquaculture Center (NAC) at El Abbasa, Sharqiya Governorate. The NAC will include large research laboratory facilities, administrative support, a hatchery for the production of carp, houses for expatriate and national experts, accommodations for trainees and students, facilities for extension workers, and other resources to make the NAC a national and regional landmark for aquaculture research and development. The NAC will accommodate over 98 personnel. The NAC will have an extensive area of research and production ponds for work with carps, tilapias, and mullet. It will also have a complex of raceways and troughs, ponds for experimenting with integrated agriculture/aquaculture, and a range of ponds for testing different production methods. These facilities will enable Egyptian aquaculturists to shape existing technology into the molds needed by the country, and in ways that are most appropriate for local conditions and resources.

- The Model Homestead Complex (MHC) adjacent to the NAC for 79 farmers trained at the NAC. Each of the 79 farms will consist of production ponds, a fingerling pond, a house within a small village, and access to shops and a mosque. A communal fish processing and icing plant located at the NAC will be available for the farmers.

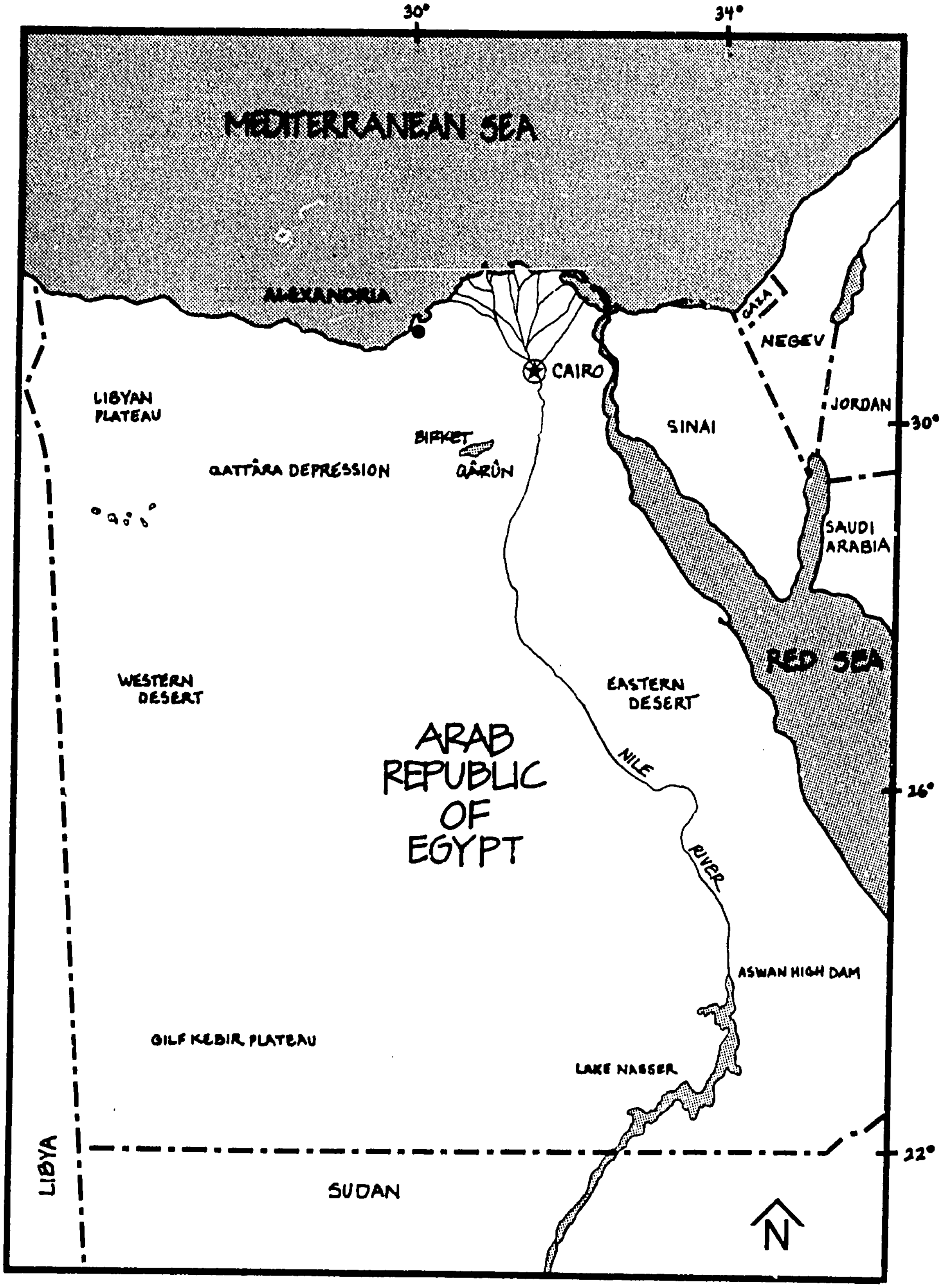
- <u>Improvements to the existing carp hatchery at Serow in Dagahliah Governorate.</u> A new intensive production hatchery for carp will be built to reinforce the extensive production system now being used at Serow. The new complex will be called the Serow Fish Hatchery (SFH). The hatchery will be similar in design to that at the NAC and have a laboratory and administrative support facilities. A number of the existing small and large pond systems will be rebuilt to meet the needs of the intensive fry production system. The SFH will accommodate 14 personnel and be an additional resource for training and extension work.

- <u>Two mullet fry collection stations</u> will be built on the coast to improve the survival of the natural resources of fry which are caught each year and to provide structured management of the resource. The fry will be sent to the NAC for freshwater acclimation before allocation to farmers, including those of the MHC. Each catching station will consist of a system of raceways or troughs for acclimating and storing the fry after collection, and an appropriate building for food storage, data collection, and offices.

- <u>A new fish market at Zagazig</u> close to the NAC to provide a ready and hygienic outlet for marketing the large volume of fish being produced at the MHC and at the NAC. The new market will be available to all fish producers in the region.

MOA realizes that Egypt has neither the technical personnel nor the trained farmers ready to take over and operate these extensive facilities. The second phase of the program is a massive five-year operation and extension/training component in all aspects of management, research, and applied technology. In addition, the ministry is establishing a large revolving credit and loan program available to the prospective farmers over the initial five-year period. The third phase is the development of over 3,800 feddans of fish ponds adjacent to the NAC and MHC for occupation by the new wave of farmers produced by the extension training program.

The Government of Egypt with the help of USAID is supporting MOA to direct a major national program. This significant effort will establish aquaculture in the next decade as a significant contributor to the country's need for self-sufficiency in food production, especially in animal protein. This approach for a total program is not original in design, but unique in the fact that it has not been attempted before for aquaculture. It will succeed because of the careful planning by the Government of Egypt and USAID, and the related support for facilities by IBRD and by FAO. The Egypt Aquaculture Project will be a model approach for aquaculture development; and the NAC and its surrounding complex of facilities will be a model focal point and resource for national and international use.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QATTÂRA DEPRESSION
SAUDI ARABIA
RED SEA
WESTERN DESERT
EASTERN DESERT
ARAB REPUBLIC OF EGYPT
NILE RIVER
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ASWAN HIGH DAM
GILF KEBIR PLATEAU
LAKE NASSER
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LIBYA
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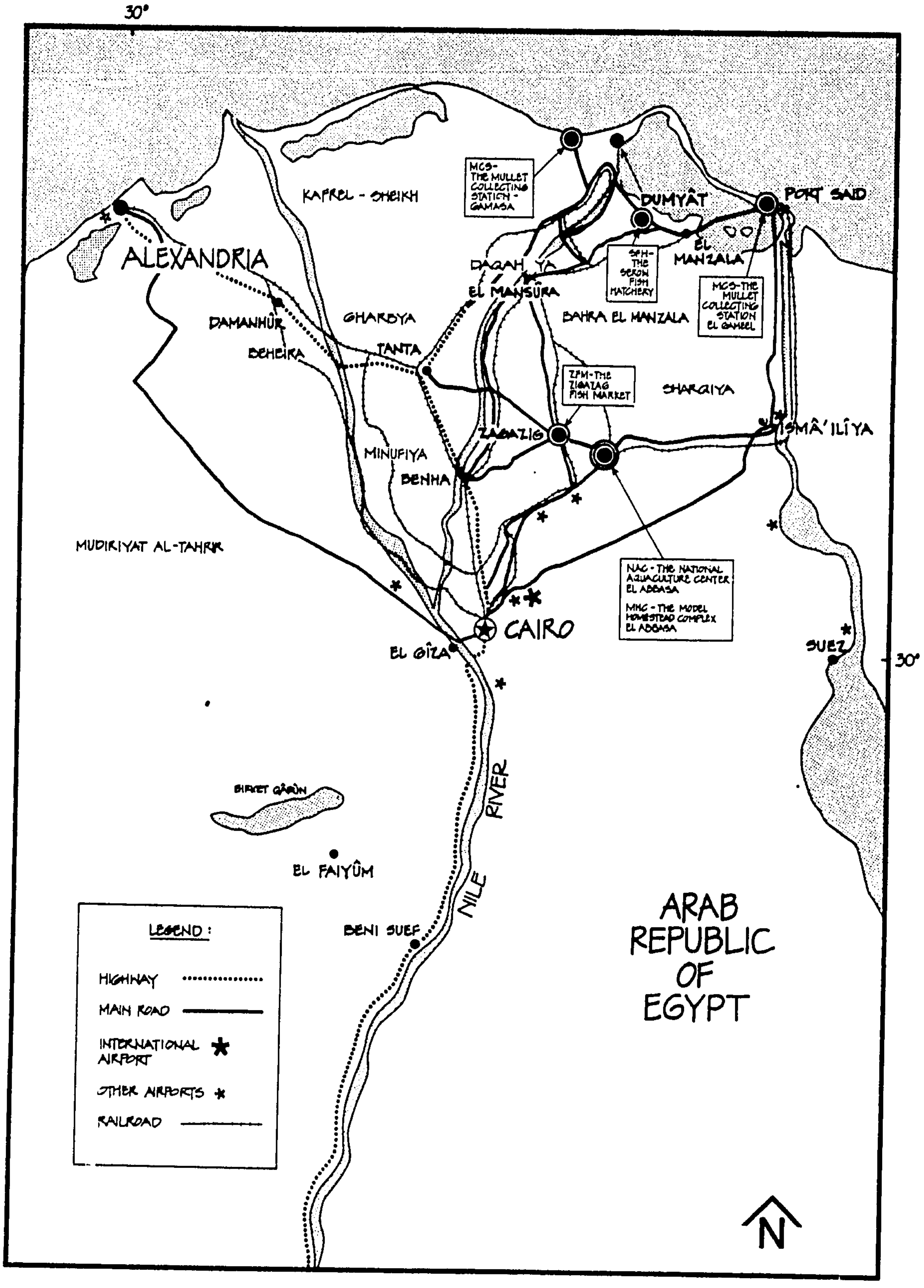
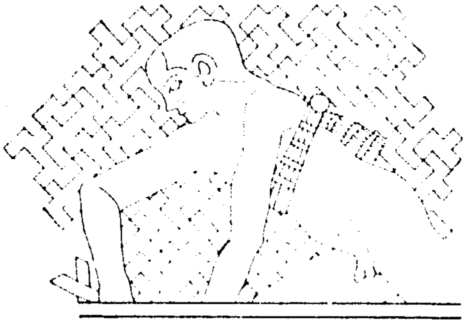
Map of Egypt



Project Location Map



NATIONAL AQUACULTURE CENTER
EL ABBASA

NATIONAL AQUACULTURE CENTER
(NAC)

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NATIONAL AQUACULTURE CENTER
CHAPTER 1
GENERAL PROJECT PROFILE

1.1 PURPOSE AND FUNCTION

The purposes of the National Aquaculture Center (NAC) at El Abbasa in the Sharqiya Governorate are: (1) to provide modern facilities where applied research can be conducted, (2) to provide training in research and development, (3) to establish extension services, (4) to conduct and demonstrate new techniques for fish farming improvements, and (5) to produce and distribute fish seed to local farmers.

The aquaculture technologies that are being developed in Egypt are already well established. Applied research and development is therefore intended primarily to fit existing technologies to the conditions which prevail in Egypt. In the future research and development will be concerned with improving fish production through such areas as genetics and stock selection, improved husbandry and nutrition, pond management, and processing and marketing techniques.

Research training will be at an advanced level for agriculture and biological students who have an interest in fish farming. It is the intention of the program that the first trainees at the NAC will be the nucleus of farmers who will occupy farms at the adjacent Model Homestead Complex (MHC), and who will subsequently consider purchasing larger areas for farming in other areas yet to be developed for fish farming.

The extension services will provide the link between the NAC and the fish farmers to keep farmers abreast of new developments in research and technology, and assist them in applying new techniques to their own situations. Demonstration projects will be a part of the extension function and will be conducted at the NAC.

Finally, the NAC will operate production hatcheries to supply seed for its own experimental facilities and to supplement the seed requirements of the MHC farmers during the initial part of their development program and subsequently during other periods of shortage.

1.2 ADMINISTRATIVE PROFILE

The NAC will have administrative responsibility not only for control of the day-to-day affairs of the complex of new facilities for the Egypt Aquaculture Program (EAP), but also for the broader aspects of aquaculture development in the region. The administrative directors will be responsible to the Ministry of Agriculture (MOA).

The director and assistant director in residence at the NAC will therefore be senior administrators and established government scientists who will have the authority to direct all research and development, appoint all national staff, and be the ultimate authority for management and operations at the new sites. They also will have the authority to relate all research and production programs to the other needs of the region, will be responsible for the collection and transfer of fish throughout the region, and will integrate the work at NAC with other technical advances in aquaculture and fisheries research conducted elsewhere.

The director and assistant director will be responsible for the appointment of research scientists and their staff, the extension officers and their staff, and the selection of students and interns who attend courses at the NAC. They will be responsible for organizing national and international meetings which might be held at the NAC and be the direct link between the national staff and the expatriate technical experts. In addition, they will have scientific and technical responsibilities within their own fields of expertise.

An administrative clerical staff will support the director and assistant director in their duties. The support staff will include a business manager and controller, and necessary secretarial and bookkeeping assistance.

The administrative spaces will be centrally located and closely associated with the public spaces and support service rooms. In addition to the separate offices for the director and assistant director, there will be offices for visiting scientists and students. There will also be spaces for public use, including a lecture theatre and library. Management of the storage and general service rooms, which will be used on a daily basis by the scientific and technical staff, will be under the control of the administration section.

1.3 EXPERIMENTAL AND RESEARCH PROFILE

All experimental work and research conducted at the NAC will be under the control of the director.

In addition to the director and assistant director, who will themselves be scientists and involved in their own research, there will be a nucleus of full-time senior scientific national staff. Each one will be responsible for research and technical development in disciplines critical to the working of the NAC complex and the other new facilities in the EAP; for example, fish nutrition, general husbandry, limnology, genetics, food processing, pathology, microbiology, reproductive physiology, engineering, and hatchery technology, etc.

Supporting the director and his scientific and technical staff will be a number of junior staff. The majority of these personnel will be junior scientists and technical assistants actively engaged in research programs, but will also include other professional staff such as the librarian and the facility engineer.

Particular emphasis at the NAC will be on research in nutrition, reproductive physiology, limnology, and pathology. For each of these disciplines there will be one or more dry laboratories and at least one wet laboratory. The two types of laboratories are distinguished by the presence or absence of running water (nondomestic water) which can be used for experimental tanks. Specific research efforts will be carried out in various laboratories according to subject area as indicated in NAC Table 1.1.

NAC TABLE 1.1
EXPERIMENTAL AND RESEARCH LABORATORIES

Space	Function
Dry Laboratories	
Visiting scientists' laboratories	Unspecified
Analytical nutrition laboratory	Analysis of dietary components
General nutrition laboratory	Diet preparation
Histology physiology laboratory	Microscopic analysis of tissues and slide preparation
Biochemistry physiology laboratory	Biochemical analysis of cellular material
General physiology laboratory	Unspecified physiological analyses
Microbiology pathology laboratory	Identify, quantify, and culture pathogens
Chemistry limnology laboratory	Aquatic chemistry
General limnology laboratory	Limnology experiments and sample preparation
Wet Laboratories	
General wet laboratory	Unspecified experiments
Diagnostics	Determination of cause of death or disease in moribund or dead fish and experimentation with remedial treatments
Postmortem	Dissection of dead fish
Weigh and measure	Determination of size of live fish
Fish processing	Post-harvest preserving and packaging

Space for conducting experiments will be provided within several laboratories designated as "general." These spaces are flexible and can accommodate a variety of projects.

Each of the senior scientists will have an individual office. The junior scientists and technical assistants will be assigned space in dry laboratories for writing and collating data as it is assumed most of their work will be directly related to the laboratories and outside facilities. For specific relationships, refer to NAC Chapter 4.

The scientific and technical staff will be responsible for all research and experimental work conducted outdoors in the variety of fish ponds available to them. They will also be responsible for the new research and development associated with the integrated agricultural farms which will use birds and animals as sources of natural fertilizer. As part of the overall program at the NAC, the operations and maintenance of the fertilizer storage facilities and animal and plant waste silos will be within the responsibilities of the scientific staff.

The experimental and research ponds, which will include the agricultural/aquacultural experimental ponds, will themselves yield a considerable annual production of fish. This fish will be processed within the

NAC site using a small ice plant and experimental processing equipment, and then sold to local markets. The produce from the integrated agricultural farm systems will also be sold. It is assumed that any revenues from these sales will contribute to the operating budget of the NAC.

The NAC will provide research facilities for other national and international staff who will work there on an interim basis. The visiting scientific staff will have their own individual offices and some experimental space but for the most part will be expected to work closely and share all facilities of both indoor and outdoor ponds with the permanent staff. For the first few years, the places for the visiting scientists will be filled by the resident expatriate experts who will work with the MOA to set up the research and development programs for the NAC.

1.4 EDUCATION PROFILE

The NAC will provide a significant educational setting designed to train personnel for research and production roles in Egyptian aquaculture. Students assigned to such positions at the NAC will participate in ongoing research efforts and may pursue university affiliated graduate research programs under the direction of the NAC. Farmers at the MHC will receive training in aquaculture technologies at the NAC prior to accepting a fish farm at the MHC.

As the NAC and its research programs are implemented, it is hoped that visiting scientists will be attracted to the NAC to pursue complementary research and to share their experience with the NAC staff. This scientific exchange is expected to start within a regional sphere and eventually include exchanges on a worldwide basis.

Educational formats have not yet been established, but may include formal classroom instruction in the NAC auditorium, classroom, and conference rooms along with the use of references in the NAC library. Student participation in laboratory and pond projects may also be included in the NAC education program.

1.5 EXTENSION SERVICES PROFILE

The NAC will be a center for the teaching of Egyptian nationals to become extension officers, as well as the focal point from which other extension agents will operate to support the needs of the future fish farmers.

For the teaching function, the extension services program will be under the leadership of a senior extension officer who will be a member of the senior staff under the director. The officer will be assisted by a second senior officer, and these two positions will bring the total of senior staff at the NAC to 10. They will be supported by 4 extension officers who, in the first instance, will act as both teachers at NAC and as extension officers assisting the existing and new farmers operating around the El Abbasa complex and at future fish farming sites within the EAP. These 4 extension officers will be considered junior staff, bringing the total complement of junior staff to 16 as indicated in NAC Section 1.10. The extension officers will be skilled in different technical disciplines such as pond engineering, fish husbandry, pond fertilization and productivity, harvesting and marketing, pest and predator control, etc. They will teach the more practical aspects of these subjects to EAP fish farmers to help them maximize their production.

In the first few years, the resident extension staff will be responsible for the training of six extension interns each year. These extension interns will become extension agents necessary for the expanding EAP, and eventually disperse throughout the country and the region. The total extension staff, upon completion of the EAP, has not yet been determined.

The extension staff will have a common office in the NAC and also have access to all laboratories and experimental facilities which will be used for teaching and demonstrating to the interns, and existing and new farmers. Instruction by the extension staff will require coordination and cooperation with the NAC research staff so as not to interfere with research projects.

1.6 PRODUCTION PROFILE

The NAC has an important role to play in the production of seed stock for new and existing fish farmers around the El Abbasa complex, and for the many experimental facilities of the NAC scientists. An important part of the NAC building is the hatchery and its related production spaces, and the many outdoor ponds. The outdoor ponds which play a particularly important role in the annual production cycles are the broodstock ponds, spawning ponds, and a variety of nursery ponds. These ponds will enable the scientific staff to experiment with a range of spawning and larval rearing techniques to develop those most appropriate for the EAP. These ponds will also produce the necessary experimental fish populations for grow-out pond experiments as well as contribute to the fry requirements for the MHC. The resources of seed stock which are required annually are species of common carp, tilapia, and mullet.

The complete cycle of common carp breeding and production will take place at the NAC. The breeding adults of the common carp will be kept in the carp broodstock ponds. The sources of these fish can be from experiments which have ended at the NAC, purchased from neighboring fish farms, or selected from any other breeding research center. Just before breeding, selected individuals are removed from the broodstock ponds and relocated in smaller, more manageable, segregation ponds. From there, individuals are selected and paired in smaller pond units for natural spawning or taken into the breeding laboratory within the hatchery complex for induced spawning. Spawned eggs from the breeding laboratory will be incubated in jars and the hatchlings reared several days in hatchery tanks prior to transfer to nursery ponds for further growth. All naturally spawned eggs will be incubated in spawning or nursery ponds dependent upon whether Dubisch ponds or kakabans are used. The Dubisch pond is a doughnut-shaped pond containing an elevated grassy spawning area; a kakaban is a framework of plant material used for egg attachment in small ponds.

The nursery ponds will be of two types—extensive and intensive. These ponds can be stocked with hatchlings or eggs resulting from either natural or induced spawning. Extensive ponds will have comparatively small populations with low water exchange rates and the fry will be dependent

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primarily upon natural food produced within the pond. Intensive ponds will have dense fry populations and contain natural feed supplies as well as receive artificial food supplements. The young fish will be transferred to larger ponds (fingerling ponds) at the NAC or MHC as they grow and the natural food supply diminishes.

Life support systems including aeration, water replacement, and live food production are required to meet the increasing demands of the young larvae in the hatchery. As part of the hatchery complex, extensive space is given to a live food culture room for the daily production of nutritionally suitable and appropriately sized for the developing larvae. These will be supplied to all fry in the hatchery as well as nursery ponds to establish populations of suitable dietary components.

Although young carp can be transferred from nursery ponds to very large outdoor production ponds for grow-out, the more successful technique is to maintain populations of juveniles together in small ponds to increase survival and to provide the basis for better management. The juvenile common carp are therefore well established and hardy before they are transferred to the final grow-out ponds. These intermediate or fingerling ponds will be at the NAC and MHC for their respective needs. All harvesting of fry and fingerling will be by netting and draining. Transport will be via live-car.

The annual cycle of tilapia production will also take place within the El Abbasa complex. Because of the reproductive behavior of the tilapia, the entire process will take place in a series of outdoor ponds. The source of broodstock for reproduction will be the production facilities at the NAC and from selected adults purchased from the nearby fish farms. Because temperatures low enough to kill tilapia can occur in Egypt, selected adults will be overwintered in heated tanks in the NAC. Solar heated circular tanks will hold sufficient adults to serve as brood for all the NAC and MHC needs. The adults will be removed from either the NAC experimental, production, or spawning ponds or the MHC production ponds in December and placed in the overwintering tanks. In February or March, the adults will be moved into the tilapia spawning ponds or the MHC grow-out ponds where they will reproduce. It is important that tilapia breeding begins early so that the juveniles will have enough time to develop fully before the next cold weather. Although large numbers of juvenile tilapia will be obtained from the spawning ponds, it is anticipated that the farmers will be able to supplement tilapia fry from natural populations which will colonize the supply canals and waterways, and from spawning within their own production ponds.

At the present time, the resources of mullet fry for the NAC and for the neighboring ponds will be the two new collecting stations being planned as part of the EAP as well as the collecting centers already established. A certain amount of acclimation of wild-spawned mullet fry to freshwater conditions and diets is necessary, and therefore all mullet coming to El Abbasa will be first located in the outdoor mullet nursery ponds at the NAC. These ponds will be sized to receive one half the mullet requirement at a time. From there they will be counted and distributed to the research and demonstration facilities at the NAC and to the MHC fingerling ponds. Eventually, the demand by the EAP for mullet fry to stock in fish ponds will exceed the capacity of the Mullet Collecting Stations (MCS) and, either additional MCS sites will have to be developed, or more likely hatcheries will have to be developed to supply mullet fry.

1.7 SUPPORT PROFILE

The laboratories, research ponds, and the production ponds will require storage space for equipment and supplies such as dry bulk, wet individual storage, equipment, chemical and solvent storage, dry food, and freezer storage.

Other support facilities will include a darkroom for photography, a storage space designated for publication materials and office supplies, an incinerator, and office for the facility engineer including a process control room.

It is expected that much of the regular maintenance required to keep the NAC functioning can be done onsite by NAC staff. This will include building, pond, and basic equipment maintenance. It is anticipated that maintenance of more sophisticated elements will be contracted to outside companies.

1.8 FEED PROFILE

Larval carp require live food organisms for about their first 10 days after first feeding. These food organisms will be cultured on the phytoplankter, Chlorella, and will consist of rotifers and cladocerans. They will be grown in the larval food production portion of the NAC hatchery. Tilapia accept artificial diets readily; however, mullet fry must be weaned onto a live freshwater diet from a saltwater diet.

Supplemental nutrients will be required in the fish ponds to maintain a high level of productivity. Fish ponds will be fertilized prior to stocking with fish and periodically during the pond culture cycle. Fertilizers used will be superphosphate and air-dried chicken manure. Supplemental feeding with cottonseed cake, rice bran, flour, and vitamins will be undertaken as necessary. Bulk storage at the NAC will permit stock piling of annual supplies of superphosphate (85 tonnes), four-month supplies of chicken manure (50 tonnes), and annual supplies of supplemental feeds (15 tonnes). Fertilizers and feed stuffs will be kept dry and vermin-free. All supplemental feeds will be prepared in the nutrition laboratories.

1.9 HOUSING PROFILE

Twelve single-family housing units will be provided for the senior staff. Of these, six will initially be assigned to temporary U.S. advisory staff and six to the Egyptian senior staff. The expatriate U.S. technical team leader and his Egyptian counterpart will be provided with somewhat larger houses than the remainder of the senior staff. Upon completion of the start-up phase of the NAC, Egyptian senior staff will replace departing expatriates in these houses.

An apartment building consisting of 10 flats will provide housing for 10 Egyptian junior staff members. NAC Chapter 5 addresses the proposed program. No other housing is planned, although there is a need for accommodations for 30 Egyptian fish farmers, 30 graduate research assistants and visiting scientists at the NAC. Future housing expansion will be located in the common facilities area described in NAC Section 3.4.3. This will include housing for junior staff, employees, trainees, and guests of the NAC.

1.10 STAFFING PROFILE

A total staff of 98 is planned for the NAC. This includes 12 senior staff under the direction of the NAC director and assistant director. Initially, 6 of the senior staff will be expatriates on temporary assignments to the NAC. The senior staff will be responsible for directing the various programs of the NAC. Ten junior staff members will assist the senior scientists and include other professionals such as the NAC librarian and facility engineer. Six extension agents and 6 extension interns will be assigned to the NAC to relate aquaculture techniques to outlying fish farmers. Up to 10 graduate students may be assigned to the NAC to conduct experiments and to support the other staff members. The remaining support staff will consist of clerical staff (10), security staff (5), drivers and mechanics (13), tradesmen (6), laborers (20), and messengers and coffee staff (12). Additional staff may be added as the NAC expands.

1.11 EL ABBASA WAY ROAD (AWR) PROFILE

The NAC is located on the El Abbasa Way Road (AWR) between the El Wadi drain and the AWR. The AWR is the principal connecting link between the NAC, the MHC to the east, El Abbasa, and other villages to the west. All visitors, staff, supplies, and fish shipments to and from the NAC will utilize the AWR. Consequently, the AWR must be maintained for heavy truck traffic.

1.12 OFFSITE IMPROVEMENTS

The successful operation of the NAC facilities and its surrounding complex will require several modifications and improvements to existing offsite structures.

The two major improvements required are:

- Increased water flow through the Ismailia and El Wadi Drain Canals by routine removal of silt and aquatic vegetation
- Maintenance of the El Abbasa Way bridge over the Ismailia Canal

Both these items are discussed in detail in the technical section of this report.

NATIONAL AQUACULTURE CENTER
CHAPTER 2
BIOLOGICAL PROCESS DESIGN

2.1 CARP PRODUCTION PROGRAM

2.1.1 Production Goals

The goal of the carp production program is to produce seven million 2-g fry annually. These fry will be used to stock the 800* feddans of production ponds at the Model Homestead Complex (MHC) the experimental training and brood ponds at the National Aquaculture Center (NAC), and approximately 3,800 feddans of additional production ponds anticipated to be constructed in the El Abbasa region.

Although 2-g fry are too small for successful stocking in production ponds, rearing from 2-g fry to 40-g fingerlings will take place in the fish farms themselves. Only fingerling production facilities for the estimated 48,000 carp fingerlings needed at the NAC will be provided.

2.1.2 Production Techniques

Two methods of spawning will be used to meet program requirements: natural spawning under controlled conditions and induced spawning. Natural spawning will take place in Dubisch ponds and concrete tanks containing kakabans. The principles of each are described below. Induced spawning will take place in the breeding room in the hatchery facility. The rationale for including facilities for both types of spawning is to permit experimentation while meeting annual production goals, and to allow a gradual transition between the low technology spawning methods to the more sophisticated induced spawning method.

Nursery ponds will be used to rear the hatchlings to 2-g size. If kakabans are used, the nursery ponds will also serve as hatching ponds. There will be two general types of nursery ponds: extensive and intensive. Extensive ponds will have a low stocking density and very little water exchange. By comparison, intensive units will contain dense populations with relatively high water exchange level and artificial feeds.

2.1.2.1 DUBISCH PONDS

Dubisch ponds are small, square ponds which are used both for spawning and early rearing. Each is surrounded by a peripheral ditch about 40 to 50 cm deep. In the center there is a grass covered spawning board with 15 : 1 slope. Prior to spawning, the water level is adjusted so that the

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* Note these are the approximate pond surface areas which can be constructed in the 1,200-feddan area if dikes, access roads, fingerling ponds, etc. are included.

spawning area is submerged. Eggs will be deposited on the vegetation in the center spawning board. The adults are removed from the peripheral ditch immediately after spawning, and the eggs are allowed to hatch. Statistically, 15 to 50 percent of the eggs will hatch. After hatching, the water level is lowered so that the fry are forced into the peripheral ditch. They can remain there for approximately 10 days until crowded conditions force transfer to nursery ponds.

2.1.2.2 CONCRETE PONDS WITH KAKABANS

Spawning with this method will take place in small, oblong ponds. These should be completely free of vegetation and the bottoms dried out for several days before being filled. In the afternoon of the day the ponds are filled with water, the kakabans are put in place and the brood fish released.

Kakabans are made of fibres taken from *Arenga pinata* palms or other suitable plants. The fibres are set out in layers from 1.2 to 1.5 m long and 40 cm wide and pressed down lengthwise by two bamboo slats so that they are about 4 to 5 cm thick. The kakabans should be placed side by side and attached perpendicularly to a long bamboo pole which supports the ensemble and is held in place by four posts driven in pairs at each end. The weight of the kakabans keeps them buoyed just below the surface of the water.

About 5 sq m of surface are required for each kilogram of female weight. One female of at least 3 kg and one to three males will be stocked in each pond. Although it is normal for spawning to be completed within 24 hours after stocking, a maximum of five days before restocking has been allowed in the production programming. After spawning, the egg-laden kakabans are placed in the prepared nursery ponds at a stocking rate of 600 eggs per square meter. A 15 percent survival rate to a size of 2 g (30 days old) is assumed.

2.1.2.3 INDUCED SPAWNING

All activities associated with induced spawning will take place in the production facilities which contain four major spaces: breeding room, hatchery, outdoor troughs, and live-food culture.

Brood will be selected from the outdoor ponds and brought into the breeding room. Up to 4 females and 12 males can be handled per day. A total of 12 tanks will be required in the room to facilitate hypophysation of females, anesthesia, spawning, and recovery.

After fertilization, eggs can be taken to the outdoor tanks for eyeing or directly to the hatchery where they will be placed in Zuger jars until hatching.

Upon hatching, the fry will be transferred to troughs containing mesh baskets where they will remain until yolk sacs are absorbed and feeding has begun. They will then be transferred to nursery ponds for rearing.

2.1.3 Facility Requirements

Facilities for spawning and fry rearing will allow maximum flexibility. The entire production goal can be met through either intensive or extensive production. Although any combination of spawning methods and nursery units is possible, NAC Table 2.1 summarizes the production potential of the nursery facilities based on one recommended program. The extensive and intensive facilities required are summarized in NAC Tables 2.2 and 2.3. Those contained within the production facility are in NAC Table 2.4.

2.2 TILAPIA PRODUCTION PROGRAM

2.2.1 Production Goals

Tilapia nilotica fry will be required at the MHC for polyculture with carp and mullet. Approximately 10,000 fry or 10 adult pair per feddan will be required to stock the production ponds.

Once a production pond has been stocked with adults or fry, there should be no need for additional stocking as long as sufficient adults from the harvest are returned to the pond. However, if there is a severe winter, a die-off in the pond or complete draining and drying of ponds is required, sufficient fry or adults must be supplied from the NAC for restocking.

2.2.2 Production Techniques and Facilities

Since tilapia are prevalent in the water supply canal, it is possible to obtain sufficient stocks directly from the canal during pond filling. However, it is difficult to control the stocking rate and obtain a preferred stock if this method is used. A more satisfactory stocking method is to stock production ponds with sufficient adults or fry of the desired species to produce the desired annual yield.

A system of five extensive ponds at the NAC will be stocked in the spring with tilapia adults. Tilapia breed readily and repeatedly once water temperatures reach approximately 23°C. Spawning every six to seven weeks is anticipated. Fry can be harvested from the ponds for stocking throughout the spring and summer months. The spawning/rearing extensive ponds will be drained and dried during the winter months. Adults will be selected from the ponds to serve as brood for the next year at the end of the spawning season. These will be placed in tanks receiving heated water to ensure temperatures are sufficient to prevent winter kill. Tilapia remaining after the brood have been selected will be sold or transferred to experimental ponds.

At least 600,000 20- to 30-g fry can be produced each year in the five ponds (assuming 25 females/1,000 m^2 and four spawnings, each producing 1,200 fry). Approximately 15,000 adults can be supplied to the MHC from the overwintering tanks in addition to 1,600 required for the NAC spawning ponds (assuming 40 tilapia/cubic meter). This would permit a restocking of 100 percent of the production ponds in the MHC with either fry or adults if required.

NAC TABLE 2.1
MAXIMUM DESIGN CAPACITY OF FRY PRODUCTION FACILITIES

Spawning Location	Rearing Location	Rearing Area (feddans)	Rearing Stocking Rate (no./ feddan)	Survival Rate to 2 g (%)	Maximum Yield of 2-g Fry Per Feddan	No. of Cycles Per Year	Total Annual Maximum Yield of 2-g Fry (no.)
Dubisch ponds	Dubisch ponds	0.3	1 female/pond				
	Extensive ponds	3.0	--	3.5	48,000	2	288,000
Concrete tanks with kakabans	Concrete rearing channels	0.03	2,520,000 eggs	15	378,000	3	34,000
	Extensive ponds	6.0	2,520,000 eggs	15	378,000	2	4,536,000
Breeding room	Intensive ponds	4.0	2,100,000 fry	45	945,000	3	11,340,000
	Extensive ponds	24.0	500,000 fry	23	115,000	2	5,520,000

NAC TABLE 2.2
EXTENSIVE PRODUCTION DATA FOR CARP FRY (2-g wt) AT THE CENTER

Farm area to be supplied (feddans)	5,000
Stocking rate of 2 g fry/feddan	1,200
Total fry required	6,000,000
Survival rate(%)	25
Fry required	24,000,000
Number of crops	2
Fry required from hatchery per crop	12,000,000
Area of one feddan (m^2)	4,200
Stock' density of 0.01 g fry/feddan	500,000
Number of feddans required per crop	24
Number of ponds required (1 feddan each) — 200 x 21 m each	24

NAC TABLE 2.3
INTENSIVE PRODUCTION DATA FOR CARP FRY (2-g wt) AT THE CENTER

Number of fry required (2 g)	6,000,000
Survival rate from hatchery (%)	25
Fry required from hatchery (0.01 g)	24,000
Number of crops	3
Fry required per crop (0.01 g)	8,000,000
Pond area (m^2)	500
Density of fry per pond	250,000
Number of ponds required	32
Number of feddans required	4

NAC TABLE 2.4
PRODUCTION FACILITY SUMMARY

Facility	Tank/ Unit	Unit #	Dimensions(m) or Capacity (l)	Unit Flow (l/min)	Total Flow (l/min)
Hatchery	Zuger jars	48	8 liters	2	96
	Fry troughs	6	5 x 0.8 x 0.5 m	15	90
Breeding room	Tanks	12	2 x 1 x 1 m	10	120
Live-food culture room	(see NAC Table 2.9)				
Outdoor covered space	Troughs	10	4 x 1.5 x 1 m	25	250

2.3 MULLET PRODUCTION PROGRAM

A further part of the nursery and production facility requirement for the NAC are earth ponds for holding young mullet brought from the new collecting stations at Gamassa and El Gameel as well as the existing research station at El Mex. Fry will arrive from the collecting stations at a size of 0.15 g and must be reared for approximately four months in fingerling ponds until reaching a size of 40 g. All fingerling facilities for mullet required in the MHC production ponds will be located within the MHC.

However, in the event that there is a need for temporary holding prior to stocking the nursery ponds and to provide nursery areas for those mullet required in the NAC, 20 feddans of extensive ponds will be required. This will permit holding of 1.7 million fry which is 50 percent of the MHC requirements as well as 100 percent of the NAC needs. Since the young fry of Mugil cephalus are captured in coastal waters between August and October—the fry of Mugil capito are taken between January and March —the ponds may be used twice each year and could provide holding for all fry transported into the El Abbasa site. Table 2.5 summarizes the mullet facility requirements.

NAC TABLE 2.5
PRODUCTION DATA FOR MULLET

Farm area to be supplied (feddans)	2,000
Stock rate of 5 g fingerlings/feddan	1,700
Total fingerlings required @ 5 g	3,400,000
Survival from nursery grounds (%)	50
Total fingerlings required @ 0.15 g	6,800,000
Stocking rate of 0.15 g fingerlings/feddan	170,000
Area required (feddans)	40
Number of ponds required (2,100 m^2)	80
Number of consecutive crops	2
Number of ponds required	40

2.4 BROODSTOCK

2.4.1 Resources

The primary function of maintaining broodstock resources at the NAC is to provide spawners for the carp and tilapia production program in support of the MHC, pituitaries for induced spawning, and experimental programs for rearing and breeding both carp and tilapia.

For the requirements for carp fry production, approximately 60 females and 90 males are required. However, to allow sufficient selection and to maintain several year classes, a minimum of 1,200 carp brood will be at the NAC.

As discussed in NAC Section 2.2, as many as 16,000 tilapia brood will be held over winter to provide adults and fry for the MHC.

2.4.2 Facilities

Carp broodstock facilities will be earth ponds. The requirements are summarized in NAC Tables 2.6 and 2.7. Holding ponds will be used for general rearing of all brood. Donor ponds will be used to rear those carp necessary for pituitary supply. These ponds will yield a minimum of 125 donors each year, but this will be supplemented with resources from the other facilities at the NAC and the MHC. The segregation and recovery ponds will be used immediately prior to and post-spawning. Because the latter ponds are needed only six months each year, they can also be used to provide flexibility when draining and drying of other brood ponds are required.

Tilapia brood will be overwintered in outdoor rectangular tanks. Water will be heated to ensure temperatures do not fall below the lethal level of 12°C.

2.5 FOOD REQUIREMENTS

2.5.1 Fertilizers and Supplemental Food

Feed for fish at the NAC will be either that produced within the ponds themselves or supplemental. The latter category includes both plant and live animal forage. NAC Table 2.8 summarizes the inorganic and organic fertilizers required to stimulate food production in the ponds.

The fertilizer storage is designed to contain a one-year supply of superphosphate (87 tonnes), and an animal waste silo with a capacity of 50 tonnes of chicken manure which will be refilled three times a year. Dry storage for rice bran, cottonseed cake, and mineral and vitamin supplements is sized for a one-year supply (13 tonnes).

2.5.2 Live Food Requirements

Live food will be required for feeding carp hatchlings in intensive units for approximately 10 days until they accept an artificial diet. Selected live food organisms will also be required to innoculate extensive ponds to ensure the desired food species are present for the carp fry when stocked, and for fish held within experimental tanks and aquaria. Both zooplankton and phytoplankton will be cultured.

Carp hatchlings placed in the intensive nursery ponds will be supplied with five rotifers/ml when they begin feeding. This density will be maintained until the fry can be switched to an artificial diet. Although much of the food requirement can be met through production within the pond itself, daily supplements will be required from the live food culture facility to maintain the desired food densities. Flour or bran particles of 100 to 500 microns diameter will be fed <u>ad lib</u> beginning three to four days after stocking.

Facilities required for live food culture are summarized in NAC Table 2.9. These facilities are sufficient for meeting the production goal of six million 2-g fry within the intensive nursery tanks.

NAC TABLE 2.6
BROODSTOCK REQUIREMENTS FOR DIFFERENT LEVELS OF PRODUCTION

Production 2-g Fry (30 days old)	Females (3-kg each)	Males
1 million	10	15
6 million	60	90
10 million	100	150
20 million	200	300

NAC TABLE 2.7
BROODSTOCK FACILITIES FOR CARP PRODUCTION

Pond Type	Number	Function	Water Surface Area (m^2)	Average Water Depth (m)	Maximum Flow Rate (l/min)
Standard	4	Holding	200 x 42	1.5	150
Standard	2	Donor	100 x 21	1.5	38
Standard	4	Segregation	100 x 21	1.5	75
Standard	2	Recovery	100 x 21	1.5	38

NAC TABLE 2.8
SUMMARY OF FERTILIZER REQUIREMENTS

			Superphosphate (15%)		Chicken Manure		Supplemental Feeds	
	No. Feddans	No. Times Fertilized	Application Rate (Kg/Feddan)	Total Requirement (Tonnes)	Application Rate (Kg/Feddan)	Total Requirement (Tonnes)	Requirement (Kg/Feddan/Yr)	Total (Tonnes)
Carp nursery	33	2	625	41.3	50	3.3	150	5.0
Carp fingerling	6	1	300	1.8	1250	7.5	750	4.5
Carp grow-out	55.7	1	340	18.9	1850	103.0	—	—
Carp brood	12	1	340	4.1	1850	22.2	—	—
Tilapia nursery	5	1	625	3.1	50	0.3	150	0.8
Mullet nursery	10	2	625	12.5	50	1.0	—	—
Intensive rearing	4.3	2	625	54	—	—	580	2.5
TOTAL	-	-	-	87.1	-	137.3	-	12.8

NAC TABLE 2.9
SUMMARY OF LIVE FOOD CULTURE FACILITY REQUIREMENTS

Food Type	Function	Volume Required (m^3)	No. of Units	Size of Units (m)	Location
Algal	inocula	29	5	4 x 1.5 x 1	Inocula culture room
Algal	production	450	16	2 x 14 x 1	Outdoors (tilapia tanks)
Rotifer	inocula	22	4	4 x 1.5 x 1	Outdoors
Rotifer	production	458	17	2 x 14 x 1	Outdoors (tilapia tanks)

2.6 FISH FACILITY REQUIREMENT SUMMARY AND SCHEDULING

NAC Table 2.10 summarizes the facilities required to meet the annual production goals for carp, tilapia, and mullet at the NAC. It excludes facilities required within the production building which are summarized in NAC Table 2.4 .

NAC Table 2.11 outlines the anticipated scheduling of major fish culture events at the NAC. To the extent that water temperatures vary from the seasonal average, the actual timing of events will vary; however, the sequence will remain the same. The anticipated schedule for carp production within the hatchery is presented in Table 2.12.

It is important to the smooth operation of the NAC to coordinate activities at the MHC, the Serow Fish Hatchery (SFH) and the MCS with the NAC, since, in many instances, ponds must be prepared several weeks in advance to ensure satisfactory conditions for the fish stocked.

2.7 ENVIRONMENTAL REQUIREMENTS

2.7.1 Water Quality

Two degrees of water quality are required for the NAC facilities. All tanks and ponds utilized for incubation, early larval rearing, or larval food rearing must receive water free of any competing microorganisms larger than 10 to 20 microns and be free of harmful chemicals such as insecticides, pesticides, petrochemicals, etc. Water used in algal culture tanks must be filtered to 1 micron.

Once the fish reach fingerling stage, they are more tolerant of adverse water conditions and predators; therefore, filtration to

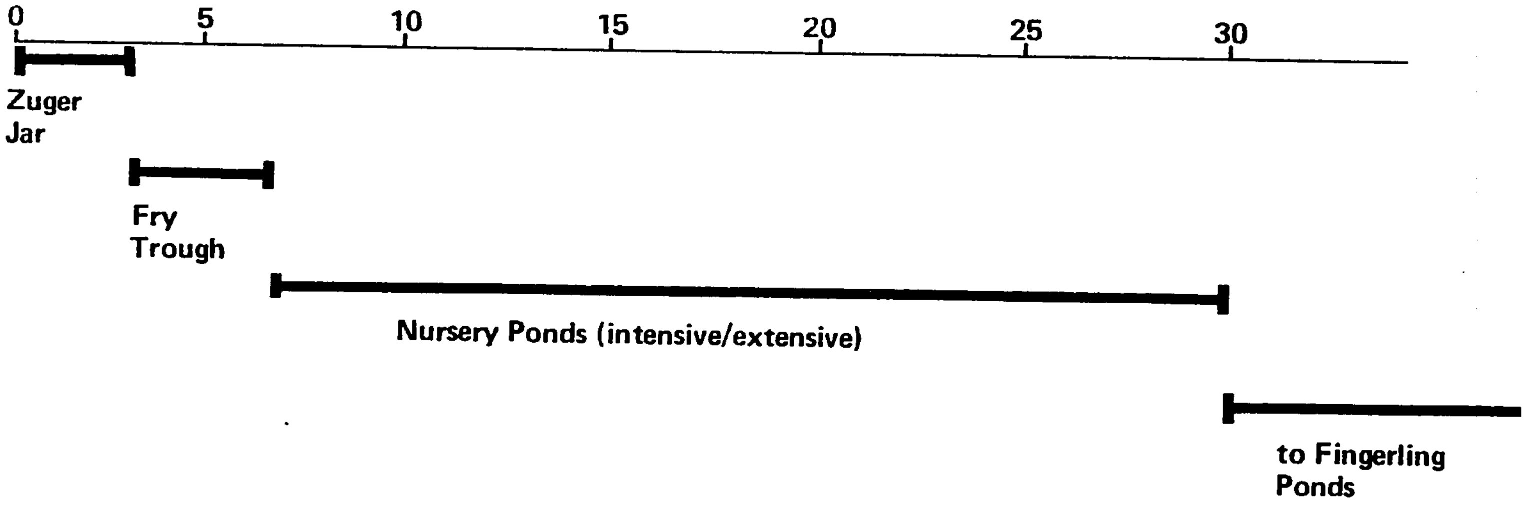
NAC TABLE 2.10
FACILITY REQUIREMENTS

PURPOSE	FACILITY	NO. OF PONDS	UNIT OR POND SIZES length & width (m)	AVG. DEPTH (m)	INDIVIDUAL UNIT/ POND AREA (m^2)	TOTAL WATER SURFACE (feddans)	MAXIMUM WATER FLOW REQUIRED (liters/min/unit)
Carp spawning	Dubisch ponds	12	10 x 10	1.0	100	0.3	180
	Concrete channels with kakabans	6	(5 x 2)	1–1.2	5–10	0.014	90
	Breeding room (see NAC Table 2.4)						
Carp nursery	Extensive ponds	24	200 x 21	1.5	4,200	24	3,630
		12	100 x 21	1.5	2,100	6	
		12	50 x 21	1.5	1,050	3	
	Intensive ponds	32	100 x 5.25	1.5	525	4	930
	Concrete troughs	6	10 x 2	1–1.5	20	0.029	10
Carp brood	Holding ponds	4	200 x 42	1.5	8,400	8	880
	Donor ponds	2	100 x 21	1.5	2,100	1	110
	Segregation ponds	4	100 x 21	1.5	2,100	2	220
	Recovery ponds	2	100 x 21	1.5	2,100	1	110
Tilapia spawning & nursery	Extensive ponds	5	100 x 42	1.5	4,200	5	1,315
Adult tilapia overwintering & live food production	Outdoor tanks	34	2 x 14	1.0	28	.23	4,006
Mullet nursery & temporary holding	Extensive ponds	20	100 x 21	1.5	2,100	10	2,200
Model training farm	Production ponds	8	200 x 63	1.5	12,600	24	2,360
	Fingerling ponds	4	200 x 31.5	1.5	6,300	6	
Experimental ponds	General extensive ponds	6	200 x 42	1.5	8,400	12	2,310
		6	200 x 21	1.5	4,200	6	
		12	50 x 21	1.5	1,050	3	
	Agri/aqua experimental ponds	18	35 x 14	1.5	500	2.14	235
	Agri/aqua demonstration ponds	36	500 x 20	1.5	1,000	8.6	945
Temporary fish holding and egg eyeing	Concrete troughs (undercover)	10	4 x 1.5	1	6	0.014	250

NAC TABLE 2.11
OPERATING SCHEDULE

MONTH / SPECIES	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
CARP			preparation	spawning								
Nursery ponds				fill fertilize		fry (2g)						
Fingerling ponds					fill fertilize			fingerling (40g)				
Growout ponds							fill fertilize				harvest (200g)	
MULLET (M. capito)		collecting (MCS) fry	(0.15g)									
Fingerling ponds		fill fertilize					fingerling (40g)					
Growout ponds							fill fertilize				harvest (200g)	
MULLET (M. cephalus)							collecting (MCS) fry	(0.15g)				
Fingerling ponds							fill fertilize					fingerling (40g)
Growout ponds		fill fertilize				harvest (200g)						
TILAPIA (T. nilotica)		fill fertilize		spawning and nursery							fingerlings (30–40g)	
Growout ponds		fill fertilize				harvest (100g)					harvest (100–250g)	
Overwinter ponds											fill	
Larval food production			fill fertilize									

NAC TABLE 2.12
CARP HATCHERY SCHEDULE
(In Days Per Cycle)



10 to 20 microns is acceptable for fingerling grow-out and brood ponds. Again, detectable levels of insecticides, pesticides, and petrochemicals must be avoided.

Experimental tanks in the wet laboratories should have the flexibility of receiving either water type. However, for outdoor experimental tanks, 10- to 20-micron filtration is acceptable.

Water heating will be required for tilapia overwintering tanks, wet laboratories, covered holding tanks, and breeding and incubation units. Water chilling will be necessary for wet laboratory experimental tanks and aquaria only.

The water sources available at the NAC are the Ismailia Canal and wells. Wells offer the advantage of not containing particulate material and should remain uncontaminated from harmful chemicals.

NAC Tables 2.13, 2.14, and 2.15 indicate typical water conditions in the Ismailia Canal near the NAC. Samples analyzed on site by the KCM staff indicated a water temperature in September of 28°C, salinity of 0.5 parts per thousand, and pH of 8.4.

2.7.2 Water Temperatures

Water temperatures in all production fish ponds and tanks will be ambient. The only water heating requirements are to maintain temperatures above 12°C in the tilapia overwintering tanks and 22°C in the breeding room, incubation tanks, and experimental wet laboratory. The experimental wet laboratory will also require chilled water (10°C) for 10 percent of the calculated water flow. Temperatures will be adjusted in the experimental tanks using immersion heating on an individual tank basis. It is anticipated that the maximum heating requirements will occur during January and February.

2.7.3 Flow Rates

NAC water supply criteria and total monthly requirements are presented in NAC Tables 2.16 and 2.17. In addition, the capacity to flush or fill simultaneously a maximum of four 3-feddan ponds within 20 to 30 hours is provided. Small (200 m^3) nursery ponds should be capable of being filled in 10 to 15 hours—10 ponds at one time.

2.7.4 Emergency Support

There will be two alternative measures for improving water conditions in the case of an emergency: aeration and rapid water exchange.

Aeration using air blowers is readily available to all intensive fish rearing tanks and holding units. During periods when water temperatures exceed 27°C, there may be a constant need for aeration of all intensive units in use. Mechanical aerators such as paddlewheels will be available for installation in extensive ponds as required.

NAC TABLE 2.13
MONTHLY PHYSIOCHEMICAL CHARACTERISTICS OF ISMAILIA CANAL WATER AT INSHAS*

Item	Concentration												Average Concentration
	1969								1970				
	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	
Specific conductivity	285.00	280.00	262.00	308.00	354.00	380.00	386.00	363.00	359.00	397.00	--	370.00	340.00 μ mho/cm
pH	8.40	8.15	8.30	8.45	8.20	8.50	8.30	8.05	8.10	8.05	8.30	8.20	8.20
Residual on evaporation	197.00	158.00	148.00	170.00	179.00	217.00	240.00	221.00	205.00	178.00	215.00	193.00	193.00 mg/l
Residual on ignition	135.00	132.00	128.00	150.00	138.00	155.00	172.00	163.00	152.00	115.00	166.00	140.00	147.00 mg/l
Nonfilterable residual	31.00	41.50	65.80	50.00	34.10	43.10	29.30	27.40	30.90	36.00	33.50	33.00	37.80 mg/l
Total hardness	111.00	106.00	117.00	111.00	127.00	131.00	133.00	111.00	117.00	111.00	111.00	128.00	118.00 mg/l
Alkalinity ($CaCO_3$)	138.00	136.00	122.00	121.00	138.00	140.00	151.00	138.00	139.00	136.00	138.00	132.00	136.00 mg/l
Na^+	--	18.00	19.50	25.00	30.10	36.50	--	60.00	36.00	26.50	35.90	30.00	31.70 mg/l
K^+	--	5.00	5.00	10.80	10.00	4.90	--	6.70	3.20	3.20	3.30	3.20	5.50 mg/l
Ca^{++}	27.80	25.60	26.70	25.60	26.70	28.90	28.90	28.30	35.00	29.40	27.70	28.90	28.20 mg/l
Mg^{++}	26.70	18.40	24.90	14.00	26.20	--	--	13.10	13.60	12.50	12.60	13.00	17.50 mg/l
Fe^{+++} and Fe^{++}	--	--	0.11	0.18	--	0.30	--	0.15	0.15	0.20	--	0.24	0.19 mg/l
Cl^-	16.70	12.30	10.70	10.80	11.30	21.90	25.00	19.70	19.50	16.30	18.70	17.20	16.60 mg/l
SO_4	--	--	--	1.03	0.99	2.80	--	--	1.73	1.50	2.19	2.01	1.75 mg/l
PO_4	0.55	0.55	0.20	0.48	0.52	0.38	--	0.23	0.17	0.25	0.35	0.32	0.36 mg/l
SiO_2	--	15.00	--	17.80	17.80	--	--	14.10	11.90	13.10	15.30	--	15.70 mg/l

* Monthly values represent average of two biweekly samples.

Reprinted from Ishak, M. and Khalil, S. Water characteristics and composition of suspended matter of Ismailia Canal, Egypt. Bull. Inst. Ocean. Fish. Egypt 3:427-443 (1973).

NAC TABLE 2.14
CONCENTRATION OF ORGANIC AND INORGANIC CONTENTS OF SUSPENDED MATTER IN ISMAILIA CANAL WATER

Month	Year	Suspended Matter Concentration (mg/l)	Organic Fraction (%)	Inorganic Fraction (%)
May	1969	31.45	31.65	68.35
June	1969	41.45	15.93	84.07
July	1969	65.85	24.14	75.86
August	1969	50.00	19.83	80.17
September	1969	34.10	30.35	69.65
October	1969	43.01	21.45	78.58
November	1969	29.30	14.45	85.55
December	1969	27.40	21.00	79.00
January	1970	30.90	22.41	77.59
February	1970	36.00	15.80	84.20
March	1970	33.50	11.65	88.35
April	1970	33.00	18.03	81.97

Reprinted from: Ishak, M. and Khalil, S. Water characteristics and composition of suspended matter of Ismailia Canal, Egypt. Bull. Inst. Ocean. Fish Egypt 3:427-443 (1973).

NAC TABLE 2.15
MONTHLY AVERAGE TEMPERATURE OF BOTH AIR AND WATER OF THE EL ABBASA POND (1974-1975)

	Air Temperature (°C)			Water Temperature (°C)		
Months	Max.	Min.	Average	Max.	Min.	Average
1974						
October	29.0	25.0	26.6	26.0	25.0	25.3
November	24.0	19.0	20.3	20.8	15.8	17.8
December	19.0	14.0	17.0	18.0	14.0	16.0
1975						
January	17.0	10.0	13.0	15.0	9.0	11.6
February	18.5	16.0	17.5	18.0	16.0	17.3
March	24.0	18.0	21.2	23.0	18.0	20.2
April	26.0	23.0	24.5	25.0	21.9	23.4
May	30.0	27.5	29.3	31.0	28.0	29.3
June	34.0	30.0	33.2	34.0	31.1	32.8
July	36.0	33.0	34.2	36.0	29.5	33.5
August	34.5	29.0	31.5	34.0	28.0	31.0
September	34.0	25.0	30.6	35.0	25.0	30.2

Information supplied by Dr. M. Ishak.

NAC TABLE 2.16
SUMMARY OF WATER SUPPLY CRITERIA

Extensive ponds	110 l/min/feddan
Incubation jars	2 l/min/jar
Breeding tanks	15 l/min/tank
Natural spawning ponds	15 l/min/pond
Intensive fry nursery ponds and troughs	1 exchange every 10 days
Fry swim-up troughs	5 l/min/50 liter vol
Holding tanks and aquaria	1 exchange every 4 hours minimum
Overwintering tanks	1 exchange per day

NAC TABLE 2.17
MONTHLY PEAK WATER REQUIREMENT SUMMARY
(liter/min)

ACTIVITY	LOCATION	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Carp spawning	Dubisch pond				180	180	180						
	Concrete channels				90	90	90						
Carp nursery	Extensive ponds				3,630	3,630	3,630						
	Intensive ponds				930	930	930						
	Concrete troughs				10	10	10						
Carp brood	Holding ponds	880	880	880	880	880	880	880	880	880	880	880	880
	Donor ponds	110	110	110	110	110	110	110	110	110	110	110	110
	Segregation ponds	220	220	220	220	220	220	220	220	220	220	220	220
	Recovery ponds				110	110	110						
Tilapia spawning and nursery	Extensive ponds			1,315	1,315	1,315	1,315						
Adult tilapia overwintering	Concrete tanks	4,006	4,006										
Mullet nursery	Extensive ponds			2,200	2,200	2,200	2,200						
Model training farm	Extensive ponds	2,360	2,360	2,360	2,360	2,360	2,360	2,360	2,360	2,360	2,360	2,360	2,360
Experimental ponds	General extensive	2,310	2,310	2,310	2,310	2,310	2,310	2,310	2,310	2,310	2,310	2,310	2,310
	Agri/aqua experimental ponds	235	235	235	235	235	235	235	235	235	235	235	235
	Agri/aqua demo ponds	945	945	945	945	945	945	945	945	945	945	945	945
Temporary holding and egg eyeing	Concrete troughs (hatchery)				250	250							
Egg incubation	Zuger jars (hatchery)				96	96							
Intensive spawning	Breeding tanks (hatchery)				120	120							
Larval food	Hatchery & outdoor tanks	50	250	250	250	250	250	250	50	50	50	50	50
Experiments	Wet laboratories	1,040	1,040	1,040	1,040	1,040	1,040	1,040	1,040	1,040	1,040	1,040	1,040
Operating rate		12,156	12,156	11,865	17,281	17,281	17,065	8,150	8,150	8,150	8,150	8,150	8,150
Filling rate			39,300					39,300					
Total rate		12,156	51,456	11,865	17,281	17,281	17,065	47,500	8,150	8,150	8,150	8,150	8,150

Flushing requirements for the NAC ponds are described in NAC Section 2.7.3.

2.8 EXPANSION REQUIREMENTS

Expansion at the NAC will be primarily directed at increasing the fry production capabilities of the NAC as more private fish farms are established in the region and perhaps to provide additional facilities capable of producing other species. However, since at present the fry production capability is approximately 22 million, considerable expansion is already built in.

Carp fry production expansion will primarily be through increasing the induced breeding program and intensive rearing ponds. NAC Table 2.18 summarizes the anticipated expansion of these and ancillary facilities.

No increases in experimental or training ponds are envisaged although there may be a requirement for future alteration of some ponds as new techniques for rearing are developed and new species are added to the research program.

2.9 TRANSPORTATION

2.9.1 Intersite

Transportation between the NAC and the MHC and other sites will primarily be via private car and truck. The major purposes will be daily inspection and assistance by the NAC extension agents and scientific staff, transfers of fry out of the NAC, and harvested adult fish transfers into the processing fish facilities.

Transfer of mullet from the collecting stations will represent the largest transfer of fish into the NAC. These will arrive over a six-month period in live cars and plastic bags and will require rapid transfer into tanks and ponds to reduce the stress of transfer.

2.9.2 Intrasite

The majority of intrasite transport will be via pickup truck containing transport tanks and via Cushman-type minitransports to supply food and fertilizers to the ponds.

NAC TABLE 2.18
SUMMARY OF FACILITY EXPANSION

Facility	% Expansion
Breeding room	30
Hatchery	30
Live food culture	30
Food storage	30
Fertilization storage	30
Intensive rearing ponds	30*
Brood ponds	30*
Offices and administrative support facilities	25

*Depending on improved water management within the present system.

NATIONAL AQUACULTURE CENTER
CHAPTER 3
PROJECT SITE

3.1 EXISTING ENVIRONMENTAL CONDITIONS

The El Abbasa site is located on the Nile Delta approximately 70 km northeast of Cairo, Egypt, and approximately 17 km east of Zagazig, the capital of the Governorate of Sharqiya. The specific National Aquaculture Center (NAC) project site is 1,500 m east of the village of El Abbasa.

Within the context of developing a major facility at El Abbasa, several areas of concern have been identified for consideration. These environmental factors will have both positive and negative impacts on the conceptualization of the NAC program.

Positive impacts include:

- Increased food/protein supply in Egypt
- Improved research, development, and promotion of a national industry
- Increased employment
- Use of swampy, nonagricultural land
- Improved facilities for community support
- Improved management of natural resources

Negative impacts include:

- Extensive increase in area for evaporation
- Socio-economic impact on villagers
- Seasonal demand on irrigation water
- Increased area of Bilhargia environment

3.1.1 Climatic Conditions

The El Abbasa site is located in an arid climate which would be desert except that irrigation water from the Nile River is carried to the region through the Ismailia Canal which is the primary water source for the El Abbasa projects. (See NAC Figure 3.1.)

Rainfall is light with a mean annual total of 33 mm over the last 40 years. The highest monthly mean rainfall is in January at 6.3 mm with the months of June, July, August, and September showing no rainfall or only a trace. The relative humidity on the site is moderate, running from a mean low in May of 50 percent to a mean high in December and January of 71 percent.

The predominant winter winds at El Abbasa are from the west and the predominant summer winds are from the northwest. The summer winds are important because the breeze can be used for ventilation. The winds are mild, mostly below 10 knots with the highest winds reaching mid-twenty knots.

The temperatures are mild in the winter and become quite warm during the summer months. The lowest mean day temperature of 13.1°C is in January with the maximum mean day temperature of 27.3°C in July and August. The minimum monthly mean temperatures occur in December, January, February, and March, which are respectively 8.5°C, 6.4°C, 7.0°C, and 9.0°C. The maximum monthly mean temperatures occur between June and September and run from 32.5°C to 34.1°C. The highest temperatures on the site can be expected to reach into the mid-40s.

Day length throughout the year is not extreme because of Egypt's position in relation to the equator. In February, the shortest day lengths occur with a total monthly average of 215.4 actual hours of sunlight, in July the longest day lengths occur with a total monthly average of 360.4 actual hours of sunlight during the month.

3.1.2 Topographic Features/Soils

The El Abbasa site is flat without any noticeable change in elevation. Plant growth in the existing ponds blocks vision from the site except for a view of the tall trees located on the banks of the Ismailia Canal. Ground elevations range from approximately 10 cm to 2 m above the highest water level of the main drain canal, and from 1 to 3 m below the Ismailia supply canal.

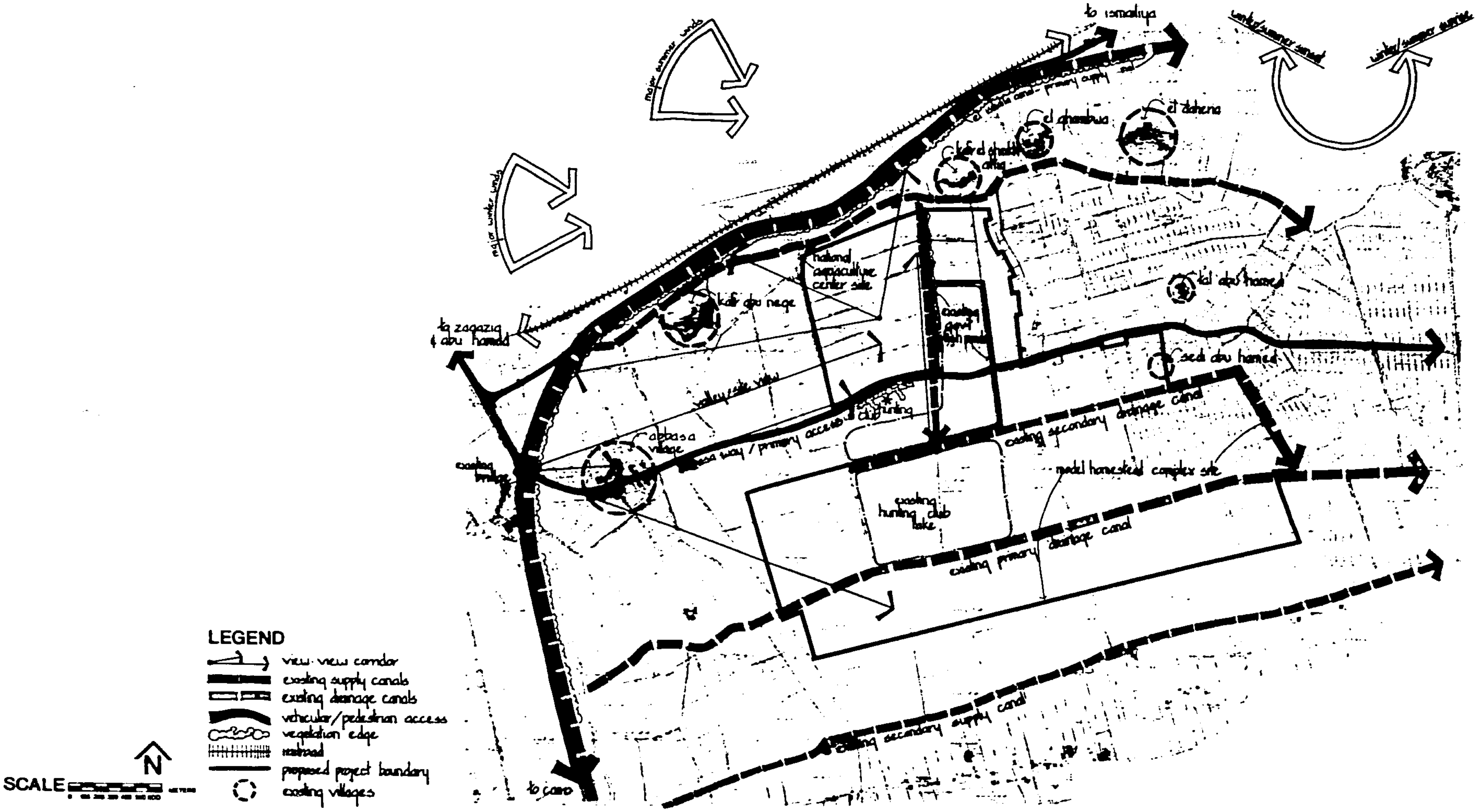
The preliminary soils investigation indicates that sand underlies a minimum of 1.5 m of alluvial material. This dictates that side slopes will be limited to 3 horizontal to 1 vertical. Bearing capacity of the alluvial material will be 0.25 tonnes per square foot. A cut-and-fill approach to pond excavation may be difficult as slumping may occur with a 1- to 2-meter surcharge on alluvial material. Foundations for buildings will be on sand which has a bearing capacity of 1 tonne per square foot. Once excavation enters the sand layer extra precautions will have to be taken to ensure sealing of exposed sand. This may be accomplished through extra excavation and replacement with clay or silty soils.

technical specification ?

3.1.3 Flora/Fauna

The flora at the El Abbasa site is a direct result of flood irrigation and is typical of very swampy areas, however, areas of the site frequently dry out causing a disturbance in this vegetative life cycle. The main cultivated crop at the site is rice. The indigenous plants include reeds, grasses, and water hyacinths; the only tall trees are eucalyptus and various species of palms.

Wildlife is rare on the site with the exception of rodents, songbirds and waterfowl. Domestic animals include donkeys, cows, horses, and an occasional camel.



NAC Figure 3.1
Site Analysis

3.1.4 Water Supply System

The Ismailia main carrier canal is the only source of surface (Nile) water that supplies water to the secondary irrigation canals (Al-Wadi, Al-Jadim, and Al Gabal) that serve the project area. Both the Al-Wadi, Al-Jadim, and Al Gabal canals are located on the right side of the Ismailia main canal and both have steel gates installed at the intake structure to control the discharge entering the canal.

The flow in these two canals is not continuous but subject to irrigation water supply rotations as imposed by the Ministry of Irrigation (MOI). The maximum carrying capacity for Al-Wadi and Al Gabal irrigation canals are estimated at 3.76 m^3/sec and 1.84 m^3/sec, respectively. The seasonal variation of canal carrying capacity can be found in Irrigation Engineering Report, dated January 10, 1980, which also contains other pertinent data such as irrigation need and water quality.

The existing condition of both Al-Wadi and Al Gabal irrigation canals is altered from that of the original design condition. Through time the canals have been subject to either erosion or siltation in different parts of the canals. Therefore, the present maximum carrying capacities of both canals is slightly less because of these conditions.

3.1.5 Drainage

The main drain is the Al-Wadi drain which goes through the NAC project area from west to east, dividing it into two unequal parts. A network of other drainage canals exists which serve the cultivated land around the project area. The Al-Wadi drain finally discharges its water into Al-Mahsama main drain by pumping. The Al-Mahsama pumping station has three pumping units electrically driven, each with a capacity 2.5 m^3/sec with a maximum head of 3.3 m.

3.1.6 Utility

The available utilities in the project area are potable water supply and power supply.

3.2 GENERAL DESIGN CRITERIA

3.2.1 Site Character

The site for the NAC near El Abbasa is typical of agricultural lands on the Nile Delta. Elevation changes appear to be nonexistent with the only noticeable landform being the dikes along the nearby Ismailia Canal. These dikes are accentuated by the trees which have been planted along the banks.

The character of the manmade landscape is typified by the village of El Abbasa which is visible from the site. Village houses are constructed of silt brick covered with mud. The houses have open roofs covered with grass or hay, are rectangular, and frequently are connected. A very narrow dirt road runs through the village which is normally crowded with pedestrians, donkeys, camels, cows, and fowl.

The lodge and houses for the duck-hunting club are the only buildings on the site. These, together with the high grasses and occasional trees, form the only relief from the flat site.

3.2.2 Future Expansion

Because expansion of the facility may be needed in the future, the water supply canals will be designed to have sufficient capacity to accommodate additional ponds. However, expansion of this type is limited by the land area available on the site.

In addition the layout of the facilities will leave sufficient space in the area of the major structures to allow expansion of the research/training/production (RTP) building(s). The buildings will also be designed to accommodate vertical expansion. Additional housing needs which are not included in the U.S. Agency for International Development/Ministry of Agriculture (USAID/MOA) Agreement have been identified and can be accommodated in the housing area designated in this concept report.

3.2.3 Flexibility

As programs at the research and training facility expand and new technology develops, physical alterations will have to take place at the NAC. Therefore, pond systems that can be subdivided and changed in the future will be designed. The supply/drain canals, however, limit this activity to dividing lineally to keep a supply at one end and drain at the opposite end. The design limits the variation in canal separations and uses modular units of 50 m, 100 m, and 200 m.

The maximum amount of land adjacent to the RTP building(s) will be left vacant to allow for changing programs. The animal husbandry area is scaled to allow for increased production.

3.2.4 Circulation

Circulation at the NAC can be divided into three categories: pedestrian, staff and visitor vehicle, and operations vehicle. It is important that vehicle circulation for staff and visitors who are approaching the RTP building(s) and the housing area be distinctly separate from the operations vehicles that circulate around the ponds.

Vehicle access via secondary roadways (minimum 3 m wide) will be provided adjacent to the ends of ponds to facilitate maintenance and harvesting. Pedestrian access will be accommodated around all ponds. These walkways will be a minimum of 2 m wide. Primary roads on the NAC site will be a minimum of 8 m wide. The main access road from the Ismailia Canal to the site, as well as major access road at the NAC, will be 12 m in width.

3.2.5 Existing Conditions

The existing conditions which have been listed previously become criteria for development of the site and must be considered as parameters.

One specific existing condition that influences the design of the project is the fact that the site is quite low and poorly drained and therefore often flooded by irrigation water. An adequate drainage system which will allow for removal of water at a sufficient rate to keep the site dry will be incorporated into the design.

3.2.6 Design/Code Standards

Design of site facilities falls into the realm of two design code standards. Many areas are not covered by Egyptian code, therefore U.S. codes will be used. Life, health, and safety considerations are not governed by Arab Republic of Egypt (ARE) law and will be set by the professional judgment of the design staff.

From the preliminary soils engineering report it was determined that a minimum design slope of 3:1 for all earth slopes on the site should be used.

3.2.7 State of the Art

The design team has endeavored to conceptualize a building and construction program that can be achieved by Egyptian contractors, using local materials and resources wherever possible. The facilities have been designed for efficient and extensive use, with a minimum of operating and maintenance costs; and readily managed and operated with a minimum of basic training and instruction.

From a technical standpoint, the NAC facilities will incorporate the most recent and the best data available from the emerging industry of aquaculture worldwide. As a result, these facilities and this program will significantly upgrade the nation's fish farming industry within the present capabilities of the country, and within the shortest possible time.

3.3 SITE DEVELOPMENT PROGRAM AND GUIDELINES

3.3.1 Introduction to Components

In master planning the site, it is necessary to consider the functional relationship of all the components which make up the NAC and then to relate them to the existing environment in order to achieve the most beneficial and functional use of the site.

The project is made up of the many components discussed in previous chapters. The buildings are described in detail in the following chapter and will only be discussed here as operational units which relate to the other site functions. The major site components which make up the NAC complex have been categorized as follows:

- Research function
- Training function
- Production function
- Housing complex
- Animal husbandry complex
- Production ponds
- Research ponds
- Model training farms
- Agriculture/aquaculture research ponds
- Parking
- Circulation system
- Wastewater treatment
- Groundwater wells
- Fish processing area

In this section the relationships of each component to the other units are discussed. The matrix in NAC Table 3.1 shows the degree of relationship of each specific unit and NAC Figure 3.2 shows diagrammatically the relationship of all components.

3.3.2 Project Building Component

The primary building component consists of one major RTP unit which may be three separate buildings or one combined structure. Secondly, there is a housing component to support the professional staff. Finally, there is a component made up of various small support structures.

3.3.2.1 NAC RESEARCH/TRAINING/PRODUCTION (RTP) FUNCTIONS

The research, training, and production functions relate directly to each other. The research function will be used to develop technology which later will be put into practice in the production component and will be taught to aquaculturists in the training component.

A direct relationship also exists between the research function, the research ponds, and the agriculture/aquaculture ponds which will be used to conduct research in the area of using animal husbandry to increase fish production through the feeding of animal wastes.

The research function also relates to the staff housing component and to parking for staff and visitors.

The training function includes teaching fish farmers who will operate the system of fish farms being developed throughout Egypt. In addition, aquaculture specialists will be brought together to exchange technology necessary to keep the Egyptian staff abreast of the state of the art.

In addition to the direct relationship of training to research and production there is a direct relationship between the training function and the Model Homestead Complex (MHC) training farms. The ponds will be used to train fish farmers who will later operate the MHC. Less directly, the training function relates to the housing and parking components.

NAC TABLE 3.1
FUNCTIONAL RELATIONSHIPS MATRIX - SITE

LEGEND

● VERY STRONG RELATIONSHIP
◉ INTERMEDIATE RELATIONSHIP
○ MINOR RELATIONSHIP
NO PARTICULAR RELATIONSHIP
X SOME DEGREE OF SEPERATION DESIRABLE

	ICULTURE DEMO. & EXP. PONDS 14m x 35m	ICULTURE DEMO. & EXP. PONDS 20m x 50m	MHC NURSERY PONDS	MHC PRODUCTION PONDS	TILAPIA FRY PRODUCTION PONDS	TILAPIA OVERWINTERING PONDS	MULLET OVERWINTERING PONDS	EXPERIMENTAL PONDS 21m x 50m	EXPERIMENTAL PONDS 21m x 200m	EXPERIMENTAL PONDS 42m x 200m	BROODSTOCK RECOVERY PONDS	BROODSTOCK SEGREGATION PONDS	BROODSTOCK DONOR PONDS	BROODSTOCK HOLDING PONDS	INTENSIVE CARP PONDS	EXTENSIVE CARP PONDS 21m x 50m	EXTENSIVE CARP PONDS 21m x 100m	EXTENSIVE CARP PONDS 42m x 100m	CARP SPAWNING PONDS	WELLS	WASTEWATER TREATMENT	PLANT WASTE SILO	ANIMAL WASTE SILO	FERTILIZER STORAGE SHED	PARKING	LAUNDRY AREA	DINING AREA	FISH FARM TRAINEE QUARTERS	TRAINEE QUARTERS	HOUSES FOR EMPLOYEES, WORKERS, ETC.	GUEST HOUSES	EGYPTIAN JUNIOR STAFF RESIDENCE	U.S. JUNIOR STAFF RESIDENCE	EGYPTIAN SENIOR STAFF RESIDENCE	U.S. SENIOR STAFF RESIDENCE	EGYPTIAN DIRECTORS RESIDENCE	U.S. DIRECTORS RESIDENCE	FISH PROCESSING AHEA	PRODUCTION BUILDING	TRAINING BUILDING	RESEARCH BUILDING
AGRICULTURE DEMO. & EXP. PONDS 14m x 35m																																									
AGRICULTURE DEMO. & EXP. PONDS 20m x 50m	●																																								
MHC NURSERY PONDS																																									
MHC PRODUCTION PONDS			●																																						
TILAPIA FRY PRODUCTION PONDS																																									
TILAPIA OVERWINTERING PONDS					◉																																				
MULLET OVERWINTERING PONDS						◉																																			
EXPERIMENTAL PONDS 21m x 50m	○	○																																							
EXPERIMENTAL PONDS 21m x 200m	○	○						●																																	
EXPERIMENTAL PONDS 42m x 200m	○	○						●	●																																
BROODSTOCK RECOVERY PONDS																																									
BROODSTOCK SEGREGATION PONDS											●																														
BROODSTOCK DONOR PONDS											●	●																													
BROODSTOCK HOLDING PONDS						○	○				●	●	●																												
INTENSIVE CARP PONDS																																									
EXTENSIVE CARP PONDS 21m x 50m														○	○																										
EXTENSIVE CARP PONDS 21m x 100m														○	○	◉																									
EXTENSIVE CARP PONDS 42m x 100m														○	○	◉	◉																								
CARP SPAWNING PONDS	○	○	◉	○				○	○	○	○	○	○	○	◉	○	○	○																							
WELLS	X	X		○	○	○									○				○																						
WASTEWATER TREATMENT																				X																					
PLANT WASTE SILO	●	●																		X																					
ANIMAL WASTE SILO	●	●																		X		◉																			
FERTILIZER STORAGE SHED	●	●																		X		◉	◉																		
PARKING			○	○																		○	○	○																	
LAUNDRY AREA																									○																
DINING AREA																									○	◉															
FISH FARM TRAINEE QUARTERS	○	○	○	○																					○	●	●														
TRAINEE QUARTERS	○	○																							○	●	●	◉													
HOUSES FOR EMPLOYEES, WORKERS, ETC.	○	○																							○	●	●	◉	◉												
GUEST HOUSES																									◉																
EGYPTIAN JUNIOR STAFF RESIDENCE																									◉					○	○										
U.S. JUNIOR STAFF RESIDENCE																									◉						○	●									
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EGYPTIAN DIRECTORS RESIDENCE																									◉			○	○	○	○	◉	○	◉	○						
U.S. DIRECTORS RESIDENCE																									◉			○	○	○	○	○	●	○	◉	◉					
FISH PROCESSING AREA	○	○		◉											○	○	○	○		○					◉			○		○											
PRODUCTION BUILDING	○	○	○	○	○	○	○	○	○	○	◉	◉	◉	◉	●	○	○	○	●	●	●				●					○	○	○	○	○	○	◉	◉	◉			
TRAINING BUILDING			●	●																○					●			◉	◉	○	○	○	○	○	○	◉	◉	○	●		
RESEARCH BUILDING	●	●						●	●	●									○	◉	○				●					○	○	○	○	○	○	◉	◉	○	●	●	

Although the production ponds also relate to the research and training components, their most important function is to supply broodstock to the hatchery.

3.3.2.2 NAC HOUSING COMPLEX

The housing complex, as contained in this design contract, is made up of two directors' residences, one for the U.S. director and one for his Egyptian counterpart; five houses for U.S. senior professional staff; five houses for Egyptian senior professional staff; and housing for 10 junior professional staff members.

NAC housing relates directly to the RTP building(s) where the professional staff will perform a majority of their work and to all other work places. An indirect relationship exists between the housing complex and the agriculture/aquaculture ponds as it is desirable to keep these units close to provide observation of the farm animals. The housing also relates directly to parking and circulation.

3.3.2.3 OTHER NAC STRUCTURES

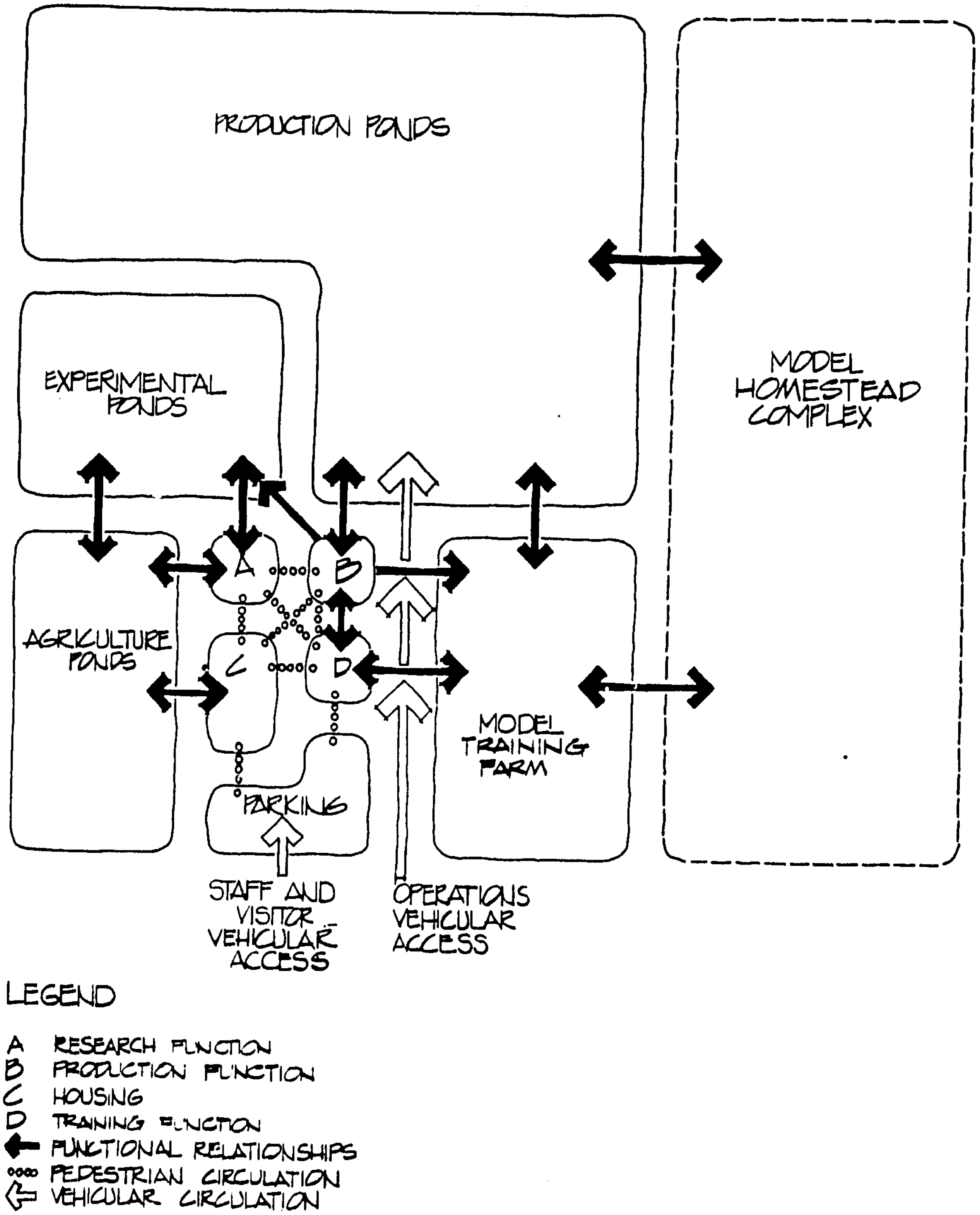
There are several other components that require minor structures on the site. The animal husbandry complex includes three structures: a fertilizer storage shed, an animal waste silo, and a plant waste silo. These structures relate directly to the agriculture/aquaculture ponds as the feed stored in these buildings will be used during research as well as to fertilize all ponds. An additional important relationship is to the wastewater treatment system. Any liquid which might seep from these storage units will be collected and treated or removed for use as liquid fertilizer. It is also important to separate the groundwater wells from this facility to alleviate any possibility of contamination.

The wastewater treatment component relates to the buildings that will produce wastewater, which include the RTP building(s), the housing component, and the storage silo. This component may be an aboveground structure, or possibly a belowground, enclosed holding structure.

Groundwater wells will provide water for the areas mentioned above, as well as the fish processing area. It is desirable to separate these wells from the fish ponds and animal husbandry area to avoid possible contamination.

The fish processing area will be shared by the NAC and the MHC. The building will also provide storage for fish nets used for harvesting at the NAC and MHC. This component relates to the production ponds and model training farms, as well as to the MHC itself. A location near the El Abbasa Way Road (AWR) and to the roads leading to the model training farms is important.

Additional NAC structures include a pump house which will be necessary to provide filtered water to the NAC. This component will relate directly to the water intake structure and, therefore, does not appear on the NAC site plan. Also there will be a standby generator house and a guard house at the entrance.



NAC Figure 3.2
Overall Functional Site Relationships

3.3.3 Ponds Component

The ponds are categorized into four functional components: 1) production ponds, 2) research ponds, 3) agriculture/aquaculture ponds, and 4) model training farms. The functional matrix, NAC Table 3.1 relates the functions of each of the 19 specific types of ponds which make up the 4 functional components.

3.3.3.1 FUNCTION

The function of each specific pond is described in NAC Chapter 2. Although, within each of the four functional groups, the individual ponds relate fairly closely to each other, individual pond-types relate much more directly to the buildings. The production ponds relate to the production function of the RTP building(s). The research and agriculture/aquaculture ponds relate to the research function of the RTP building(s). Model training farms relate to the training function of the RTP building(s). Each of these groups also relate indirectly to the fish processing component, as their products must go through this area on their way to market.

3.3.3.2 AREA

The area of each specific pond is listed in NAC Table 2.10, and is shown on NAC Figure 3.3, Recommended Site Concept.

3.3.4 Circulation Component

This component can be divided into access, circulation, and parking.

3.3.4.1 ACCESS

Access to the site will be divided to separate the staff and visitors from the operations vehicles. The staff and visitors require access to the RTP building(s), the housing component, and the parking component. The operations vehicles, which include larger trucks and maintenance vehicles, need access to the RTP building(s) and all of the ponds and related structures.

3.3.4.2 CIRCULATION

The major pedestrian circulation is between the separate functions of the RTP building(s), the housing complex, and the parking component. Sidewalks paved with asphalt will connect these major functions. Walkways immediately adjacent to the buildings may be paved with concrete tiles. Pedestrians circulating between the ponds will use the roadways.

Roadways for use by staff and visitors will connect the main access road to the RTP building(s) and the housing and parking components. These roadways will be paved with asphalt.

The operations vehicles will have separate access from the El Abbasa Way road to the RTP building(s), the ponds, and related structures. The main roads in this system will be paved in crushed stone. The secondary roads which connect the ends of all ponds will be constructed of compacted earth.

3.3.4.3 PARKING

Parking space will be adjacent to the RTP building(s) and the housing complex. The parking spaces for the senior staff will probably be adjacent to the housing units, while other vehicles will be consolidated in a central lot. The parking area will be paved with asphalt. Space will be provided for 40 cars and 2 buses; this is based on the following criteria:

Automobiles	
Directors	2
Senior professionals	10
Junior professionals	6
Visitors	6
Extension agents	6
Extension interns	6
Graduate research assistants	4
	40

Buses	
Trainees	1
Visiting aquaculturists	1
	2

The official operations vehicles will be provided garage space in the RTP building(s) with limited parking on the operations side of the building.

3.3.5 Landscaping

Landscape treatment will be restricted to the public access, the housing component, the parking area, and the RTP building(s). The landscape will stress environmental control in addition to aesthetic concerns. Trees will be located to shade walls and outdoor living spaces from the fierce summer sun, and to take full advantage of any cooling breezes. Proper placement of trees can have a very beneficial impact on the cooling costs of buildings in the summer.

Outdoor living spaces will be provided adjacent to the RTP building(s), where staff and visitors can eat and relax in a shaded, breezy garden area. This entire area of the NAC will be seeded with grasses to help cool the area and provide dust control.

Indigenous plants, such as eucalyptus and palms, which are proven to be previously acclimatized to the site, will be used rather than bringing in foreign plant materials. Vines such as bougainvillea that can be grown on trellises and building structures can be planted to provide shade and color.

3.4 RECOMMENDED NAC PROGRAM EXPANSION

3.4.1 Introduction

During the planning of this project the USAID Program Report defined the facilities that would be funded by the U.S. government grant; in addition other limited facilities were defined which would be funded by the Egyptian government. However, as the detailed planning process proceeded, several needed support facilities were identified by the design team and the ministry staff.

3.4.1.1 RATIONALE

Because of the remote site of the NAC at El Abbasa and the lack of existing public facilities, it is necessary that the NAC be a nearly self-sufficient unit. Therefore housing and support facilities need to provide for the needs of the entire staff of the NAC. Many of the support units were not defined or funded in the USAID Program Report.

3.4.1.2 STATUS

The Professional Services Agreement between the MOA and KCM International Inc (KCMI) which is funded by USAID provides for planning, design, and construction management of all facilities which are defined in the USAID Program Report. This document defines housing units for 6 U.S. senior professional staff, 6 Egyptian senior professional staff, and 10 junior professional staff members.

As the staffing of the NAC has been further defined by the MOA staff and the design team, it has become evident that a good number of additional housing units and support facilities are required. The USAID mission in Cairo has agreed to have KCMI plan for these facilities in the master plan for the NAC; however cost for the specific design and construction of the units will have to be funded separately by the Government of Egypt. To maintain visual unity of the NAC complex the design team strongly recommends that the proposed additional units be designed by the same team; this may best be accomplished by a separate contract directly between the MOA and P.B. Sabbour, the Egyptian subcontractor of KCMI, with design review by KCMI.

3.4.2 Site Summary

3.4.2.1 RECREATION FACILITIES

The only recreational facility which the design team recommends is a large open grass area where field sports such as soccer can be played. This area may be shared by the large number of NAC families and the families of the nearby MHC village. It is not customary in Egypt to provide highly developed playgrounds for children; because of this and the fact that the rural setting provides a number of adventure and play opportunities, it is not necessary to construct a playground.

3.4.3 **Building Summary**

3.4.3.1 COMMON FACILITIES

To provide for those living in dormitory-type rooms, there will be a central laundry, dining and kitchen facility. This facility will relate directly to the 60 housing units provided for the trainees and fish farmer trainees. The following program has been defined for this facility:

Restaurant, Kitchen (60 trainees)

1. Kitchen to prepare 60 meals - 30 m^2
   - a. Delivery and receiving area
   - b. Common storage
   - c. Refrigerator and frozen storage
   - d. Meal preparation area
   - e. Staff area for cooks
   - f. Dishwashing

2.	Serving area	-	8 m^2
3.	Dining room	-	75 m^2
4.	Toilet	-	8 m^2
5.	Office	-	9 m^2
	Total net area	-	130 m^2
Allowance for walls, structure, and corridors - minimum 25 percent		-	35 m^2
TOTAL GROSS AREA			165 m^2

The dining area shall be designed to be divided into two units.

Laundry

1. Delivery and receiving area (desk, storage closet, shelves)
2. Washers
3. Dryers
4. Ironer

TOTAL GROSS AREA	25 m^2

3.4.3.2 JUNIOR STAFF HOUSING

In addition to the 10 units of junior staff housing which are defined in the USAID Program Report, there is a need for 14 additional units which will bring the total to 24. The following program is defined for these units:

Junior Staff Housing

- Kind of housing : residential blocks, 2 flats on each floor
- Required number : 14 flats
- Finishing standard : upper middle class
- Number of floors : 3 floors
- Built-up area for 1 flat : 86 m^2
- Built-up area for 2 flats : 172 m^2
- 10% for horizontal and vertical circulation : 17.2 m^2
- Built-up area for 1 floor : 190 m^2

Each unit comprises:

Description	Number	Area (m^2)
Living room	1	15
Dining room	1	15
Bedrooms	2	30 (2 x 15)
Bathroom	1	5
Toilet	1	2
Kitchen	1	6
Entrance	1	2.5
Lobby	1	2
Terrace	1	5
Balcony with washing hanger	1	3

Notes

- For junior staff, there will be four residential blocks. Each one will consist of three floors, two flats on each floor.
- The total is 24 flats, 10 as per contract and 14 as proposed; there is the possibility for one more floor as an extension.
- Each flat includes a living space divided to two spaces:
    1. Living room
    2. Dining room
- A suitable terrace attached to the living space, a kitchen, and a toilet will be included.
- The sleeping quarters will have 2 bedrooms, 1 bathroom, 1 balcony with area for a washing hanger.

3.4.3.3 EMPLOYEE HOUSING

Twelve housing units will be required at the NAC to support employees, workers, drivers, and guards. These units will be semi-attached houses and are programmed as follows:

Employees, Workers, Drivers, and Guards Housing

- Type of housing : semi-attached houses (family units) including courtyard
- Required number : 12 houses
- Finishing level : economical
- Number of floors : 1 floor
- Built-up area : 60 m^2
- Courtyard area : 40 m^2
- Total area of land : 100 m^2

Each unit comprises:

Description	Number	Area (m^2)
Living room	1	20
Bedrooms	2	25 (2 x 12.5)
Bathroom	1	4
Kitchen	1	5
Entrance & Lobby	1	4.5

Notes

- These houses will be designed to take into consideration the social life and customs of the users.
- The house consists of a living room, two bedrooms, a kitchen, and a bathroom in addition to the entrance and the internal lobby.
- The most important item in this type of house is the courtyard which is used to provide the families with their domestic needs.

3.4.3.4 TRAINEE HOUSING

Housing will be provided for 62 trainees at the NAC. These trainees are divided into two groups. 32 government employees and 30 fish farmers. Social custom requires that the two units must be divided into separate buildings. The program for these two groups is defined as follows:

Fish Farmers Quarters

- Type of housing : dormitories
- Required number : 32
- Finishing level : economical
- Number of floors : 2 floors
- Ground floor area : 171 m^2
- Upper floor area : 153 m^2

Unit items/floor:

Description	Number	Area (m^2)
Dormitory	2	2 x 50
Bathroom	2	2 x 10
Kitchenette	2	2 x 4
Lounge	1	25
Storage	1	6
Control room	1	10
Toilet	1	2

Notes

- For fish farmers, there will be one building consisting of 2 floors. Each floor comprises 2 wings.
- Each wing comprises a dormitory which accommodates up to 8 fish farmers.
- There is one bathroom for each wing, a kitchenette, and a lounge.
- At the ground floor - in addition to the items at the upper floor - a storage and a control room with its private toilet will be provided.
- These areas do not include the staircase, the horizontal and vertical circulation.
- The roof will be accessible to fish farmers. A laundry room will also be provided.
- A temporary shed may be provided using the original support.

Government Employee Quarters

Quarters for 32 government employees:

- Type of housing : a residential block, 8 units on each floor
- Number : 16 units (32 bed)
- Finishing level : upper middle class
- Number of floors : 2 floors
- Built-up area:
    - ground floor : 155 m^2
    - upper floor : 136 m^2
    - restaurant : 85 m^2

Each unit/floor comprises:

	Description	Number	Area (m^2)
Ground and upper floor	Living + bedrooms	4	100 (4 x 25)
	Bathrooms	2	12 (2 x 6)
	Lounge	1	20
	Kitchenette	1	4
Additions in ground floor	Storage	1	6
	Control room	1	10
	Toilet	1	2
Restaurant	Dining hall	1	
	Bathroom	1	10
	Kitchen	1	17
	Service area	1	8

Notes

- This residential block consists of 2 floors connected by a staircase.
- Every floor consists of two wings and a lounge.
- Each wing consists of four units, two bathrooms (one for each unit), and a kitchenette.
- Each unit is designed for two employees.
- At the ground floor, there will be - in addition to the items of the upper floor - a storage and a control room with its private toilet.
- These areas don't include the staircase, the horizontal and vertical circulation areas.

3.4.3.5 GUEST HOUSING

It is anticipated that visiting scientists will conduct research and training at the NAC. To house these individuals, two villas will be provided and programmed as follows:

Houses

- Kind of housing : villas (family units) including a garden
- Required number : 2 villas
- Finishing level : luxe
- Number of floors : 1 floor
- Built-up area : 95 m^2
- Garden area : 100 m^2
- Total area of land : 195 m^2

Each unit comprises:

Description	Number	Area (m^2)
Living room	1	15
Dining room	1	15
Bedrooms	2	30 (2 x 15)
Bathroom	1	5
Toilet	1	2
Kitchen	1	8
Entrance	1	4
Lobby	1	3
Terrace	1	8
Balcony with washing hanger	1	3

Notes

- The guest villas consist of one floor containing a single living space divided to two areas:

  1. Living room
  2. Dining room

- This living area has a suitable terrace. It will also have a kitchen and an extra toilet in addition to the entrance and the internal lobby.

- The sleeping area has 2 bedrooms, a bathroom, a balcony with washing hanger area.

- In this type of villa, a place for a staircase, if an upper floor is added later, will be designated.

- Air-conditioning will be provided using solar energy heaters.

3.5 RECOMMENDED SITE CONCEPT

3.5.1 Introduction

After analyzing the biological criteria with the existing environmental conditions and the design criteria, a recommended site concept has been formulated. All buildings are grouped in the south central portion of the site with the pond groups fanned out from the building complex (see NAC Figure 3.3).

Vehicles will approach the NAC from the village of El Abbasa and their first view of the site will be of the agriculture/aquaculture research ponds with the main building in the background. Staff and visitor vehicles will then proceed to the public entrance located at the midpoint of the south side of the site. The public access road will proceed due north through the housing complex to the parking area. The alignment of the road will provide an entrance vista of the RTP building(s). Staff and visitors will park in the lot and proceed on foot to the building. This road system will not allow access to the operations areas of the NAC.

The operations access road will enter the site approximately 100 meters to the east of the public access. This road will run north through the entire site forming an axis from which all other roads and ponds will be aligned. The operations circulation system consists of three major roads running north and south, the main access road, and a road running along the east and west boundary. The major roads are connected by east-west secondary roads running along the ends of all ponds. This system also provides access to the operations side of the RTP building(s) and to the animal husbandry area.

The water provided to the NAC comes from two sources: the canal running along the north side of the site and from groundwater wells located adjacent to the building complex where it will be used. From the canal, water is pumped through a filter system into a major supply channel which runs along the east side of the NAC. Four feeder canals run from this main supply between the ponds. These canals alternate with drain canals between the rows of ponds and both the secondary supply and drain canals run into a major drain channel which runs to the south along the west boundary of the site. The feeder canals and secondary drains will run between the roads which provide access to the ends of all ponds.

The agriculture/aquaculture ponds are located in the southwest corner of the site and west of the housing complex. The animal husbandry area connects these ponds to the research function of the RTP building(s). Immediately adjacent to the north are the research ponds which are also located as close as possible to the research function of the RTP building(s). The production ponds cover the entire northern section of the site with the ponds most closely related to the production function of the RTP building(s) running through the middle of the site to the RTP building(s). The model training farms are located in the southeast corner of the site related to the training function of the RTP building(s) and as close as possible to the MHC.

The fish processing area is located to the east of the operations access road on the south edge of the site. This provides easy access to the MHC and to the main access road to the markets in Zagazig or other villages in Egypt.

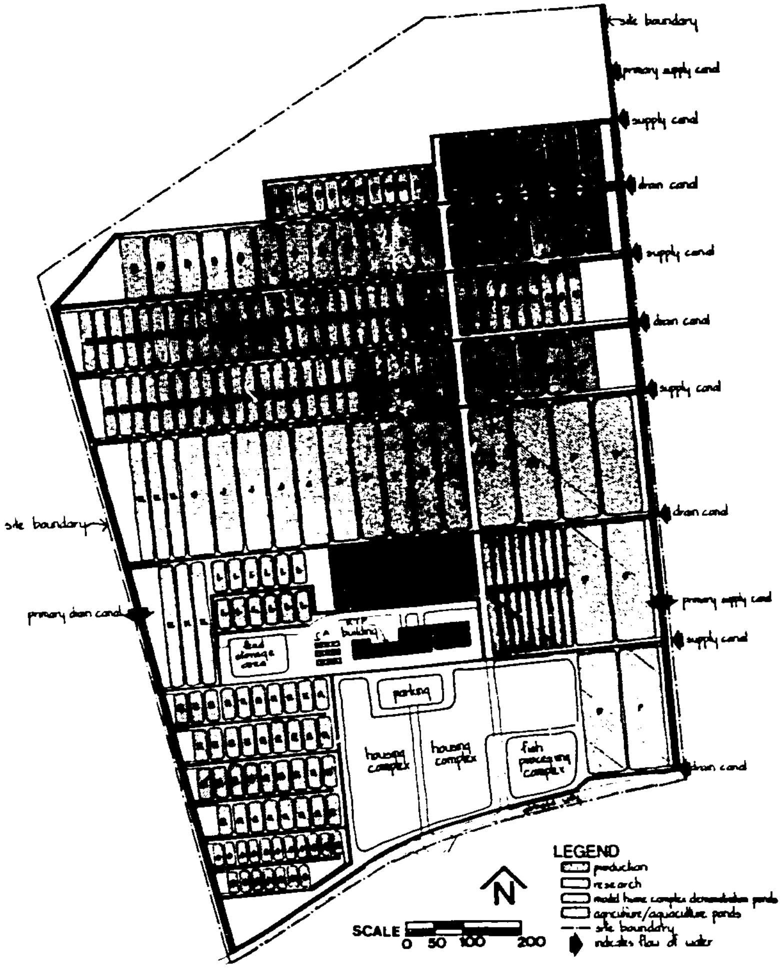
3.5.2 Advantages

The project requirements fit very well on the site and the needed relationships will work with minimum conflicts. The area of the RTP building(s), the housing complex, fish processing area, and animal husbandry area allows sufficient space for easy expansion in the future. Limited expansion space for future ponds is available.

Observation is conveniently provided by the location of the housing complex which allows easy visibility of the RTP building(s), the food processing area, the animal husbandry area, and the road to the MHC. In addition, the housing has a less direct observation of the pond areas.

NATIONAL AQUACULTURE CENTER
POND LISTING

Pond Designation	Category	Type	Number	Size
A	Production	Carp spawning	12	10 m x 10 m
B	Production	Extensive carp ponds	24	42 m x 100 m
C	Production	Extensive carp ponds	12	21 m x 100 m
D	Production	Extensive carp ponds	12	21 m x 50 m
E	Production	Intensive carp ponds	32	7.25 m x 100 m
F	Production	Broodstock holding ponds	4	42 m x 200 m
G	Production	Broodstock donor ponds	2	21 m x 100 m
H	Production	Broodstock segregation ponds	4	21 m x 100 m
I	Production	Broodstock recovery ponds	2	21 m x 100 m
J	Research	Experimental ponds	6	42 m x 200 m
K	Research	Experimental ponds	6	21 m x 200 m
L	Research	Experimental ponds	12	21 m x 50 m
M	Production	Mullet overwintering ponds	40	21 m x 100 m
N	Production	Rotifer and algal production ponds/ tilapia overwintering ponds	32	2 m x 14 m
O	Production	Tilapia fry production ponds	5	42 m x [illegible] m
P	MHC Demo.	Production ponds	8	63 m x 200 m
Q	MHC Demo.	Nursery ponds	8	12.0 m x 200 m
R	Agriculture	Demonstration and experimental ponds	36	20 m x 50 m
S	Agriculture/Aquaculture	Demonstration and experimental ponds	18	14 m x 35 m



NAC Figure 3.3
Recommended Site Concept

3.5.3 Disadvantages

A great majority of the pond expansion space is located near the northern boundary which is a long distance from the building complex. There is no area within the existing canal system to build additional 200-meter ponds. Because of the huge area of ponds included in the NAC, they cannot all have a location near the building complex.

NATIONAL AQUACULTURE CENTER
CHAPTER 4
RESEARCH/TRAINING/PRODUCTION BUILDINGS

4.1 DESIGN PARAMETERS

4.1.1 Introduction

Design parameters are factors that influence the design of a building. Examples are climate, building technology for the region, energy conservation requirements, and governing building codes. In this section, all important design parameters for the National Aquaculture Center (NAC) research, training, and production (RTP) building(s) are discussed. Parameters are divided into seven major categories: function, flexibility and expansion, site, building technology, character, culture, and codes. Reference is made to other chapters of the Egypt Aquaculture Project (EAP) Report and other sections of NAC Chapter 4 where the parameters are expanded upon.

4.1.2 Function

The RTP Building(s) will house a wide variety of functions which are discussed in detail, in NAC Chapter 1, General Project Profile, and NAC Chapter 2, Biological Process Design. Certain of these primary functions are rather general in nature; others are very specialized. Accommodating these functions must be accomplished without overdesigning, yet facilities must be adequate to encourage development of strong RTP programs without rooms or sections of buildings being underutilized.

NAC Section 4.2, Building Program, is the result of a detailed analysis of space requirements for the functions of the RTP building(s). NAC Section 4.3, Relationships, is the result of analysis of various types of relationships between the spaces developed in the building program. These two sections are the basis of developing a functional design.

During the initial stages of analyzing space requirements, it was discovered that providing distinct space for each primary function would result in unnecessary duplication of spaces which could be shared. Therefore, the principle that was adopted was to maximize multiple use of spaces wherever possible, thereby minimizing capital construction costs. An example is the educational facilities which will be used for post-graduate training for research staff and aquaculture extension agents, training for model home farmers, and national and international aquaculture conferences. An advantage of employing this multiple-use principle in the space programming is that staff persons in a particular program will not become isolated from the NAC as a whole by virtue of never leaving the spaces designed specifically for them. For example, if an entirely separate hatchery building were designed, with its own offices, crew room, etc., the hatchery staff would rarely have occasion to visit the research building and vital exchange and interaction between staff persons would be lost.

4.1.3 Flexibility and Expansion

NAC Section 4.2, Building Program, was developed allowing for the degree of flexibility indicated in NAC Chapter 1, General Project Profile, and NAC Chapter 2, Biological Process Design. Research flexibility is provided through 1) a general-use dry laboratory in each major field of study in addition to the specialized laboratory for the particular field, 2) a separate dry laboratory for the use of visiting scientists, and 3) a large general wet laboratory that can be used simultaneously for a variety of experiments. Training flexibility is provided through the inclusion of a series of educational spaces to accommodate various sizes of classes simultaneously. The hatchery and live food production spaces are designed to accommodate the latest technology at a specific production level, which is anticipated to be adequate for 10 years. When the current technology becomes outmoded, the equipment in the spaces would be replaced.

An expansion program for the RTP building(s) can be developed based on the expansion data found in NAC Chapter 1, General Project Profile, and NAC Chapter 2, Biological Process Design. The proposed building(s) will accommodate research expansion anticipated to occur within the next 10 years. This expansion would require a 30 percent increase in dry and wet laboratory space and a 25 percent increase in office and shop spaces.

An increase in carp fry production may also be necessary and would require up to a 30 percent increase in hatchery and live food production spaces. This would include breeding, incubation, algal culture, algal inocula, algal production, rotifer inocula, and rotifer production spaces. The impact of this expansion on other spaces would be minimal. It is also possible that a hatchery for a new species would need to be constructed after 10 years. The size of such a hatchery is difficult to estimate at this time, but for planning purposes, it was assumed to be as large as the carp hatchery included in this current program. Live food production facilities would be required, along with the hatchery for a new species. Peak demand in use of the educational facilities will probably occur in the first 5 years because of the general lack of trained personnel for the extension program, research program, and model home farms. The educational program might well be more diversified after 10 years, but in general, classes or training sessions would be smaller and more likely to be held in the field (laboratories, ponds, shops, etc.) than in a classroom setting. On this basis, expansion of the educational spaces will not be planned until such a need arises.

4.1.4 Site

The climate is undoubtedly the site factor that will most heavily influence design of the RTP building(s). NAC Section 3.1.1, Climatic Conditions, outlines the climate at El Abbasa. The primary climatic influence on building design will be the hot weather from late May through early October. If comfort from the heat were the only criteria, the solution would be well insulated, sealed, air-conditioned buildings. However, two of the design parameters outlined in NAC Section 4.1.5, Building Technology, are to minimize equipment that will be difficult to maintain and reduce energy consumption. This means that use of air-conditioning and mechanical ventilation systems should be kept to a minimum and use of passive systems to keep spaces cool during the hot season should be maximized. In Egypt, the principles of such a passive system are based upon the fact that 1) prevailing winds in the hot season are from the northwest, and 2) because Egypt is in the northern hemisphere, the sun travels from east to west in the southern half of the sky. The principles are as follows:

1. Buildings should be sited so that north and west walls are exposed to prevailing winds.

2. North and west walls should have operable windows to take in the breezes and provide natural lighting (the light from the north wall is preferrable for most tasks, particularly reading and writing). Windows on the west side should have sunshades, blinds, curtains, etc. Also, exterior sunscreens should be designed for west windows to keep the glass shaded until late afternoon. North windows do not need such protection unless controlling the amount of natural light during the day is desirable or necessary.

3. East and south walls should have a small amount of operable windows to expel the breezes. The small amount of ventilation as compared with the north and west walls will increase the velocity of the natural air movement inside the building. The east and south walls should be thick and constructed of a material such as masonry or concrete, that will retain large quantities of heat. The thick walls will take on heat during the day and as long as the wall is massive enough, will prevent heat storage from penetrating the full thickness. Thus, the inside face remains at room temperature and will not radiate heat into the room. At night when temperatures normally drop considerably due to lack of any cloud cover, the heat stored in the walls will radiate to the outside.

4. Spaces where natural light is desired should have a north or west exposure; where natural light is not desired, there should be a south or east exposure. Spaces in which undesirable odors are generated (bathrooms, kitchens, some laboratories, etc.) should be in the southeast quadrant of the building so that the natural air movement inside the building carries the odors directly outside. Partitions should be designed when possible so that there is allowance for air movement, with openings at the top or advantageous location of doors. In general, buildings should be long and narrow to minimize partitions that interfere with the natural movement of air from northwest to southwest.

5. Roofs should be well insulated to prevent heat gain. A light-colored roof surface is preferable. In lieu of insulation, a

thick, heavy roof deck will work on the same principle as described above for south and east walls. A secondary roof, allowing passage of heat expelling breezes below it, is another possibility.

6. Because of the almost nonexistence of precipitation and cold temperatures, outdoor circulation space appears most viable and will minimize corridors and other circulation space inside the building. Outdoor circulation space must be protected from the sun, thus arcades are a very practical solution. Sun angles should be carefully studied in the design of covered walkways and arcades to ensure that they provide maximum shade.

7. Because of the lack of precipitation, sloped roofs are rarely employed. Flat roofs can easily be designed to accommodate the small amount of runoff. Moisture penetration at doors and windows will not be an important consideration, however, the building must be capable of being tightly sealed from dust.

8. The location selected for the RTP building(s) currently has poor drainage. Periodically, it is inundated with water. However, the recommendations of NAC Section 6.4, Recommended Civil Systems, will result in a finished grade of about 1.5 meters higher than existing at the site of the building complex. This will eliminate the possibility of flooding of the building complex; finished floor elevations will be set somewhat higher (approximately 0.25 m) than the new finished grade, dependent upon local custom, desired architectural effect, and minimum recommended differential.

How the building design will respond to existing soils conditions is discussed in NAC Section 6.5, Structural Systems. How the architectural character of the building design will respond to the site is discussed in NAC Section 4.1.6, Character.

4.1.5 Building Technology

It is not the intention to utilize new or rarely used building technology in the design of the building(s). Current typical building construction in Egypt is well suited to locally available materials and the labor situation. A radical departure from typically used materials or methods of construction would almost certainly add to capital construction cost as well as maintenance costs.

Energy conservation is another good reason not to depart from typical building construction. Heating is generally not required, and to keep building energy demand low, passive cooling systems as described in NAC Section 4.1.4 will be utilized.

For specific recommendations on materials, systems, and methods of construction to be employed, the following references are provided.

Architectural finishes	NAC Appendix A.1
Structural systems	NAC Section 6.5
HVAC systems	NAC Section 6.2
Mechanical systems	NAC Section 6.1
Electrical systems	NAC Section 6.2

4.1.6 Character

The RTP Building(s) is the heart of the NAC. As such the building complex upon approach by vehicle should be prominent without being pretentious. It should be obvious to the first time visitor approaching by car through the housing area that the building complex to the north is the hub of the NAC. This feeling of prominence should remain with visitors as well as staff as they walk from the parking area toward the building entrance. As one approaches, an impression of being invited to enter should prevail. The public spaces inside should reinforce the feeling of welcoming staff and visitors, allowing people to feel at ease in these spaces.

Prominence of the RTP building(s) will be achieved through the bold and simple use of forms, colors, and textures that will contrast rather sharply with the flat surroundings.

The contrast between the bright sunlight and shadows cast by the building forms and openings will be exploited.

The building complex will be inviting and comfortable to its users through careful attention to scale and detailing. As one approaches the building entrance on foot, carefully detailed human-scaled elements such as doors, handrails, and stairs will be apparent. Inside, spaces will be scaled and detailed with people in mind. The palette of materials, colors, and forms used throughout the building complex will be limited in the firm belief that endless variety with its resulting complexity is not the answer to creating a building for its users.

4.1.7 The Cultural Imperative

Egyptian culture has had one of the largest and most illustrious histories in the world. Today that culture is changing. Economic development has affected all elements of society and Egypt's political, intellectual, and artistic leaders seek to define modern Egypt - to incorporate the beauty, traditions, and integrity of the past into a progressive future. This transition is reflected in the daily lives of Egyptians for whom religion continues to weave a strong cultural bond while new economic and political opportunities disrupt many of their traditional social customs. For this reason, the design of the EAP has two objectives: (1) to be sensitive to the traditional social and religious customs of the people it will serve; and (2) to be capable of adapting to future economic and social needs.

This section of the report examines briefly the social, economic, and religious fabric of Egyptian society and presents particular characteristics of the culture that will impact building design.

4.1.7.1 THE SOCIAL FRAMEWORK

Egyptian society is made up of four economic and social classes: upper, upper-middle, middle, and lower. In general, managers in the public and governmental sector will belong to the upper class, senior staff to the upper-middle, junior staff to the middle and unskilled labor to the lower classes. These class distinctions are important not so much for their rigidity (there is considerable upward mobility especially within the public and governmental sectors), but for the effect these class distinctions have on developing design criteria. For example, housing requirements will be different for junior staff than for managers. Another example involves transportation and parking. Until recently private automobiles have only been available to the upper and upper-middle classes. Although increasingly middle-class Egyptians are buying cars, the majority of public workers use public transportation or walk to work. Even senior staff walk if their residences are located close to their place of work. Therefore the number of parking areas required for a public facility will depend generally on the number of managers and senior staff and on its proximity to the workers' residences.

Another important distinction closely related to social and economic class is the cultural differences between city and village dwellers. Typically, village dwellers are less well educated than their city counterparts and lead more traditional agricultural lives. Where these two classes of people interact, distinct if not separate facilities that accommodate differences in living and eating habits must be provided.

4.1.7.2 THE WORK FORCE

The availability of free elementary, secondary, and college education to everyone in Egypt who qualifies has resulted in a burgeoning professional work force. The Egyptian government encourages this by guaranteeing jobs to all Egyptians who graduate from colleges and universities. If a graduate cannot find a job in the private sector or prefers a job in the public sector, the government will provide one.

Another contributing factor to the increase in the professional work force has been changing attitudes toward women. In all classes, the women are finding their way into colleges and universities and then into the professional work force.

The availability of inexpensive skilled labor, on the other hand, has been declining in the past few years. Skilled tradesmen are scarce and command high wages. Many have emigrated to neighboring Arab countries.

Unskilled labor, however, is still abundant and as a result, performs many of the tasks that could be performed by technology. For example, offices in Egypt rely heavily on messengers for transferring files, reproduction, paper work between offices. These messengers also function to serve coffee and soft drinks to the people working. Building design, therefore, must provide wide corridors to accommodate heavy traffic and each floor must have a small coffee room where a preparer makes coffee for distribution by the messengers. Typically the room will have a sink and a counter and several chairs for sitting.

It is doubtful that in the future Egypt's unskilled labor force will remain as abundant and inexpensive as it is currently. As unskilled labor becomes more expensive and more difficult to obtain, technology may assert itself. Telephones may do more of the work of messengers and self-serve dispensers may replace the people who currently prepare and distribute the drinks.

4.1.7.3 THE WORK DAY

People working in the public sector and the governmental offices work from 8:00 am to 2:30 pm six days a week, Saturday through Thursday. Normally a worker will eat breakfast before arriving at work and eat a mid-day meal after arriving at home. For this reason, no dining facilities are generally necessary in public office buildings.

After having their mid-day meal, people usually sleep through the hot afternoon and wake up around 6:00 or 7:00 in the evening. Their evenings are often spent visiting friends or frequenting coffeehouses or clubs.

4.1.7.4 THE HOME

In an Egyptian house, the kitchen, living area, and sleeping area are separated. Traditionally the house also has a separate reception area where visitors are greeted and entertained. The formal reception area is disappearing from modern city apartments due to space limitations and changing attitudes, but is still an important design element in village houses.

Ideally each house also has three bedrooms so that parents can have privacy, and children can be separated according to sex at puberty. In the villages, when children marry, often the parents' house will be expanded either horizontally or vertically so the child and his or her spouse can continue to live close to the family.

Another important element of the village house is the courtyard. This provides space for the family to raise poultry or rabbits or to tend beehives.

4.1.7.5 RELIGIOUS CUSTOMS

Islam is the predominant religion in Egypt and plays a prominent role in the life of most Egyptians. Other religions include Christianity and Judaism. All Moslems must pray five times a day and because some of these times are during working hours, a suitable area should be provided at the place of work for group praying. The area should be carpeted and capable of accommodating up to 50 percent of the total persons employed. For large offices, the area can be made to accommodate smaller groups on a scheduled basis. If possible the prayer room should be centrally located and close to restrooms to facilitate the ablution. A Keblah, or niche, in the prayer room indicates the direction of Mecca (southeast).

Moslems generally prefer praying in the mosque; however, according to the Islamic faith, Moslems must pray in the mosque on Friday. The importance of the mosque in most Egyptians' daily lives makes it essential to provide a mosque in any new residential community. The mosque should be centrally located and consist of two parts - the mosque hall which is the area for praying and the ablution place which includes toilets and sinks. Some mosques have a private area for women and may also include a library.

4.1.7.6 CHARACTER OF EGYPTIAN ARCHITECTURE

It is difficult to define a special character for modern Egyptian buildings because Egypt stands now between the old Egyptian aesthetic and the new design and technology imported from advanced countries. Traditional design depended on an abundance of inexpensive labor and tedious construction methods. New construction methods and materials are required, but they must be chosen such that they are suitable for the Egyptian environment and expressive of the Egyptian aesthetic. The dilemma for modern architects is how to preserve Egypt's religious and artistic legacy while taking advantage of modern building technology.

Another factor affecting modern architectural design is the availability of land. In the cities, where land is expensive, new buildings rise vertically as they do in most larger cities elsewhere. In the country, where land is less expensive, the design solutions tend to be horizontal, and the main design objective is to have the building relate aesthetically to its natural surroundings.

The NAC design team will take into consideration all the social, religious, and economic factors that will impact architectural design. The design goal will be to develop facilities that are compatible with important traditional values as well as present and future needs.

4.1.8 Codes

The safety of the occupants of a building as well as protection from loss of property (buildings and contents) is generally ensured through compliance with governing building codes. The U.S. Agency for International Development (USAID) directive has stipulated that the Uniform Building Code (UBC) is to be adhered to. Therefore, the 1979 edition of the UBC will be the primary design code for the RTP Building(s). The UBC will not be adhered to in specific cases when local conditions or practical reasons dictate otherwise. In these cases, professional judgement of the designers will govern. For information on codes to be followed for mechanical and electrical work within the buildings see NAC Sections 6.1.12, 6.2.5, and 6.3.6.

4.2 BUILDING PROGRAM

4.2.1 Introduction

The building program for the RTP building(s) provides basic information about all rooms or definable areas required as a result of function. The building program was developed through analysis of project profiles (NAC Chapter 1) and the biological process design (NAC Chapter 2).

NAC Section 4.2.2 is a summary of the building program. Each space is identified by name and number and the net area (actual floor area measured inside the walls) given. A description of the purpose or function of the space is provided. Spaces are grouped based on the results of the analysis of functional relationships (see NAC Section 4.3, Relationships Analysis). In NAC Table 4.1, total estimated gross floor area is calculated from the net areas of the individual spaces.

In Appendix A.1, a standardized form is used to provide the complete basic information about each space. The form was designed to be comprehensive and yet flexible enough to work for the variety of spaces involved. Appendix A.1 is the heart of the building program because the Relationships Analysis (NAC Section 4.3) and Recommended Building Concept (NAC Section 4.4) are highly dependent on the information provided for each space.

4.2.2 Building Program Summary and Notes

4.2.2.1 EDUCATIONAL SPACES

Reception/Display

Space No: E-1 Area: 150 m^2

Function: Visitors to the NAC are screened and oriented by receptionist/guard. Visitors may educate themselves about the NAC and aquaculture in Egypt through self-guiding displays. Participants in NAC conferences confer informally, drink coffee, rest between meetings. NAC parties are held.

Library

Space No: E-2 Area: 150 m^2

Function: Staff locates literature required for their work and either studies the material in the library or borrows it. Visitors to the NAC do the same except are not allowed to borrow material. The librarian assists staff and visitors in locating literature and maintains the library. The library will be stocked with literature on all aquatic species native to Egypt as well as general aquaculture, science, and reference handbooks.

NAC TABLE 4.1
CALCULATION OF ESTIMATED GROSS FLOOR AREA FOR NAC RESEARCH, TRAINING, AND PRODUCTION BUILDINGS

Group of Spaces	Net Area of Group of Spaces	% Added to Net Area to Obtain Gross Area[1]	Square Meters Added to Net Area to Obtain Gross Area	Gross Area
1. Educational Spaces	574	50	287	861
2. Offices	369	50	185	554
3. Dry Laboratories	198	50	99	297
4. Wet Laboratories	260	30	78	338
5. Hatchery	150	30	45	195
6. Live Food Production	1,500[2]	30[3]	36	1,536
7. Feed Facilities	99[4]	30	30	129
8. Shops	887	30	266	1,153
TOTAL	4,037		1,026	5,063

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[1] Percentage is added for walls, structural elements, restrooms, mechanical and electrical rooms, pipe spaces, loading docks, corridors, stairways, etc.

[2] Number includes 1,380 m^2 of uncovered area (rotifer inocula, rotifer production, algal production). Covered area is 120 m^2.

[3] 30% added only to covered portion.

[4] Does not include area of plant waste silo or animal waste silo.

Lecture Hall

Space No: E-3 Area: 150 m^2

Function: NAC staff, NAC visitors (Egyptian and international aquaculture specialists), MHC trainees, MHC farmers, etc., attend lectures, conference sessions, classes, etc., conducted by the NAC. For gatherings of 15 or more.

Classroom

Space No: E-4 Area: 100 m^2

Function: NAC staff, NAC visitors (Egyptian and international aquaculture specialists), MHC trainees, MHC farmers, etc., attend lectures, classes, conference sessions, etc., for gatherings of 4 to 30 persons.

Conference Room

Space No: E-5 Area: 24 m^2

Function: NAC staff, NAC visitors (Egyptian and international aquaculture specialists), MHC trainees, MHC farmers, etc., attend seminars, briefings, study groups, conferences, classes, etc., for gatherings of 5 to 15.

4.2.2.2 OFFICES

Directors' Reception

Space No: O-1 Area: 14 m^2

Function: Visitors to the director and assistant director are greeted by receptionist/secretary. Visitors wait to meet director and assistant director. Receptionist/secretary does typical secretarial work for director and assistant director.

Director's Office

Space No: O-2 Area: 24 m^2

Function: Director does typical managerial office work. Director confers with staff and visitors.

Assistant Director's Office

Space No: O-3 Area: 18 m^2

Function: Assistant director does typical managerial office work. Assistant director confers with staff and visitors.

Visiting Scientists' Offices

Space No: O-4 Area: 3 @ 12 m^2 = 36 m^2

Function: Visiting scientists do nonlaboratory research work and confer with staff and visitors.

Senior Staff Offices

Space No: O-5 Area: 8 @ 12 m^2 = 96 m^2

Function: Senior staff do typical managerial office work and nonlaboratory research work. Senior staff confer with staff and visitors.

Extension Agents Office

Space No: O-6 Area: 50 m^2

Function: Six extension agents do typical office work and confer with extension agent interns, other staff, and visitors.

Extension Agent Interns' Classroom

Space No: O-7 Area: 35 m^2

Function: Six extension agent interns receive instruction, study, draft typical farm layouts, perform minor experiments, etc. Extension agents.

Graduate Research Assistants' Carrels

Space No: O-8 Area: 25 m^2

Function: Graduate research assistants do nonlaboratory research work.

Clerical Staff Offices

Space No: O-9 Area: 50 m^2

Function: Clerical staff (except those specifically assigned to other spaces such as directors' receptionist/secretary) do secretarial and clerical work for senior staff, extension agents, and visiting scientists.

Mail

Space No: O-10 Area: 6 m^2

Function: Clerical staff receives and sorts incoming mail for distribution. Clerical staff packages and stamps outgoing mail.

Reproduction

Space No: O-11 Area: 9 m^2

Function: Clerical staff reproduces, collates, and binds extension and research publications. Staff reproduces general documents. Extension and research publications stored prior to distribution.

Office Supplies

Space No: O-12 Area: 6 m^2

Function: Office supplies stored. Controlled by one clerical staffperson.

4.2.2.3 DRY LABORATORIES

Visiting Scientists' Laboratory

Space No: D-1 Area: 20 m^2

Function: Visiting scientists do their personal laboratory work. They are assisted by junior staff or graduate research assistants as necessary.

General Nutrition Laboratory

Space No: D-2 Area: 20 m^2

Function: Senior staff, junior staff, visiting scientists, and graduate research assistants do general laboratory work on formulation and composition of diets. The laboratory work is either part of the NAC research program or personal work of the students. Senior nutritionist in charge.

Analytical Nutrition Laboratory

Space No: D-3 Area: 20 m^2

Function: Senior staff, junior staff, visiting scientists, and graduate research assistants do chemical analysis on formulation and composition of diets. The laboratory work is either part of the NAC research program or personal work of the students. Senior nutritionist in charge.

General Physiology Laboratory

Space No: D-4 Area: 20 m^2

Function: Senior staff, junior staff, visiting scientists, and graduate research assistants do general physiology laboratory work on tissues, organs, etc., of fish. The laboratory work is either part of the NAC research program or personal work of the students. Senior physiologist in charge.

Histology Physiology Laboratory

Space No: D-5 Area: 14 m^2

Function: Senior staff, junior staff, visiting scientists, and graduate research assistants do histology laboratory work on tissues, organs, etc., of fish (such as preparation of slides for viewing, viewing slides). The laboratory work is primarily part of the NAC research program. Senior physiologist in charge.

Biochemistry Physiology Laboratory

Space No: D-6 Area: 20 m^2

Function: Senior staff, junior staff, visiting scientists, and graduate research assistants do biochemical analysis of tissues, organs, etc., of fish. The laboratory work is primarily part of the NAC research program. Senior physiologist in charge.

General Limnology Laboratory

Space No: D-7 Area: 10 m^2

Function: Senior staff, junior staff, visiting scientists, and graduate research assistants do general limnology laboratory work (such as water sample preparation, some microscopic work). The laboratory work is either part of the NAC research program or personal work of the students. Senior limnologist in charge.

Chemistry Limnology Laboratory

Space No: D-8 Area: 20 m^2

Function: Senior staff, junior staff, visiting scientists, and graduate research assistants do chemical analysis of water samples. The laboratory work is either part of the NAC research program or personal work of the students. Senior limnologist in charge.

Microbiology Pathology Laboratory

Space No: D-9 Area 20 m^2

Function: Senior staff, junior staff, visiting scientists, and graduate research assistants identify, culture, and quantify pathogens (viruses and bacteria). The laboratory work is either part of the NAC research program or personal work of the students. Senior microbiologist in charge.

Dry Laboratory Storage

Space No: D-10 Area: 18 m^2

Function: Storage of dry chemicals and laboratory apparatus. Senior staff, junior staff, and graduate research assistants will obtain necessary items. Staff will sign out for nondisposable laboratory apparatus.

Solvent Storage

Space No: D-11 Area: 6 m^2

Function: Storage of solvents and wet chemicals for use in the dry laboratories. Senior staff, junior staff, and graduate research assistants will pour solvents and wet chemicals from large storage containers into small containers brought from their laboratories.

Dark Room

Space No: D-12 Area: 10 m^2

Function: Senior staff, junior staff, extension agents, visiting scientists, and graduate research assistants develop film as part of their research or extension work.

4.2.2.4 WET LABORATORIES

Fish Receiving and Holding

Space No: W-1 Area: 40 m^2

Function: Temporary holding for fish destined for wet laboratories, food processing, breeding, etc. Possibly used for egg hardening.

General Wet Laboratory

Space No: W-2 Area: 120 m^2

Function: Senior staff, junior staff, graduate research assistants, and visiting scientists do research work involving live fish, experiments of varying duration (one month to five years) are set up (special tanks, apparatus, water systems as required), maintained, monitored, modified, and results recorded. Laborers and tradesmen assist as required.

Weigh and Measure

Space No: W-3 Area: 20 m^2

Function: Staff weighs and measures live fish from NAC production and experimental ponds. Fish are returned to ponds.

Diagnostics

Space No: W-4 Area: 20 m^2

Function: Diseased fish from NAC and MHC ponds are held in tanks. Senior staffperson in charge of pathology department plus assistants as required diagnose, monitor, and experimentally treat diseased fish.

Postmortem

Space No: W-5 Area: 10 m^2

Function: Senior pathologist plus assistants as required observe, dissect, diagnose fish from the diagnostics room that have died. Fish or fish parts are sent on to general physiology laboratory, microbiology pathology laboratory.

Fish Processing

Space No: W-6 Area: 50 m^2

Function: Senior staff, junior staff, visiting scientists, and graduate research assistants experiment with methods of canning, freezing, and salting fish.

4.2.2.5 HATCHERY

Breeding

Space No: H-1 Area: 80 m^2

Function: Junior staff and laborers induce carp to breed and gather the eggs. Carp are brought from brood ponds, returned to recovery ponds. Eggs are sent to incubation. Senior staffperson in charge of hatchery directs the process. Process carried out intermittently over period of 6 months. During off-season, space used for gathering and preparing carp pituitary glands.

Incubation

Space No: H-2 Area: 70 m^2

Function: Junior staff and laborers hatch carp eggs. Eggs are brought from breeding, washed and counted, placed in Zuger jars where they hatch, pumped into fry trough where they begin feeding, and taken to extensive or intensive ponds by truck. This process is carried out intermittently for about six months. Senior staffperson in charge of hatchery maintains an office and directs the process.

4.2.2.6 LIVE FOOD PRODUCTION

Plankton Culture Maintenance

Space No: L-1 Area: 20 m^2

Function: Staff initiates phytoplankton (algal) cultures and maintains culture inocula in support of live food production.

Rotifer Inocula

Space No: L-2 **Area:** 80 m^2

Function: Rotifer multiply in tanks for use in rotifer production.

Algal Inocula

Space No: L-3 **Area:** 100 m^2

Function: Algae multiply in tanks for use in algal production.

Rotifer Production

Space No: L-4 **Area:** 650 m^2

Function: Rotifers multiply in tanks as feed for carp fry from beginning of March through end of June. From December through February used for tilapia overwintering.

Algal Production

Space No: L-5 **Area:** 650 m^2

Function: Algae multiply in tanks as feed for carp fry from beginning of March through end of June. From December through February, used for tilapia overwintering.

4.2.2.7 FEED FACILITIES

Feed Preparation

Space No: F-1 **Area:** 35 m^2

Function: Staff mixes feed ingredients from feed storage and the feed freezer. Mixed feeds are 1) returned to feed storage, 2) returned to freezer (if fish flesh is an ingredient), or 3) taken directly to wet laboratory tanks, intensive rearing production ponds, or experimental ponds.

Feed Storage

Space No: F-2 **Area:** 20 m^2

Function: Brans, vitamins, oils, etc., are stored before and after mixing. The mixed feed is fed to intensive rearing production ponds and experimental ponds as a diet supplement and to wet laboratory tanks as a main diet. Feed is stored in drums, boxes, and sacks.

Ponds Storage

Space No: F-3 Area: 30 m^2

Function: Storage for equipment for outdoor ponds (such as nets, buckets, grading trays, hand tools, aerators). Any motorized equipment will be stored in garage.

Fertilizer Storage

Space No: F-4 Area: 14 m^2

Function: Store inorganic fertilizers in sacks for use in fertilizing ponds to increase natural biogrowth. Capacity 35 tonnes.

Plant Waste Silo

Space No: F-5 Area: 10 m^2

Function: Store cereal bran and other plant waste for use as pond fish food.

Animal Waste Silo

Space No: F-6 Area: 30 m^2

Function: Store manures, principally chicken manure, for use in fertilizing ponds to increase natural biogrowth.

4.2.2.8 SHOPS

Facility Engineer's Office

Space No: S-1 Area: 12 m^2

Function: Facility engineer (responsible for maintenance of NAC buildings, equipment, ponds, etc., and in charge of tradesmen). Does typical office work and confers with maintenance staff.

Crew

Space No: S-2 Area: 60 m^2

Function: Drivers and mechanics (13), tradesmen (6), laborers (20), and some junior staff (4 out of 12) take coffee breaks, eat lunch, change clothes, use toilet facilities.

Workshop

Space No: S-3 Area: 120 m^2

Function: Tradesmen repair and maintain facility components, i.e., mechanical equipment, electrical equipment, furniture, casework, door hardware, fiberglass tanks, plastic piping, fittings, and nets. Tradesmen construct new tanks, tank supports, piping systems, troughs, etc., for research. About 50 percent of all work would be done in the workshop, the other 50 percent to be done on location. Some major repair work would not be attempted by tradesmen.

Workshop Storage

Space No: S-4 Area: 25 m^2

Function: Storage of wood, metal, and plastic materials for workshop. Fabricated tanks and piping systems designed for a completed wet laboratory experiment would be stored as is if likely to be used in the future.

Janitor

Space No: S-5 Area: 20 m^2

Function: Cleaning and basic maintenance materials and equipment stored. Janitor prepares for cleaning and basic maintenance work.

Vehicle and Heavy Equipment Workshop

Space No: S-6 Area: 50 m^2

Function: Mechanics repair and maintain all NAC vehicles and heavy equipment. Certain major repair work would not be attempted by mechanics.

Garage

Space No: S-7 Area: 600 m^2

Function: Storage of NAC vehicles and heavy equipment.

4.3 RELATIONSHIPS

4.3.1 Introduction

In this section, relationships between the spaces programmed in NAC Section 4.2 are analyzed. The term relationships as used here, refers to similarities and differences between spaces. Types of relationships include functional, dimensional, light, sound, security and privacy, HVAC, and outside access. The results of the analyses are incorporated when arranging the spaces on site (schematic floor plans). For example, the outcome of an analysis of dimensional relationships would be the grouping of spaces with similar ceiling heights and clear span requirements, thereby keeping construction costs down and simplifying building design both visually and technically. In some instances, there will be conflicts; for example, all of the spaces grouped together because of a similar ceiling height might not functionally relate to each other. Resolution of the relationships analyses is found in NAC Section 4.4, Recommended Building Plan.

The relationships between spaces are studied irrespective of site design determinants such as the size and shape of the building site, location of the various types of fish ponds in respect to the building site, location of access roads, etc. This provides an opportunity to idealize the relationships between spaces before the realities of the actual site are considered. In NAC Section 4.4, site design determinants become one of the factors that influence the recommended building concept.

4.3.2 Functional Relationships Analysis

Functional relationships are based upon how the spaces are utilized by staff and visitors. Where the convenience or efficiency of the staff and/or visitors would be enhanced by some degree of proximity of two spaces, a functional relationship is said to exist, such as that between the clerical staff office and the reproduction room. NAC Table 4.2, Functional Relationships Matrix, charts the functional relationships between all programmed spaces; they are classified as very strong, intermediate, minor, or none in particular.

From the matrix, groups of spaces between which there are numerous relationships can be identified. These functional groups are listed in NAC Table 4.3. The spaces within each of these groups will function optimally when they are clustered together on site. The relationships between these functional groups are shown on NAC Figure 4.1; groups of spaces connected by bold arrows have a significant functional relationship and those with light arrows have a minor functional relationship. Otherwise, no particular functional relationship exists.

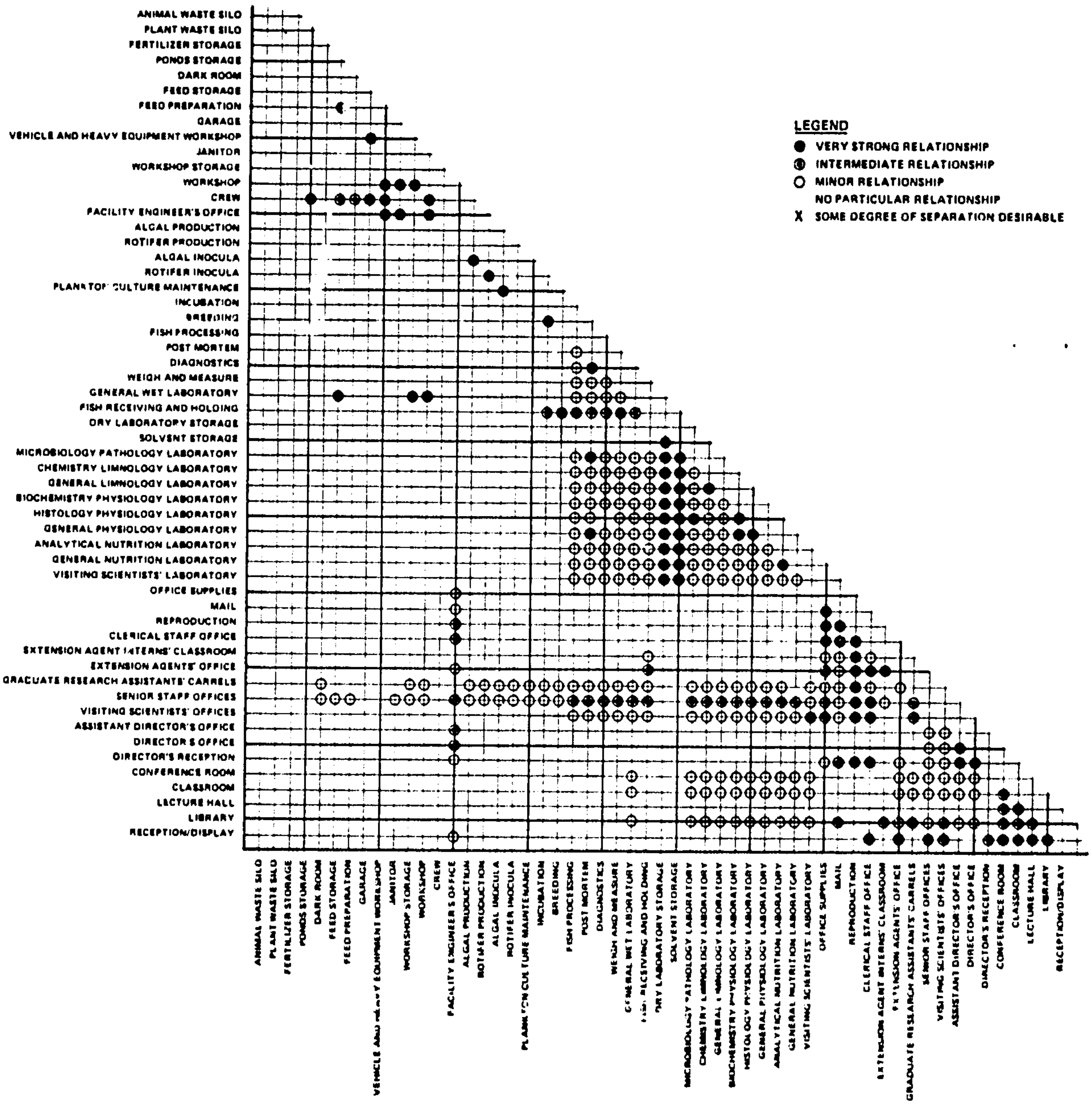
These functional clusters and their interrelationships should be a primary determinant in the final building concept for maximum convenience and efficiency.

4.3.3 Dimensional Relationships

Dimensional relationships are those which exist between spaces based upon similar ceiling heights or clear spans. The result of grouping together spaces that share those similarities will be a building that is aesthetically and technically simplified.

In NAC Table 4.4, spaces are grouped by ceiling heights. All of the spaces fall into two basic groups: 1) 2.7 to 3 m and 2) 3.0 to 4.0 m. Most of the spaces in the 2.7 to 3.0 range will possibly have a suspended ceiling with a mechanical/electrical plenum above while most of those in the 3.0 to 4.0 m range would not. The height distance to the structural roof slab will be similar

NAC TABLE 4.2
FUNCTIONAL RELATIONSHIPS MATRIX - BUILDING



NAC TABLE 4.3
FUNCTIONAL GROUPS

- EDUCATIONAL FACILITIES
  - Reception/display
  - Library
  - Lecture hall
  - Classroom
  - Conference room

- OFFICES
  - Directors' reception
  - Director's office
  - Assistant director's office
  - Visiting scientists' offices
  - Senior staff offices
  - Extension agents' office
  - Extension agent interns' classroom
  - Graduate research assistants' carrels
  - Clerical staff office
  - Mail
  - Reproduction
  - Office supplies

- DRY LABORATORIES
  - Visiting scientists' laboratory
  - General nutrition laboratory
  - Analytical nutrition laboratory
  - General physiology laboratory
  - Histology physiology laboratory
  - Biochemistry physiology laboratory
  - General limnology laboratory
  - Chemistry limnology laboratory
  - Microbiology pathology laboratory
  - Dry laboratory storage
  - Solvent storage
  - Darkroom

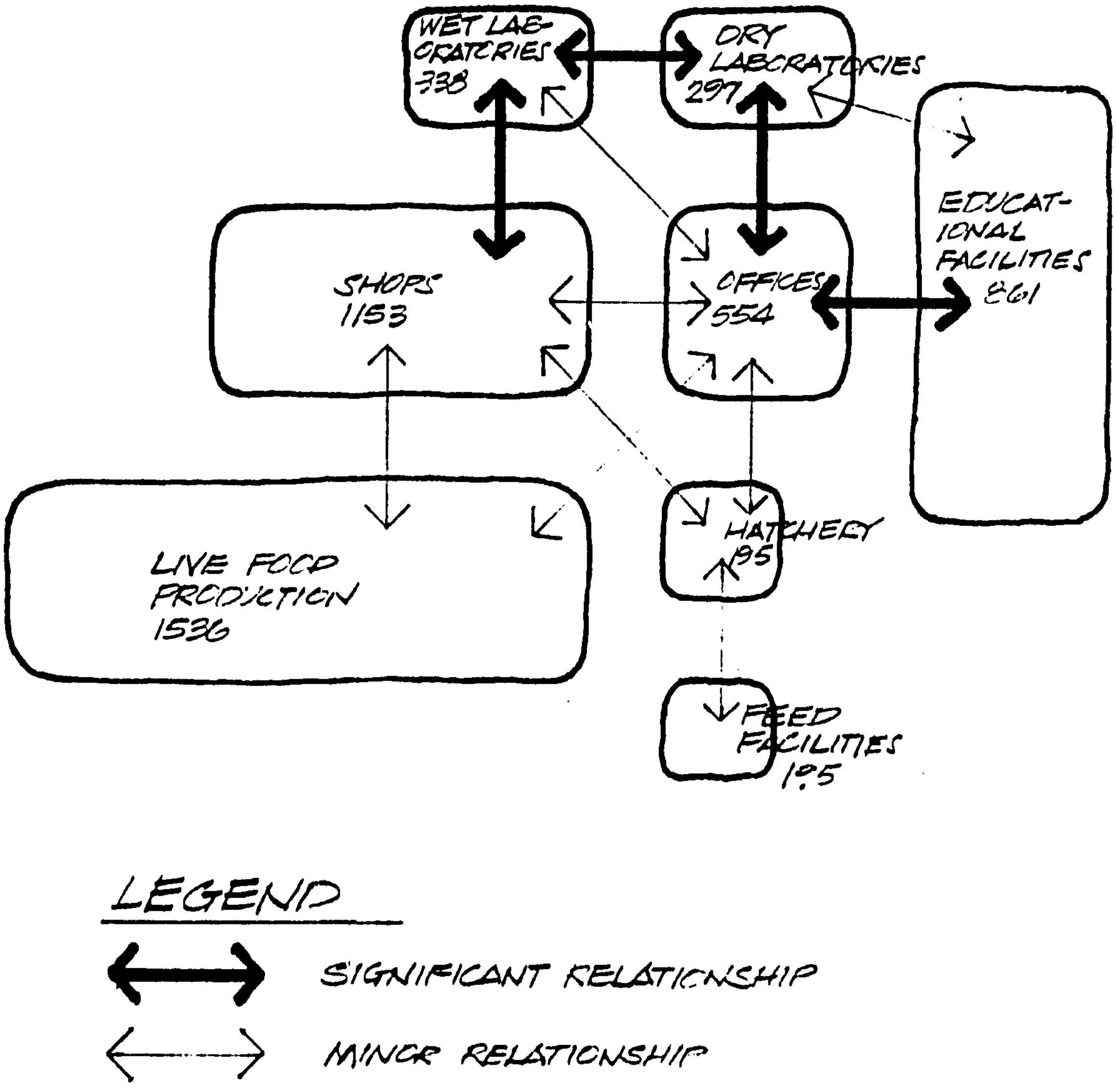
- WET LABORATORIES
  - Fish receiving and holding
  - General wet laboratory
  - Weigh and measure
  - Diagnostics
  - Post mortem
  - Fish processing

- HATCHERY
  - Breeding
  - Incubation

- LIVE FOOD PRODUCTION
  - Plankton culture maintenance
  - Rotifer inocula
  - Algal inocula
  - Rotifer production
  - Algal production

- SHOPS
  - Facility engineer's office
  - Crew
  - Workshop
  - Workshop storage
  - Janitor
  - Vehicle and heavy equipment workshop
  - Garage

- FEED FACILITIES
  - Feed preparation
  - Feed storage
  - Ponds storage
  - Plant waste silo
  - Animal waste silo
  - Fertilizer storage



NUMBERS ARE GROSS SQUARE METERS OF CLUSTERS

NAC Figure 4.1
Functional Relationships

NAC TABLE 4.4
CEILING HEIGHT GROUPS

2.7 TO 3.0 METERS
- Conference room
- All offices
- All dry laboratories
- Plankton culture maintenance
- Facility engineer's office
- Crew

3.0 TO 4.0 METERS
- Reception/display*
- Library
- Lecture hall**
- All wet laboratories
- Breeding
- Incubation
- Algal inocula
- All feed facilities (except silos)
- Workshop
- Workshop storage
- Janitor
- Vehicle and heavy equipment workshop
- Garage

*All or part of space may be higher for aesthetics.

**Floor slopes and probably ceiling slopes.

for nearly all spaces. If the visual effect were desirable of higher and lower ceiling heights when viewed from the exterior, this could be accomplished by minimizing the plenum height and maximizing the ceiling height in the higher spaces (close to 4 m).

Analysis of relationships based on common clear spans is made complex by the fact that it is not known at this point whether nonload-bearing partitions will be employed. Columns interior to any of the spaces are undesirable and therefore the minimum clear spans will be the estimated width of each space. In NAC Table 4.5, spaces are grouped by clear spans on this basis.

4.3.4 Light Relationships

Light relationships are based upon space requirements for natural and artificial lighting. One of the design parameters is to minimize energy consumption in all facilities; therefore, full advantage will be taken of natural light. NAC Table 4.6 indicates the natural and artificial light requirements for each space based upon maximizing the use of natural light. Natural light from the north is always preferable. Because windows on the west side also catch the flow of breezes, west is the second choice for the direction of natural light. East and south are least desirable.

4.3.5 Sound Relationships

Sound relationships are based upon the amount of noise generated within the spaces and the relative degree of quiet that should be maintained in spaces. In NAC Table 4.7, spaces are divided into three groups: quiet, semiquiet, and noisy. Spaces in the quiet group generate low sound levels and need to be isolated from moderate to high sound levels. Those in the noisy group generate high sound levels. Spaces in the semiquiet group generate moderate sound levels and need to be isolated from high sound levels. Because of other relationships, it is not always practical to group these in their respective sound areas. However, most of the advantages achieved through such clustering can be obtained by the use of sound barrier partitions, doors, etc., to isolate a particular space. The recommended building concept will respect sound control zones to the extent practical and in further stages of design, sound control design features will compensate for any zoning shortcomings.

4.3.6 Security and Privacy Relationships

In NAC Table 4.8, spaces are grouped on the basis of security and privacy requirements. Signs explaining restrictions, locked doors, and guards can be employed; however, the need for such methods, which have a generally negative impact on people can be reduced significantly through proper arrangement of spaces. In other words, people can be discouraged from total access to restricted or private areas by more subtle means such as private, semiprivate, and public zones: locating private spaces away from primary circulation routes and making the interface between public and private zones obvious.

NAC TABLE 4.5
CLEAR SPAN GROUPS

2 TO 5 METERS
- Director's reception
- Director's office
- Assistant director's office
- Visiting scientists' office
- Senior staff offices
- Graduate research assistants' carrels
- Mail
- Reproduction
- Office supplies
- All dry laboratories
- Weigh and measure
- Diagnostics
- Post mortem
- Plankton culture maintenance
- Feed preparation
- Feed storage
- Ponds storage
- Fertilizer storage
- Facility engineer's office
- Workshop storage
- Janitor

5 TO 8 METERS
- Extension agents office
- Extension agents interns' classroom
- Clerical staff offices
- Fish receiving and holding
- Fish processing
- Breeding
- Incubation
- Crew
- Vehicle and heavy equipment workshop

8 TO 12 METERS
- Reception/display
- Library
- Lecture hall
- Classroom
- General wet laboratory
- Algal inocula
- Workshop
- Garage

NAC TABLE 4.6
LIGHT REQUIREMENTS

SPACE NAME	Natural light from the north should provide 100% of the functional light requirement on most days during regular working hours. Back-up artificial area light provided.	Natural light preferably from the north, should provide an average of 50% of the functional light requirement. Artificial area and task lighting provided.	Natural light not required. Artificial area lighting provided.	No natural light should be provided. Artificial area and task lighting provided.	Special artificial lighting required (display, process, etc.)	Pleasant outlook (view) desirable.	NOTES
EDUCATIONAL FACILITIES							
Reception/display		X			X	X	
Library		X				X	
Lecture hall				X	X		
Classroom	X						
Conference room	X					X	
OFFICES							
All spaces except office supplies		X				X	
Office supplies			X				
DRY LABORATORIES							
All spaces except dry lab, storage and solvent storage, and darkroom		X				X	
Dry lab storage			X				
Solvent storage			X				
Darkroom				X			
Fish receiving & holding	X						
General wet laboratory				X	X		
Weigh and measure		X					
Diagnostics		X					
Post mortem		X					
Fish processing		X					
Hatchery							
Breeding		X					
Incubation				X	X		Rheostat on area lighting
Live food production							
Plankton culture maintenance				X	X		
Algal inocula							Maximize natural light through skylighting with south orientation.
FEED FACILITIES							
Feed preparation		X					
Feed storage			X				
Ponds storage			X				
Fertilizer storage			X				
SHOPS							
All spaces		X					
Crew		X				X	
Facility engineer's office		X				X	

NAC TABLE 4.7
SOUND CONTROL GROUPS

QUIET
- Library
- Directors' reception
- Director's office
- Assistant director's office
- Visiting scientists' offices
- Senior staff offices
- Extension agents' office
- Graduate research assistants' carrels
- Clerical staff office

SEMINOISY
- Reception/display
- Lecture hall
- Classroom
- Conference room
- Extension agents interns' classroom
- Mail
- Reproduction
- All dry laboratories
- Breeding
- Incubation
- Plankton culture maintenance
- Algal inocula
- All feed facilities
- Facility engineer's office
- Crew
- Janitor

NOISY
- Garage
- Workshop
- Workshop storage
- Vehicle and heavy equipment workshop

NAC TABLE 4.8
SECURITY AND PRIVACY GROUPS

PUBLIC SPACES. Generally open to all staff and visitors during regular business hours with control exercised by responsible staff as necessary.

Reception/display
Library
Clerical staff office
Lecture hall*
Classroom*
Conference room*
Fish receiving and holding

PRIVATE SPACES. Except for selected staff, access by invitation only for staff and visitors.

Director's office
Assistant director's office
Visiting scientists' office
All dry laboratories
Plankton culture maintenance

SEMIPRIVATE. Visitors should not enter without guide or authorization.

All other spaces

*Access may be limited when in use.

4.3.7 HVAC Relationships

HVAC relationships are based upon requirements for heating, ventilation (both natural and mechanical), and air-conditioning. In NAC Table 4.9, spaces are listed in three groups: natural ventilation only, mechanical ventilation supported by natural ventilation, and air-conditioning.

As explained in NAC Section 4.1.4, Site, the value of natural ventilation as a means of reducing energy consumption and complex mechanical equipment should be maximized. The design implications are especially strong for spaces that will have natural ventilation only. These spaces preferably should have both a north or west exposure and an east or south exposure. If this type of space has only a north or west exposure or only an east or south exposure, then partitions separating it from the other exposure should allow for free air movement.

Air-conditioned spaces, which have been kept to an absolute minimum, should be clustered together wherever feasible for maximum energy efficiency.

Spaces that would experience humidity build-up if only natural ventilation were provided will be mechanically ventilated. These are generally spaces with large tanks of process water. Shops will also be mechanically ventilated due to possible fumes and dust in the air. Natural ventilation should be encouraged when possible in all spaces that are mechanically ventilated. However, achieving the proper exposures for these spaces to optimize natural ventilation must be considered of secondary importance.

4.3.8 Outside Access Relationships

Outside access relationships are based upon requirements for service (truck) and pedestrian access. In NAC Table 4.10, spaces that require truck access are listed in two categories: those requiring an adjacent truck dock and those requiring good access to a truck dock within a reasonable distance. The garage, vehicle and heavy equipment workshops require direct vehicle drive-in capability.

The primary pedestrian access for staff and visitors will be through reception/display. All visitors will use this entrance and all professional staff will arrive and depart each day through this entrance. A secondary pedestrian entrance in the shops' cluster will be used by workers that are arriving and departing. Secondary pedestrian entrances for convenient ingress and egress from the building complex will be provided as the design takes shape.

4.4 RECOMMENDED BUILDING CONCEPT

4.4.1 Introduction

In this section, a recommended building concept for RTP building(s) (NAC Figures 4.2 through 4.5) is presented in the form of conceptual floor plans. The recommended building concept was developed from pertinent parts

NAC TABLE 4.9
HVAC GROUPS

NATURAL VENTILATION ONLY

- Reception/display
- Classroom
- Conference room
- Graduate research assistants' carrels
- Directors' reception
- Senior staff
- Visiting scientists' office
- Extension agents' office
- Extension agents interns' classroom
- Clerical staff office
- Reproduction
- Mail
- Office supplies
- Fish receiving and holding
- Weigh and measure
- Facility engineer's office
- Crew
- Workshop storage
- Janitor
- Garage
- Ponds storage

AIR-CONDITIONED

- Library
- Lecture hall
- Director's office
- Assistant director's office
- All dry laboratories
- Culture plankton maintenance

MECHANICAL VENTILATION SUPPORTED BY NATURAL VENTILATION

- General wet laboratory
- Diagnostics
- Post mortem
- Fish processing
- Breeding
- Incubation
- Algal inocula
- Workshop
- Vehicle and heavy equipment workshop
- Feed preparation
- Feed storage

NAC TABLE 4.10
OUTSIDE ACCESS GROUPS

TRUCK DOCK ADJACENT TO SPACE REQUIRED

- Fish receiving and holding
- Diagnostics
- Fish processing
- Incubation
- Rotifer production
- Algal production
- Feed preparation
- Feed storage
- Ponds storage
- Animal waste silo
- Plant waste silo
- Fertilizer storage

TRUCK DOCK NEAR TO SPACE REQUIRED

- Dry laboratory storage
- Solvent storage
- Weigh and measure
- General wet laboratory
- Post mortem
- Workshop
- Workshop storage
- Janitor

of NAC Chapter 3, Project Site, and the first three sections of this chapter (NAC Section 4.1, Design Parameters; NAC Section 4.2, Building Program; and NAC Section 4.3, Relationships).

The process of developing a building concept from the relevant information is complex. The recommended concept is considered most responsive to all of the design determinants. In NAC Section 4.4.2, the recommended building concept is explained and the advantages and disadvantages of the concept are discussed.

4.4.2 Explanation of Concept

The building concept is single-story throughout. Because there is no shortage of land to build on, the difficulties that arise with vertical circulation will be avoided.

In NAC Figure 4.2, Conceptual Floor Plan, spaces are grouped together as delineated by NAC Table 4.3, Functional Groups (i.e., all wet laboratory spaces in one cluster, all educational facilities in one cluster, etc.). The only exceptions are 1) the separation of S-7 garage from the remaining shops' spaces and 2) the decision to locate F-5, Plant Waste Silo, and F-6, Animal Waste Silo, in the animal husbandry area, separate from F-1 through F-4.

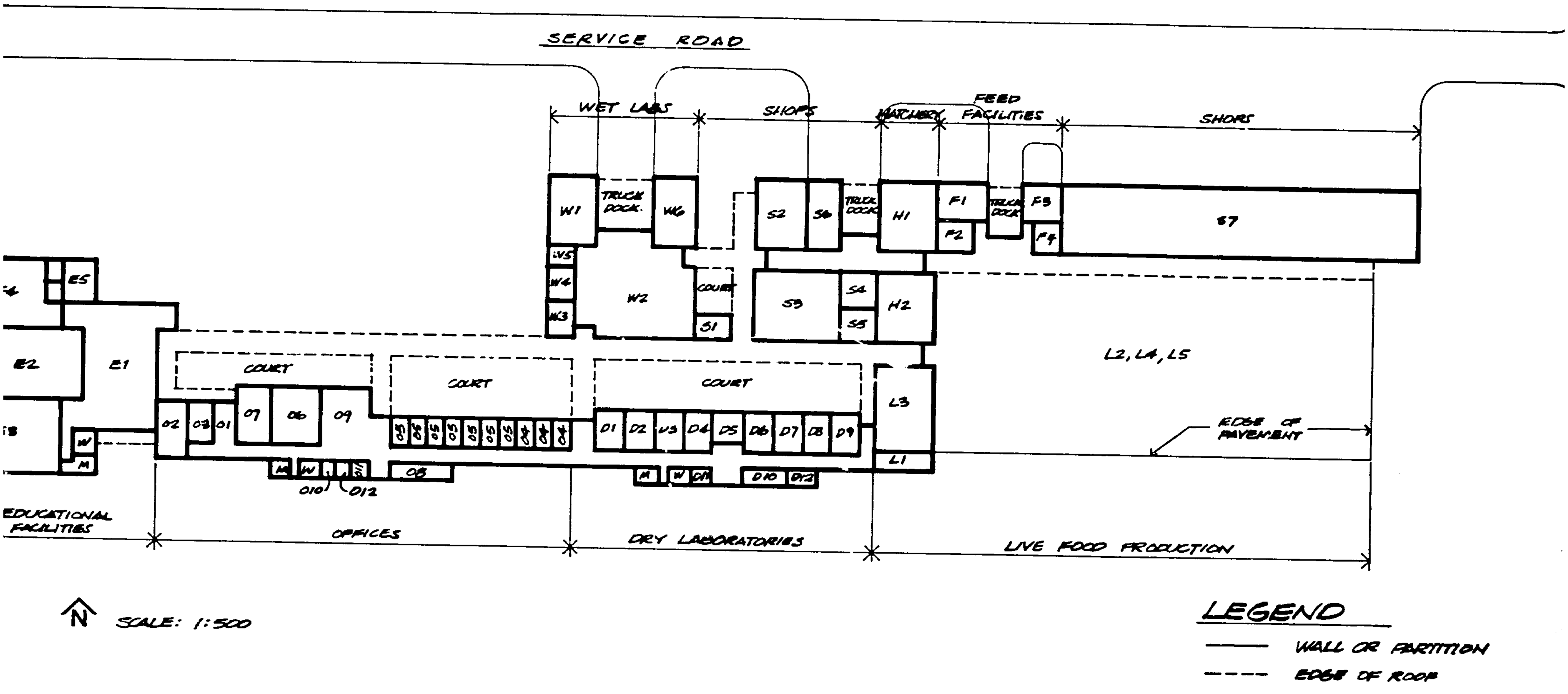
All of the significant relationships between groups of spaces from NAC Figure 4.1 (wet laboratories to dry laboratories, offices to dry laboratories, offices to educational facilities, and shops to wet laboratories) are respected by locating these groups adjacent or very near to each other.

Expansion capability as called for in NAC Section 4.1.3, Flexibility and Expansion, is indicated in NAC Figure 4.3. NAC Figure 4.4 shows pedestrian and truck access to the building complex and pedestrian circulation within the complex.

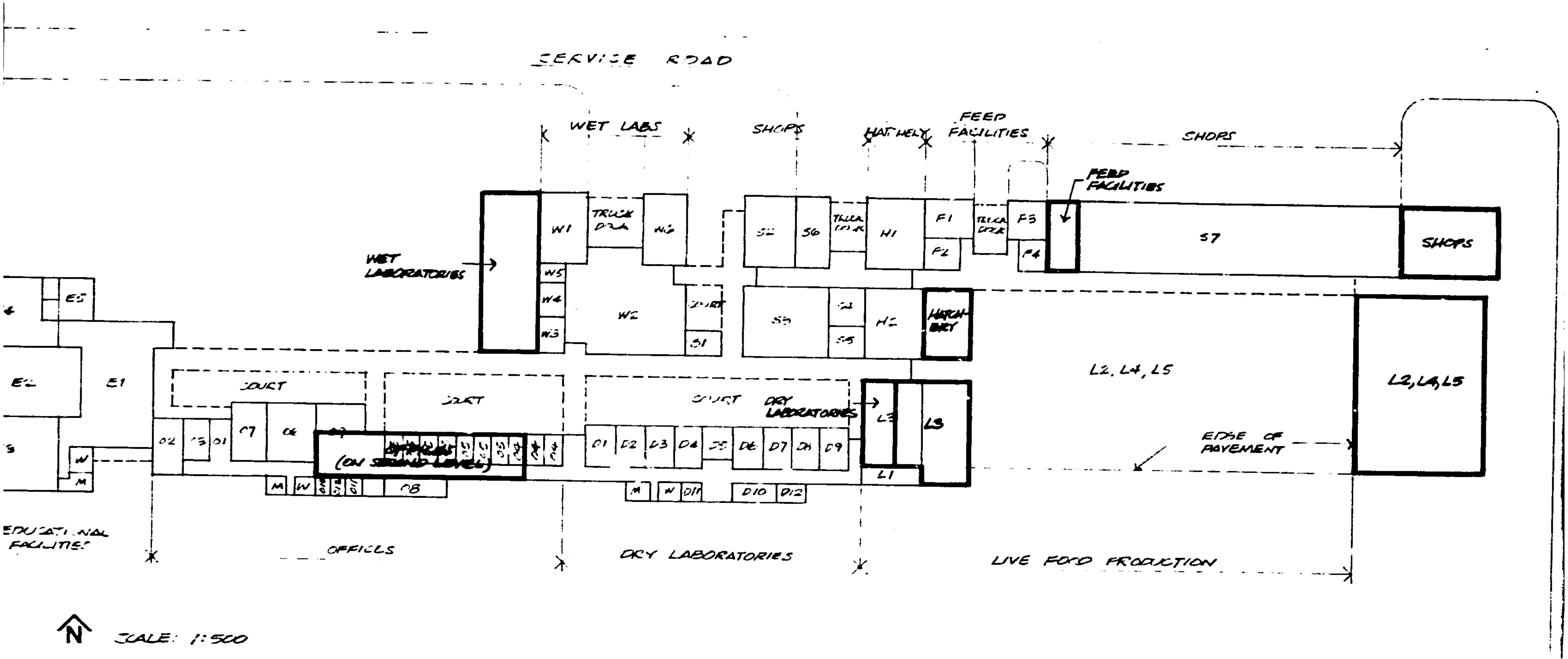
The primary entrance for all visitors and staff (except tradesmen, laborers, and drivers) is at the west end of the building complex. Through this entrance lies E-1 reception/display where a full-time receptionist/guard can screen and direct visitors. The lecture hall, library, classroom, and conference room (E3, E2, E4, E5) are all entered from the reception/display space. Most visitors attending a training session or conference would not be inclined to venture out of this clustering of educational spaces; this is the public zone of the building. Staff and visitors reach all other spaces by exiting on the east side of the reception/display space.

An entrance for tradesmen, drivers, laborers, etc., is provided on the north side. This entrance opens onto a courtyard. Staff may stop at the crew room (S2) near the entrance or go directly by covered walkway to their destination.

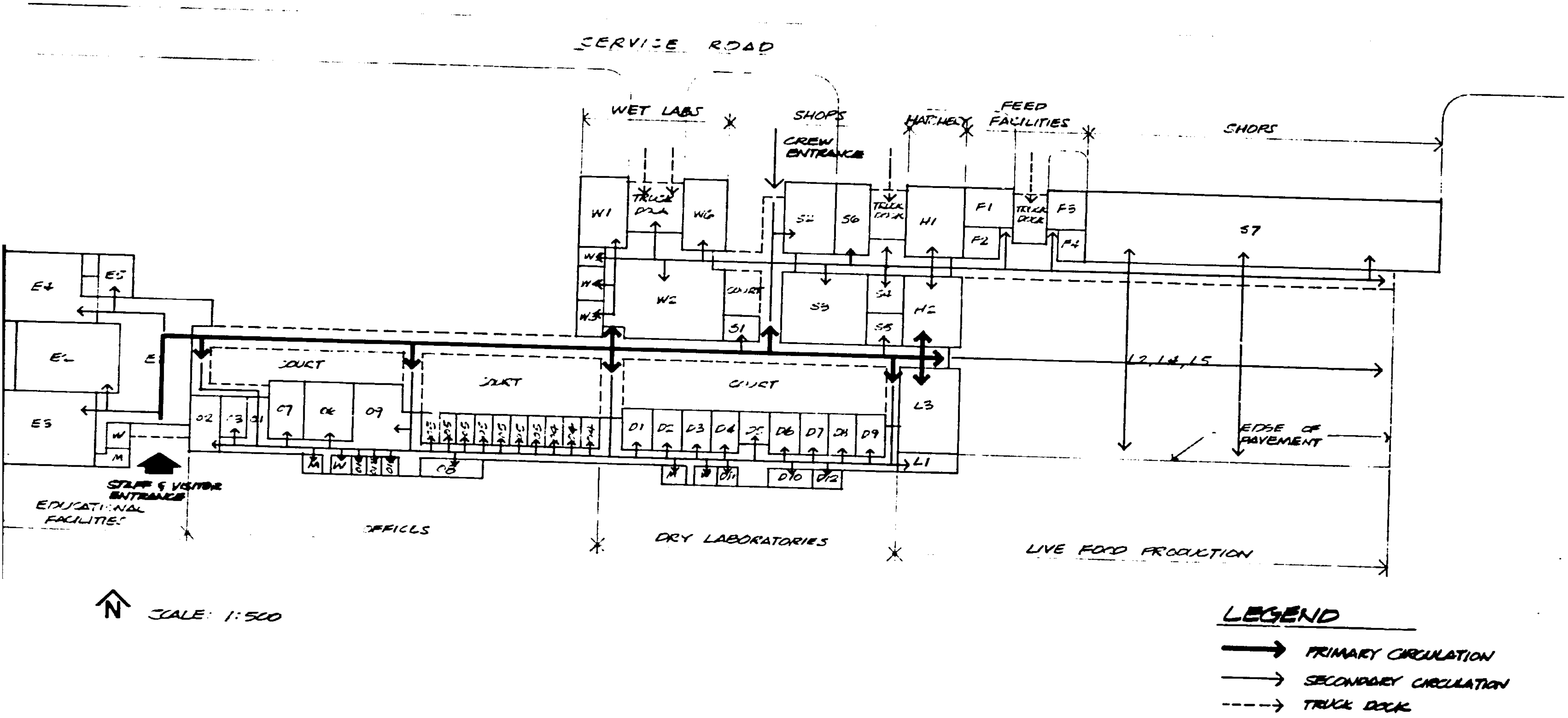
Truck access is exclusively on the north side of the building complex. Three truck docks serve all spaces that require direct or fairly direct access to a truck dock. Trucks back up to the truck docks from a service roadway running east to west at the north edge of the building complex site. Access into the garage (S7) and vehicle and heavy equipment workshop (S6) is similar.



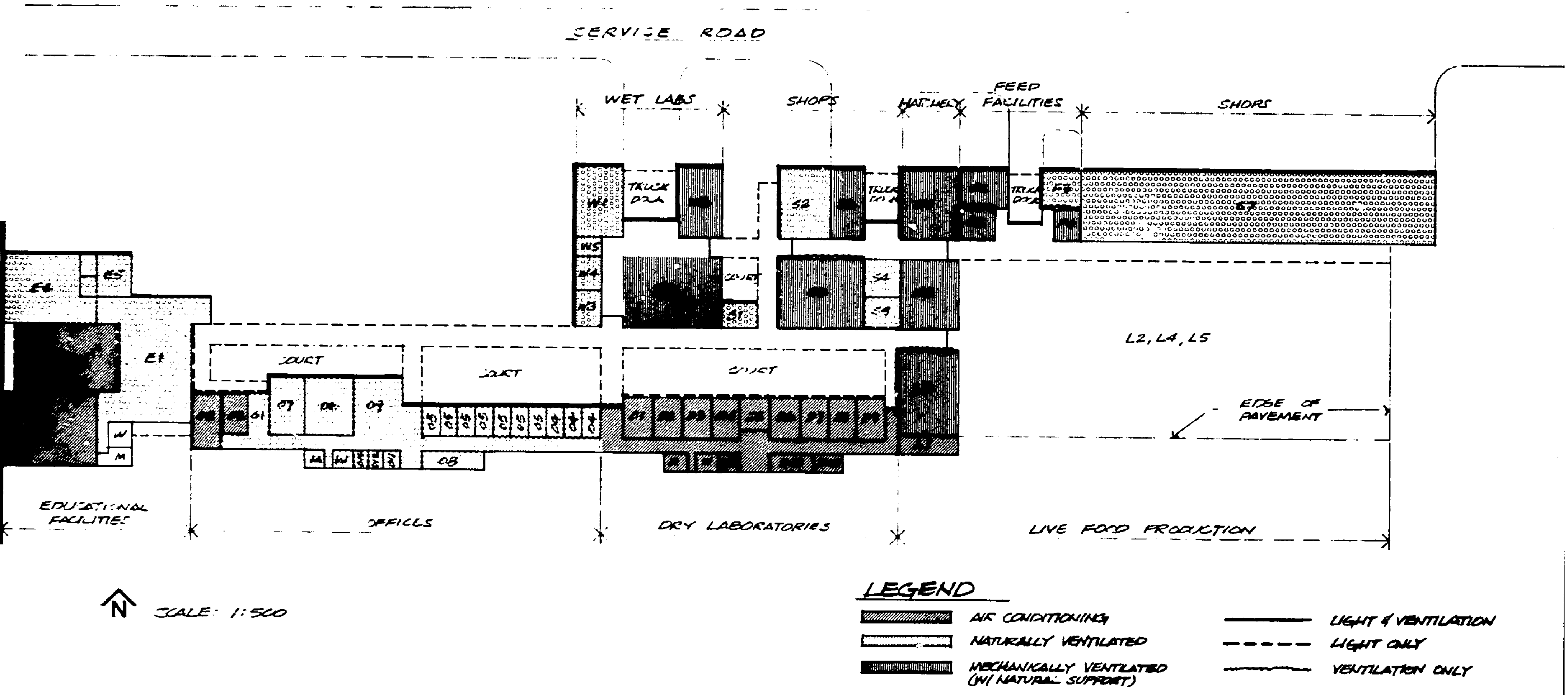
NAC Figure 4.2
Conceptual Floor Plan



NAC Figure 4.3
Conceptual Floor Plan – Expansion



NAC Figure 4.
Conceptual Floor Plan – Circulatio



NAC Figure 4
Conceptual Floor Plan – Light and HVA

Primary internal circulation to the building complex is a west-to-east, covered walkway that runs from reception/display to the hatchery and live food production clusters. Each of the eight functional clusters are joined to this "spine".

Two east-to-west corridors, one to the north and one to the south of the primary covered walkway, provide secondary internal circulation. The corridor to the south of the spine runs the length of the office and dry laboratory clusters, connecting all spaces within these clusters. The corridor to the north runs through the wet laboratory, shop, and hatchery clusters, connecting all spaces within these clusters. This secondary pedestrian link continues as a covered walkway past the feed facilities and along the south side of the garage. Short corridors and covered walkways connect the two corridors to the primary covered walkway.

NAC Figure 4.5 indicates how the recommended building concept responds to two important design parameters: maximizing the use of natural light and natural ventilation. The indication of the basic HVAC system for each space (air-conditioned, naturally ventilated, or mechanically ventilated with natural back-up) is from NAC Table 4.9, HVAC Groups. All spaces that are solely naturally ventilated have either a north or west exposure to catch the breezes. Most spaces that are mechanically ventilated with natural back-up have either a north or west exposure as well.

Nearly all spaces which should obtain at least 50 percent of their functional light requirements from natural light (see NAC Table 4.6, Light Requirements) have a northern exposure. Most of the few spaces without a northern exposure have a protected western exposure. Nearly all office spaces and dry laboratory spaces have a pleasant view into the courtyard which separates them from the primary internal circulation spine. From the offices, it is possible to look beyond this courtyard through the covered walkway to the ponds beyond.

One result of accommodating the requirements for natural light and ventilation is an elongated office cluster and dry laboratory cluster. This elongation increases walking distances between, for example, the library and dry laboratories. A study of these distances will be made in the preliminary design phase and the building complex shortened if it is determined that the distances are excessive.

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NATIONAL AQUACULTURE CENTER
CHAPTER 5
NAC HOUSING COMPLEX

5.1 INTRODUCTION

Because of the intimate relationship existing between a house and the culture of its occupants, it is important that the design be carried out by individuals informed and sensitive to the issues involved.

5.2 BUILDING PROGRAM SUMMARY

The purpose of NAC housing is twofold: initially to provide housing for the technical assistance team and, subsequently, for the NAC-based staff (see NAC Section 1.9, Housing Profile). Currently the housing program is comprised of the following units:

1. 12 units of senior staff housing:
    a. Two Type A units
    b. Ten Type B units
2. 10 units of junior staff housing

Appendix A.2, NAC Building Program expands on the program and design criteria.

In response to the proposed NAC staffing requirements, an expanded housing program is being proposed in MHC Section 3.4, Recommended MHC Program Expansion.

5.3 STATUS

On November 15, 1979, P.B. Sabbour presented to the Ministry of Agriculture (MOA) the proposed Housing Program Report. The proposed program was approved by MOA the same day. On December 2, 1979, members of the design team submitted to MOA and the U.S. Agency for International Development (USAID) the Preliminary Design Scheme which was subsequently approved by both parties subject to minor revisions. P.B. Sabbour presented the final preliminary design incorporating the revisions requested by MOA and USAID.

The NAC housing construction documents are being completed simultaneously with the concept design phase of the work.

The current design configuration for the NAC junior housing includes two buildings, two and three stories high, respectively. The two-story building will eventually have a third story added. Foundations for each building will be designed to support an ultimate four-story load. Minor revisions will include modification to support a proposed roof-mounted, solar-heated domestic hot water tank.

In the forthcoming Schematic Design Phase, the housing design will be refined and sited.

NATIONAL AQUACULTURE CENTER
CHAPTER 6
ENGINEERING SYSTEMS

6.1 RECOMMENDED MECHANICAL SYSTEMS

The mechanical process systems are the backbone of the National Aquaculture Center (NAC) facility. Their complexity reflects the need to meet the broad demands of various research and production programs. The concept of conserving energy has been incorporated into all the mechanical systems and individual concepts have been developed for solving the major engineering problems. However, it should be emphasized that these engineering concepts are not substitutes for the schematic design documents and that actual systems may vary during design development. The preliminary concepts presented here provide a basis for planning and a preliminary cost estimate.

6.1.1 Process Water Supply System

Only fresh water is needed to meet the requirements of the intended biological process at the NAC. The total water requirement for NAC is estimated to be 52,000 l/min. Process water will be obtained from two sources: (1) El Wadi El Quadim Canal, and (2) well water. Process water supply for the NAC laboratory building and outbuilding pond system is shown schematically in NAC Figure 6. 1, Water Flow Diagram.

6.1.1.1 EL WADI EL QUADIM CANAL

Canal water will be the main water supply for the pond system. As shown in NAC Figure 6.1, water drawn from the canal will be treated and aerated before use. The required treatment method will consist of sedimentation, slow sand filtration, and aeration as shown in NAC Figure 6.2. From existing information, it appears the treated canal water will meet water quality requirements for the pond system as well as for NAC research/training/production (RTP) building(s).

The location of water intake in the canal and the method of transporting water to the NAC will be discussed in NAC Section 6.4, Recommended Civil Systems.

6.1.1.2 WELL WATER

Well water will serve as primary water supply for the RTP building(s)' production area. As shown in NAC Figure 6.1, well water will be pumped, aerated, and then transported to the production area. If the well yields more than 2,100 l/min, the excess water can be used for domestic consumption. The treated canal water will be used for the NAC laboratory building if well yield is less than 2,100 l/min. This will be verified when the well study report is available.

6.1.2 Service Water Supply System

The treated canal water will be used for service water supply as shown in NAC Figure 6.2. Service water is intended primarily for cleaning the wet laboratories, production area, and facility support.

6.1.3 Fire Water Supply System

The treated canal water will be pumped through boost pumps to provide fire protection water as shown in NAC Figure 6.3. The boost pumps should be capable of increasing the pressure up to 45 psi (3.2 kg/cm^2) for adequate fire protection. The required flow of fire water will be determined using the recommendation established by the National Board of Fire Underwriters (U.S.A.).

6.1.4 Domestic Water Supply

Potable water will be obtained either from the El Abbasa community water system or from the well water if available. The transportation of potable water from the existing water system will be through pipelines. Potable water will be distributed throughout the entire RTP building(s).

6.1.5 Tempered Water Supply System

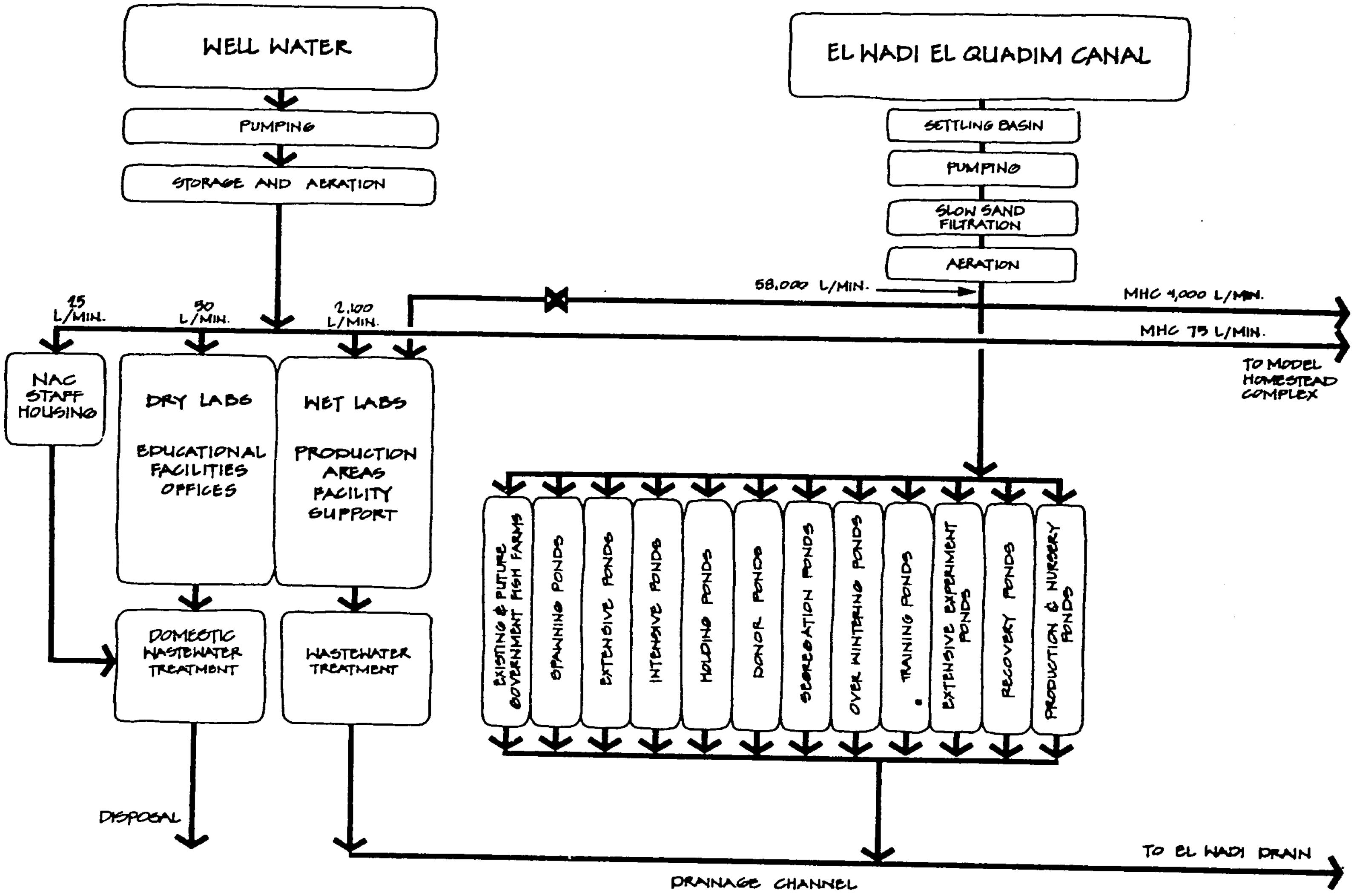
A need to control water temperature within the range of 18^oC to 30^oC has been established. About 100 l/min of process water is needed to be tempered for wet laboratory use. The water tempering system is presented schematically in NAC Figure 6.4. Solar energy will serve as the primary source for heating and an absorption refrigeration system will be the primary source for cooling. However, other alternate systems should be included for further study.

6.1.6 Process and Service Wastewater Treatment System

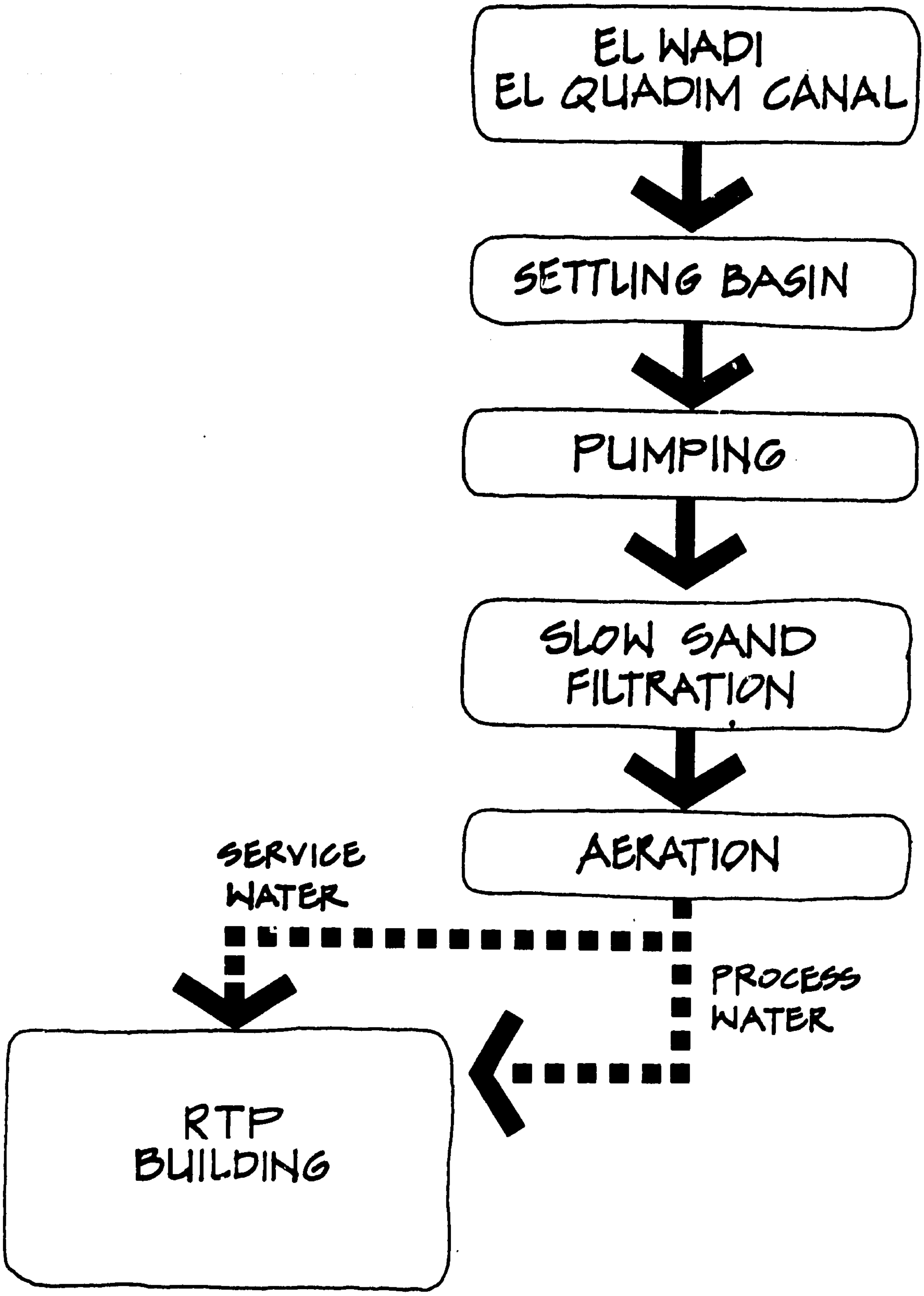
Process and service wastewater generated from the wet laboratory and production area will be treated prior to discharge to El Wadi Drain. The treatment system will include sedimentation and aeration as shown in NAC Figure 6.5. The sedimentation pond is for the settling of solids which will be hauled away for disposal. The aeration is to increase the dissolved oxygen content of the wastewater before it is discharged to the El Wadi Drain. The flow of both process and service wastewater is estimated to be 2,300 l/min.

6.1.7 Domestic Wastewater Treatment System

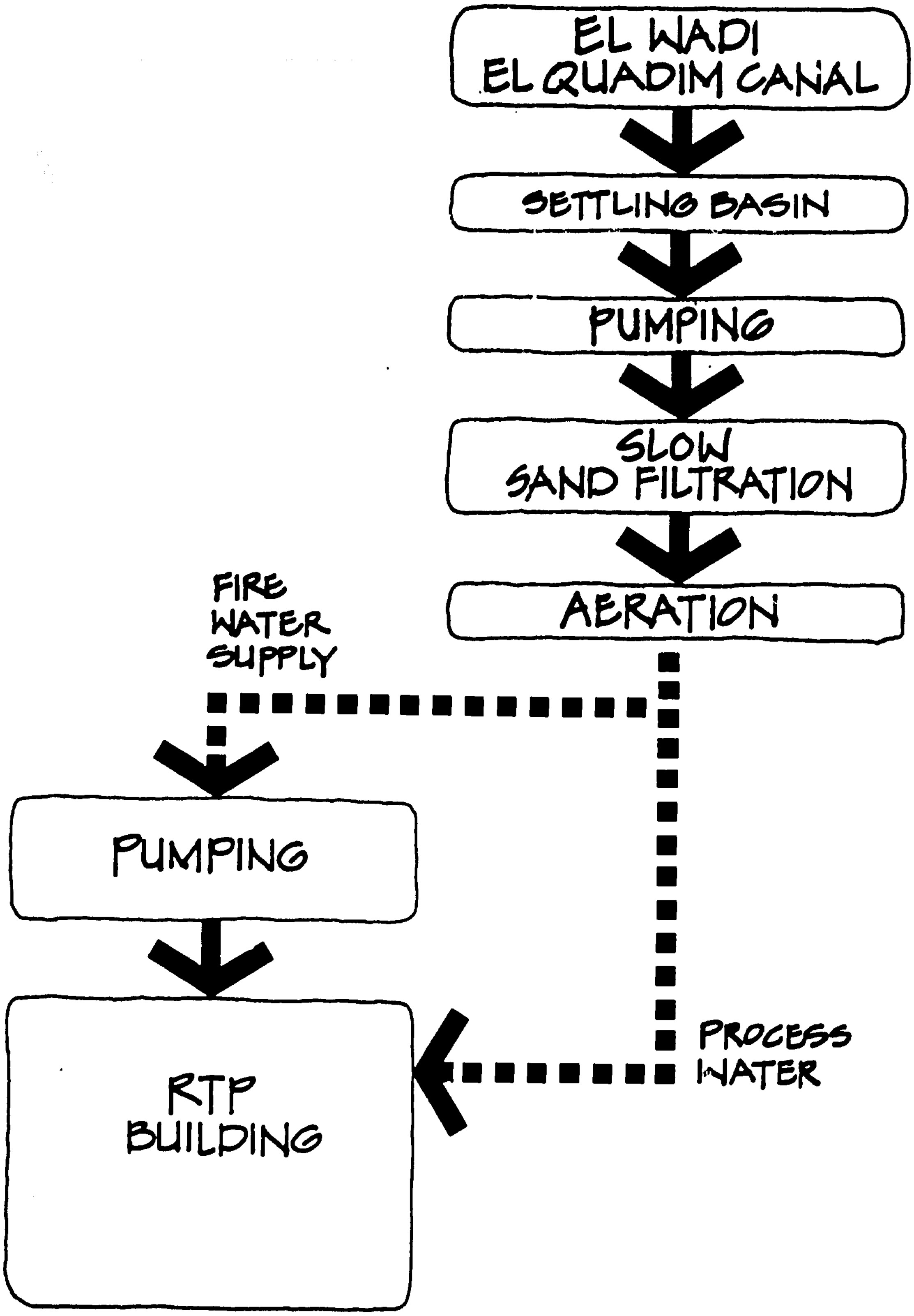
Domestic wastewater is generated from: (1) sanitary and dry laboratory wastewater of RTP building(s), and (2) sanitary wastewater from the NAC housing and (3) storage silos. The flows from both the RTP building(s) and NAC housing are estimated to be 11,400 l/day and 29,600 l/day, respectively. The total domestic wastewater of 41,000 l/day will be aerated, stored, and trucked away for disposal as shown in NAC Figure 6.6. However, septic tank and drainfield methods may be used if soil permeability is sufficient enough. The final decision on the disposal of domestic wastewater will be made when the soil report becomes available. The decision will also take into account the consideration for minimizing the spread of Bilharzia disease.



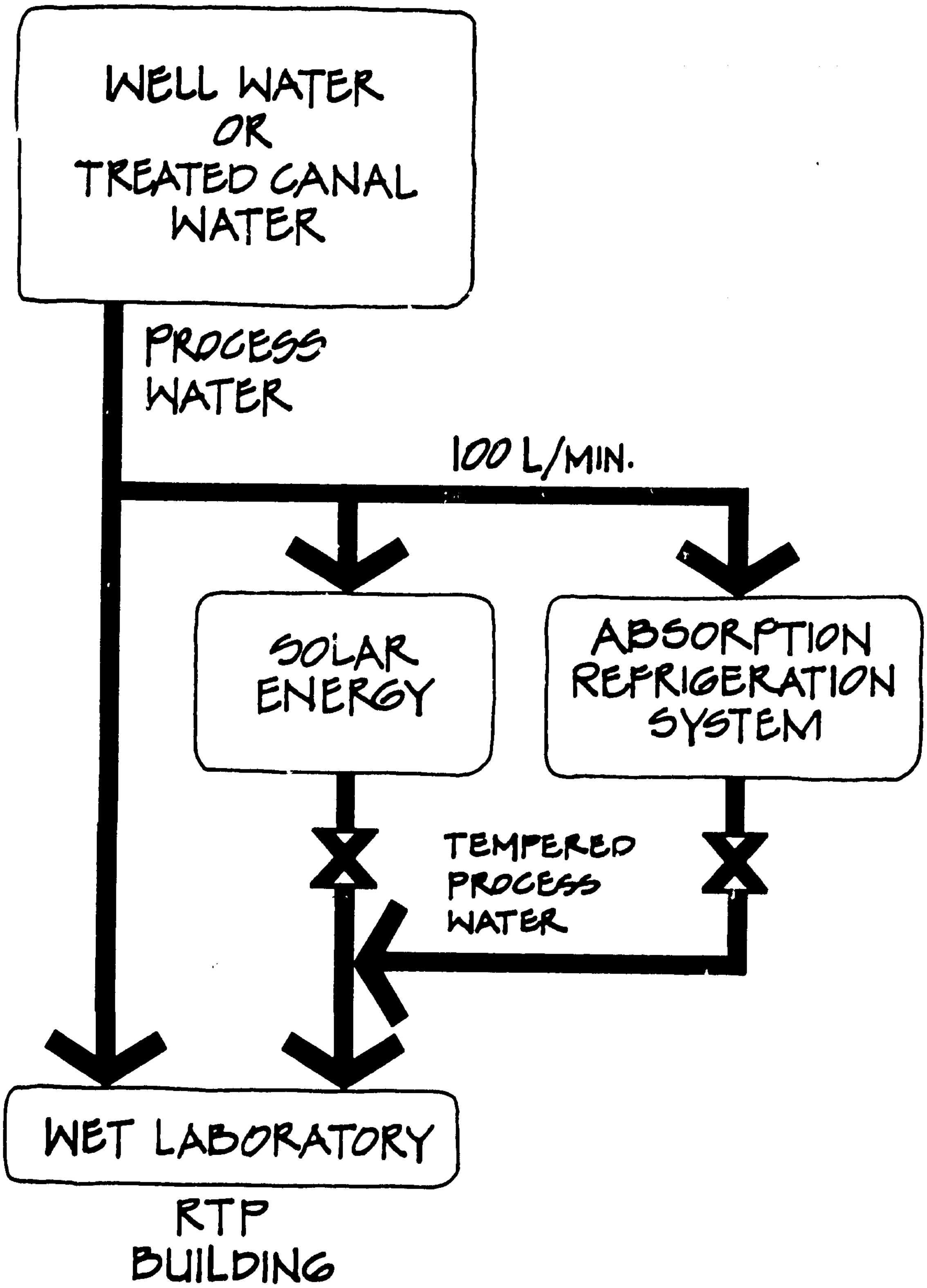
NAC Figure 6.1
Water Flow Diagram



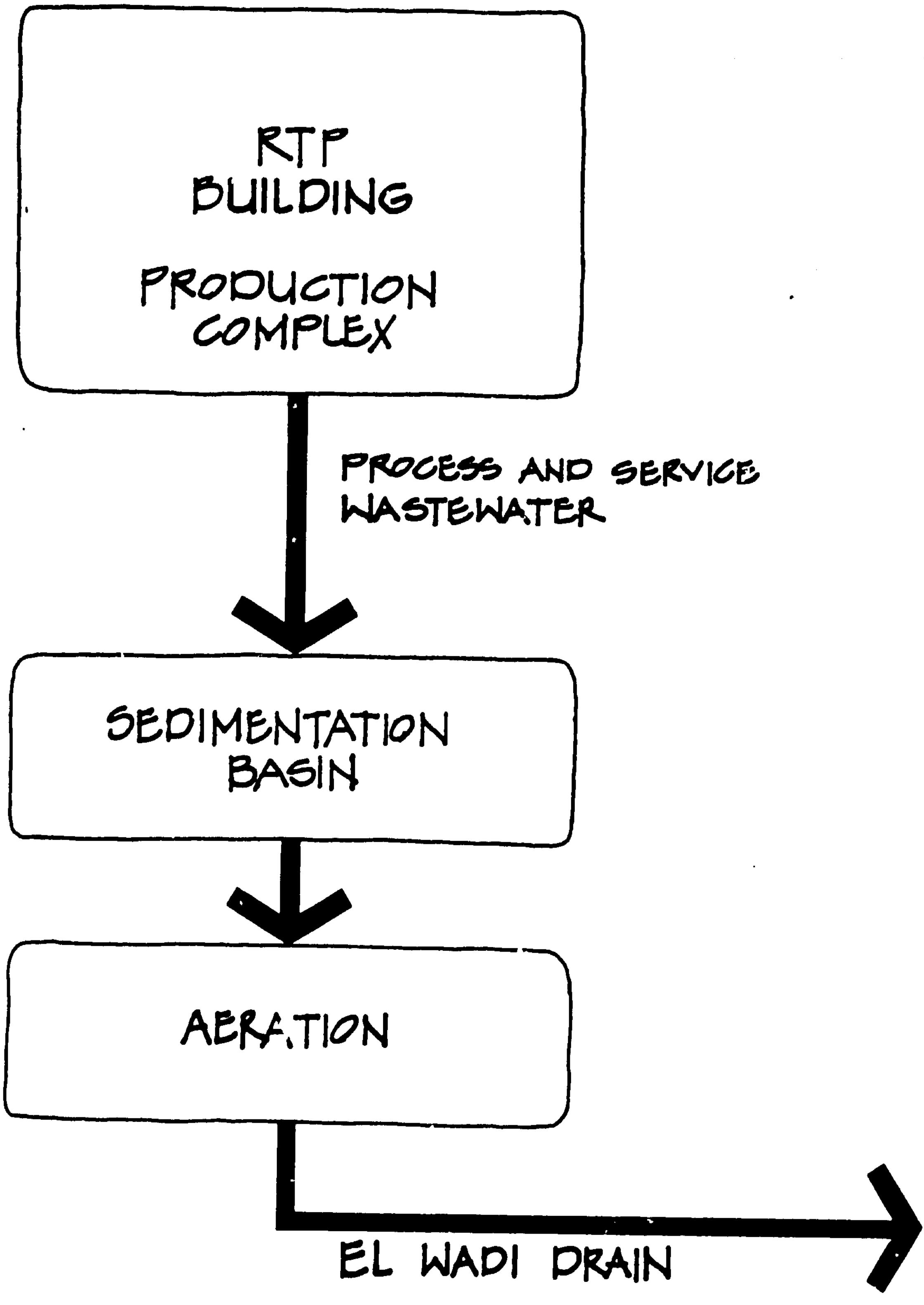
NAC Figure 6.2
Service Water Supply System



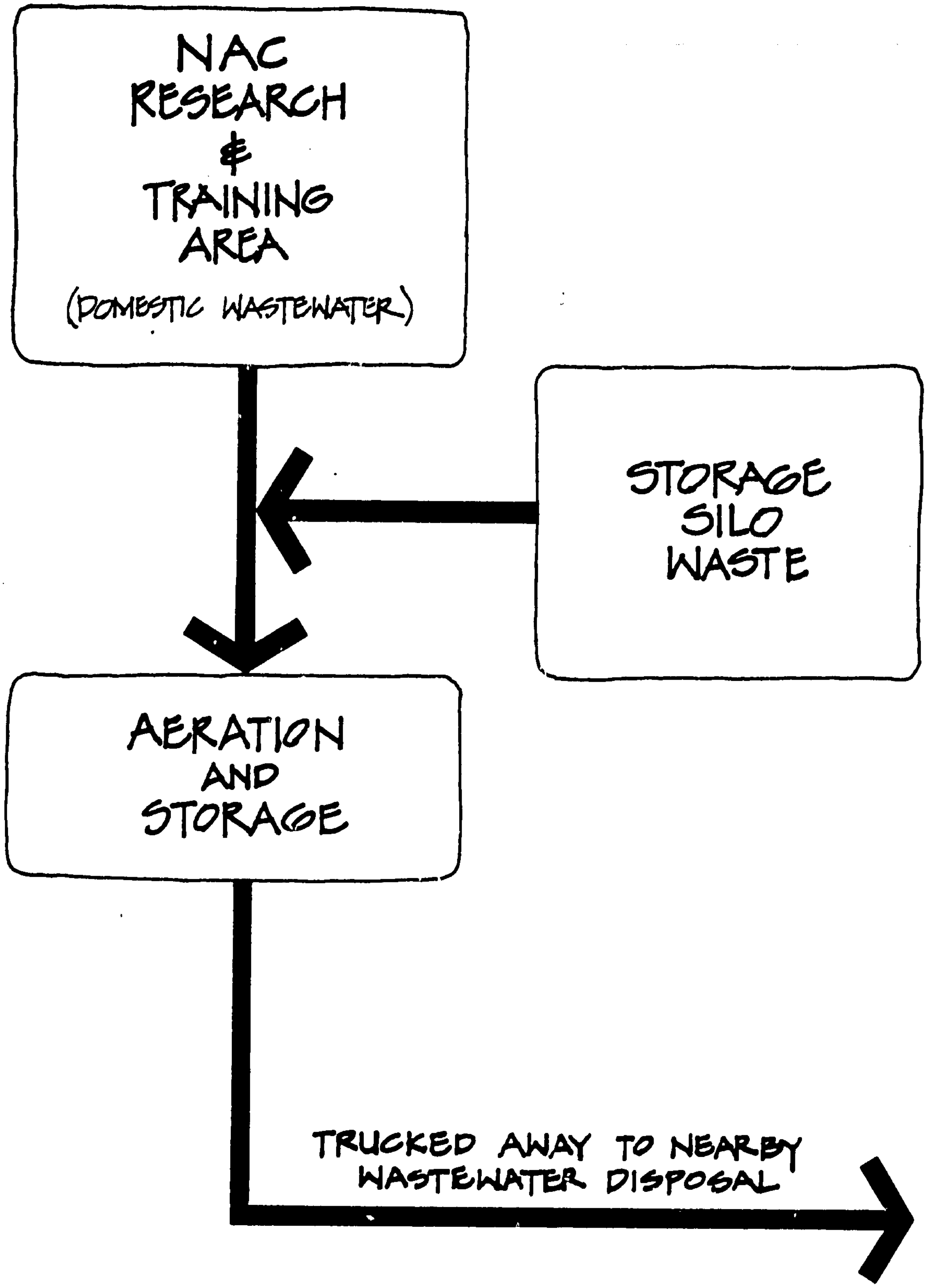
NAC Figure 6.3
Fire Water Supply System



NAC Figure 6.4
Tempered Water Supply System



NAC Figure 6.5
Process and Service Wastewater
Treatment System



NAC Figure 6.6
Domestic Wastewater Treatment System

6.1.8 Compressed Air System

The compressed air system will consist of an air compressor and storage tank in the mechanical space. Air will be piped to laboratories and other areas in the building that require this utility.

6.1.9 Vacuum System

A central vacuum system will be provided for service to each laboratory bench.

6.2 RECOMMENDED HVAC SYSTEMS

6.2.1 Heating System

Heating systems at the NAC will occur only in those laboratories requiring somewhat close environmental control. For example, laboratories where experiments require close, continuous water temperature control may need space heating to prevent heat loss from the experimentation water to the ambient air. Space heating will consist of electric baseboard heaters sized to compensate for heat loss due to transmission and/or ventilation/ infiltration when outside temperatures are cool.

6.2.2 Ventilating System

6.2.2.1 MECHANICAL VENTILATION

Areas of the NAC which do not require heating or cooling will have mechanical ventilation only. The mechanical ventilation will maintain humidity control, remove toxic fumes, and/or control odor. Areas anticipated to require mechanical ventilation are the following:

NAC TABLE 6.1
MECHANICAL VENTILATION REQUIREMENTS

Area	Air Changes/Hour
Solvent Storage	4 normal 60 emergency
Dry Laboratory Storage	4 normal 60 emergency
Fish Processing	8
Breeding	8
Incubation	6
Algal Inocula	6 (filtered)
Workshop	8
Vehicle and Heavy Equipment Workshop	8
Feed Preparation	8
Feed Storage	8
Postmortem	12

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Mechanical ventilation will be accomplished using electrically powered fans of the following types: wall-mounted propeller fans, wall-mounted centrifugal fans, centrifugal roof exhausters, and cabinet centrifugal fans. Some fans will be provided with two-speed or variable-speed control.

6.2.2.2 NATURAL VENTILATION

Other areas not requiring heating, cooling, or mechanical ventilation will have operable windows.

6.2.3 Air-Conditioning Systems

Air-conditioning will be provided for selected comfort zones and those areas where ambient temperature control is essential such as the dry laboratories, library, and culture maintenance room. NAC Table 6.2 lists those areas requiring air-conditioning and indicates the anticipated system designations and capacities.

Space cooling will be accomplished using electrically powered air-conditioners such as (1) packaged through-the-wall units (2) roof-mounted, single-package units, and (3) split-type systems using air-handling units equipped with direct expansion cooling coils. In the interest of energy conservation and cost savings, independent systems will be provided so only those areas requiring cooling will be air-conditioned at any one time.

Those areas using single-package, through-the-wall units will not require ductwork and control will be accomplished using wall-mounted thermostats. Air-conditioning systems serving several rooms will use ductwork fabricated from either fiberglass ductboard or insulated, galvanized sheet metal. Ceiling diffuser terminal units will be mounted in the suspended ceiling system. Again, temperature control will be accomplished using wall-mounted thermostats.

In those areas requiring humidity control, independent dehumidifiers of the dessicant or refrigeration type will be used where a need for dehumidification is required, and duct-mounted independent humidifiers of the atomizing type and/or electrically generated steam type will be utilized where a need for humidification is required. Control of these dehumidifying and/or humidifying devices will be controlled individually using duct-mounted or room wall-mounted humidistats.

Since some process water will require cooling, it is possible that the water-cooling devices can also be used for space cooling in the larger system(s). More detailed analysis is required, however, to determine if this alternative is economically advantageous. Further discussion regarding the water-cooling system can be found in NAC Section 6.1.5, Tempered Water Supply System.

6.2.4 Refrigeration System

Major refrigeration required will consist of a packaged walk-in freezer completely factory-assembled with condensing unit(s) and evaporator(s). This walk-in freezer unit will be located in the fish processing area. All other required refrigeration in various laboratories will consist of residential appliance-type, electrically operated, refrigerator/freezers.

NAC TABLE 6.2
AREAS REQUIRING SPACE COOLING

Room or Area	System Designation No.	Type	Capacity
Library	AC-1	Single-package, roof-mounted with humidity control	5 tonne
Lecture hall	AC-2	Single-package, roof-mounted	5 tonne
Visiting scientists' lab	AC-3	Single-package, roof-mounted	5 tonne
General nutrition lab	AC-3		
Analytical nutrition lab	AC-3		
General physiology lab	AC-3		
Physiology histology lab	AC-3		
Physiology biochemistry lab	AC-3		
General limnology lab	AC-3		
Chemistry limnology lab	AC-3		
Microbiology pathology lab	AC-3		
Plankton culture maintenance	AC-4	Through-the-wall	1/2-tonne
Darkroom	AC-5	Through-the-wall	1/2-tonne
Director's office	AC-6	Through-the-wall	1/2-tonne
Assistant director's office	AC-7	Through-the-wall	1/2-tonne

6.2.5 Design/Code Standards

Design/code standards will be those standards established by the American Society of Refrigeration and Air-Conditioning Engineers (ASHRAE) along with requirements of the U.S. Uniform Mechanical Code and the U.S. Uniform Building Code. These standards will be departed from when the code requirement cannot be met because of local technological limitations or when these standards are not applicable.

The following is design criteria published by the U.S. Departments of the Air Force, the Army, and the Navy and will be used for design and sizing of equipment:

Latitude : 30°North
Longitude : 31°East
Elevation : 112 meters (367 feet)
Heating degree days : 689
Wind speed : 11 km/hr (6 knots)
Cooling degree days : 3,089
Winter design temperature (outside) : 8°C (46°F)
Summer design temperature (outside) :
  36°C (97°F) dry bulb
  21°C (70°F) wet bulb (mean coincident wet bulb)
Extreme wet bulb : 23°C (74°F)

6.2.6 State of the Art

At present, in Egypt very little air-conditioning is used and almost no heating. Most air-conditioning is accomplished with window-mounted, single-package units, through-the-wall units, or single-package, roof-mounted units. Complex cooling and conditioning systems are not widely used in most office buildings. Control of solar heat gain is usually accomplished with passive systems such as wall and roof building methods and materials.

6.3 RECOMMENDED ELECTRICAL SYSTEMS

6.3.1 Lighting System

Lighting in public spaces, support areas, laboratories, and production areas will be fluorescent fixtures. Supplementary incandescent fixtures will be provided in the wet laboratories and for task area lighting or specialized use wherever required. Banks of corrosion-resistant industrial fluorescent fixtures using special sun-spectrum tubes will be grouped around the fiberglass algal culture tanks to provide a 5,000-lux surface intensity. In the event of a power failure, the emergency generator will maintain all essential lighting circuits.

In staff accommodations and any miscellaneous detached structures (pump houses, etc.), all lighting will be incandescent fixtures. Emergency and exit lighting will be provided from the emergency generator or by means of individual battery-operated units, depending on the configuration of the power system at each location.

All outdoor lighting will be industrial-type sodium vapor or similar discharge fixtures. For convenience of maintenance and simplification of spare parts inventory, a minimum number of fixtures suitable for mounting on poles or on the sides of buildings and walls should be selected for outdoor applications.

6.3.2 Power System

The basic power system throughout the installation will be an 11-kV, 3-phase, 3-wire overhead distribution system. Construction will be pole and cross arm with bare copper conductors supported on pin-type insulators (see NAC Figure 6.7).

The secondary utilization voltage will be the national standard 380/220-volt, star-connected, 3-phase, 4-wire system. Pole-mounted transformers will be provided at each building or group of buildings. Service from the distribution transformers to the various buildings and structures will be by means of overhead insulated copper conductors constructed below the primary wires or on a system of separate poles.

Inside buildings, the electrical distribution will be conventional 380/220-volt, 3-phase power panels and 220-volt, single-phase lighting panels. Two conductor building cables will be used for concealed work in finished areas. Construction in production and other unfinished areas will be galvanized steel conduit holding individually insulated conductors. Convenience receptacles will be provided throughout the facilities, rated 10 amperes at 220 volts. Ground fault protection will be provided for all receptacles installed outdoors or in wet locations.

Emergency power will be supplied by a diesel generator set sized to carry all of the essential load at the facility. Generator sets will be of the housed design, for outdoor operation, and shall be installed under light metal sun shades. Each unit will be provided with integral engine, governor, and generator instruments and controls, engine cooling system, starting battery and battery charger, and fuel system. A fuel tank will be provided with sufficient capacity to allow emergency system operation for a period of 48 hours at rated load.

6.3.3 Communications System

6.3.3.1 TELEPHONE

The NAC will be served by the national telephone system. Within the RTP building(s), telephones will be provided essentially on the basis of one for each separate room or area. In addition, one telephone will be provided for each management-level individual. Telephones will also be provided in each pump house, guard or entry building, or other separate structure containing equipment or personnel.

6.3.3.2 INTERCOMMUNICATIONS

An intercom system will be provided within each office between the desk of each management-level individual and the secretaries' post. In addition, an annunciator-type signaling system will be provided between each office and a central refreshment preparation area, actuated by a desk-top push button and designed to signal which office is requesting service. These signaling circuits and all other similar remote control, annunciation, graphic display, and communications circuits (other than telephone) will operate at 24 volts, AC or DC, as applicable for utilization of the system.

6.3.3.3 OTHER CONSIDERATIONS

Outdoor communications between individuals or vehicles is not believed necessary at this time. Should it be required at a later date, it can be provided by means of a system of personal and vehicular radios with a central station located at the NAC.

6.3.4 Hydraulic Monitor/Alarm System

Monitoring of the facility's hydraulic system will be limited to indicating the temperature of the tempering water system at each required location in the laboratory and production areas, plus alarms indicating any malfunction of the basic water supply or storage system. These alarms will notify operating personnel of any high- or low-level water conditions in pump station wet well and water storage facilities or of any instance of pump or pump control failure.

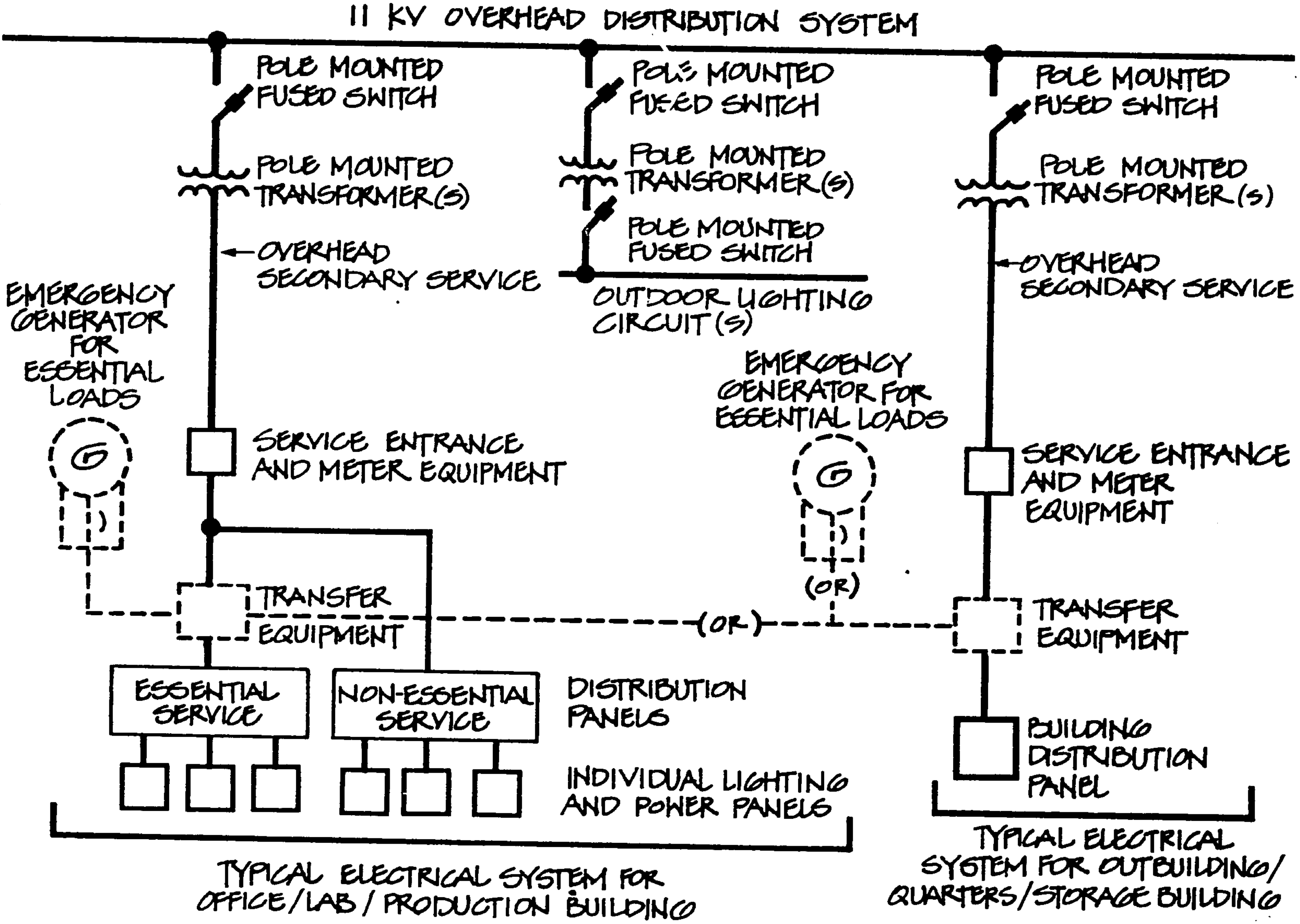
6.3.5 Fire Alarm System

A proprietary-type fire detection and alarm system consisting of heat sensors, zone-type control equipment and central station panels, and manual alarm stations will be installed throughout all laboratory and office areas (see NAC Figure 6.8). In the laboratory areas, the fire detection and alarm system will be interconnected in such a manner as to initiate the Laboratory Firefighting Gas System described under NAC Section 6.6, Special Systems. In other areas and rooms, the fire detection and alarm system will sound audible alarm devices but initiation of sprinklers will be by other means. The fire alarm system should be extended to include outbuildings housing important equipment, such as pump houses, plus areas used for storing flammable or hazardous materials, whether these areas utilize sprinkling or extinguishing systems or not.

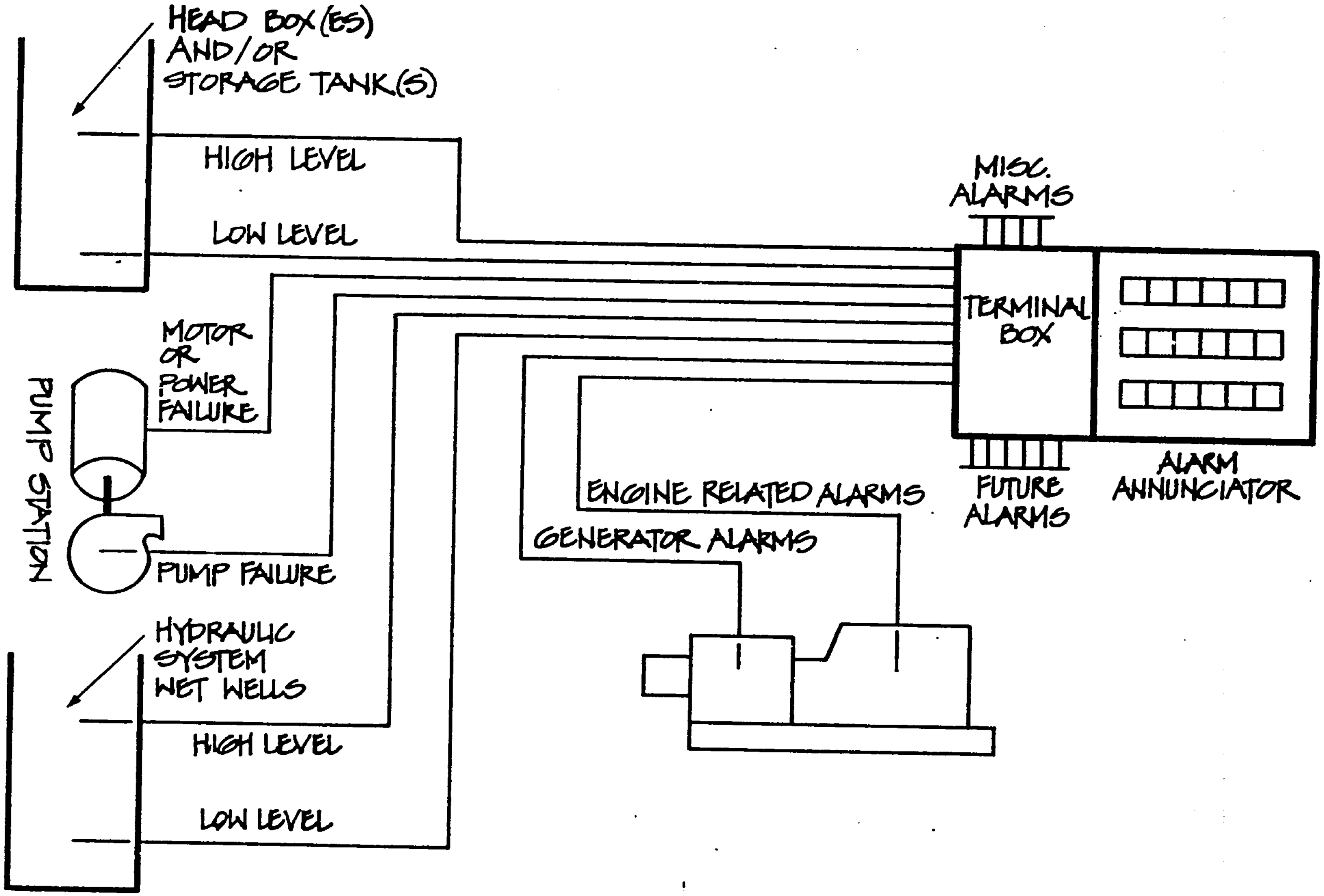
6.3.6 Design/Code Standards

The basic design of the site and building electrical systems will be done in accordance with the U.S. National Electrical Code, (NEC) 1978 Edition. This document is also identified as publication No. 70 of the National Fire Protection Association. Only minor deviations will be necessary in order to accommodate standard Egyptian hardware, devices, and construction practices. Receptacles and lamp bases, for example, will be of the Egyptian pattern, but the 220-volt, single-phase branch circuits will be designed to NEC standards. Low-voltage circuits will conform to NEC Article 720.

Overhead electrical distribution systems of either the 11-kV (or other) distribution voltage or the 380/220-volt secondary configuration will be designed in accordance with the applicable requirements of the NEC with respect to clearances between circuits, structures, etc., except where overruled by the standards and practices of the local power authority.



NAC Figure 6.7
Power Diagram



NAC Figure 6.8
Typical Alarm Diagram

6.3.7 State of the Art

Design sophistication envisaged for electrical facilities at this location will be at a level appropriate for a light industrial complex where highly trained operating and maintenance personnel are not always plentiful. The configuration of electrical distribution and communications systems should reflect the practices of the local and national utilities. Complicated control and instrumentation equipment should be avoided in favor of straightforward systems allowing rapid repairs without dependence on a long parts-and-supply pipeline. Construction materials should reflect the same philosophy and should be selected to afford the widest possible interchangeability between systems and structures.

6.3.8 Other Considerations

The site presents few inherent design problems, being essentially free of adverse seismic or weather conditions other than relatively warm temperatures and considerable solar insolation for exposed equipment. Electrical equipment, such as motors, emergency generators, transformers, etc., located outdoors should be provided with sun shields.

6.4 RECOMMENDED CIVIL SYSTEMS

This section of the report is devoted principally to the description of site grading and open-channel water distribution and drainage systems for the outdoor pond areas. Grading will consider energy conservation, economy of construction, and protection from flooding. Water system considerations include:

- Peak transmission rates
- Quality
- Energy conservation
- Operation and maintenance requirements

Preliminary construction cost estimates for the systems described in this section are summarized in NAC Chapter 7 and detailed further in Appendix A.

It must be emphasized that the following descriptions are for conceptual schemes which will either be refined or modified and possibly changed during design development. The conceptual schemes, however, provide a basis for planning and for the preliminary cost estimate.

6.4.1 Site Grading

Grading of the site will be such that the major portion of the water distribution system and all of the drainage system will operate by gravity. The proposed grading scheme partly illustrated in NAC Figure 6.9 would also result in a more nearly balanced cut and fill requirement, thus minimizing construction costs. The area where the housing complex and the RTP building(s) are to be located will be elevated 0.25 m above the maximum expected water level in the drainage system.

The generous dimensions of the drainage system combined with the slightly elevated siting of buildings will ensure the prevention of flooding. This concept, however, is based on the assumption that the El Wadi main drain will be cleaned out to at least the design conditions shown in the Irrigation Engineering Report and/or that additional pumping be provided at El Qassasim pump station. This topic is discussed further in NAC Section 6.4.6.

The quantities of excavation and fill listed in Appendix A for the NAC site grading are based on 3:1 side slopes for all earthen ponds and water-carrying canals. These relatively flat slopes do increase excavation and fill requirements, but should reduce maintenance needs and improve water quality by preventing embankment failures during the normally saturated soil conditions encountered.

Care must be exercised during final grading of all pond and canal systems in order to seal all areas which expose sand or other permeable soils. This can be accomplished through extra excavation and replacement with suitable clay or silty soils.

6.4.2 Paving

The staff and visitor entrance road will be paved in asphalt as will the staging area for vehicles on the operations side of the RTP building(s). The north-south operations vehicle spine plus the north-south road on each side of the NAC will be paved with crushed stone. The secondary roads which connect the ends of all ponds will consist of compacted earth. The crushed-stone base and paving thicknesses will vary, based on the largest weight class vehicles expected to travel on the surfaces.

Footpaths atop the pond embankments will not be paved nor are they expected to require soil stabilization measures such as gravel. Asphalt sidewalks will only be provided from the staff housing complex to the RTP building(s).

6.4.3 Water Intake

The water requirements for the outdoor ponds at the NAC site will be supplied from the existing El Wadi El Quadim irrigation canal which flows from west to east a few hundred meters to the north of the site. Pond operating and filling water requirements have been estimated to reach a maximum of about 49,000 l/min during the months of February and July. In addition, about 5,000 l/min and 4,000 l/min will have to be supplied by the system to the government fish farms and a few MHC ponds, respectively.

The inlet works are shown on NAC Figure 6.10 and include a sedimentation basin, pump station, sand filters, and an aeration basin. The amount of material which must be filtered can be greatly reduced by ten minutes of detention according to available data. The sedimentation basin dimensions will provide such detention during peak demand conditions. It is also very important that turbidity and competing aquatic organisms be eliminated from all experimental ponds, hatchery facilities, and nursery ponds as water conditions are extremely critical during early stages of development and to ensure

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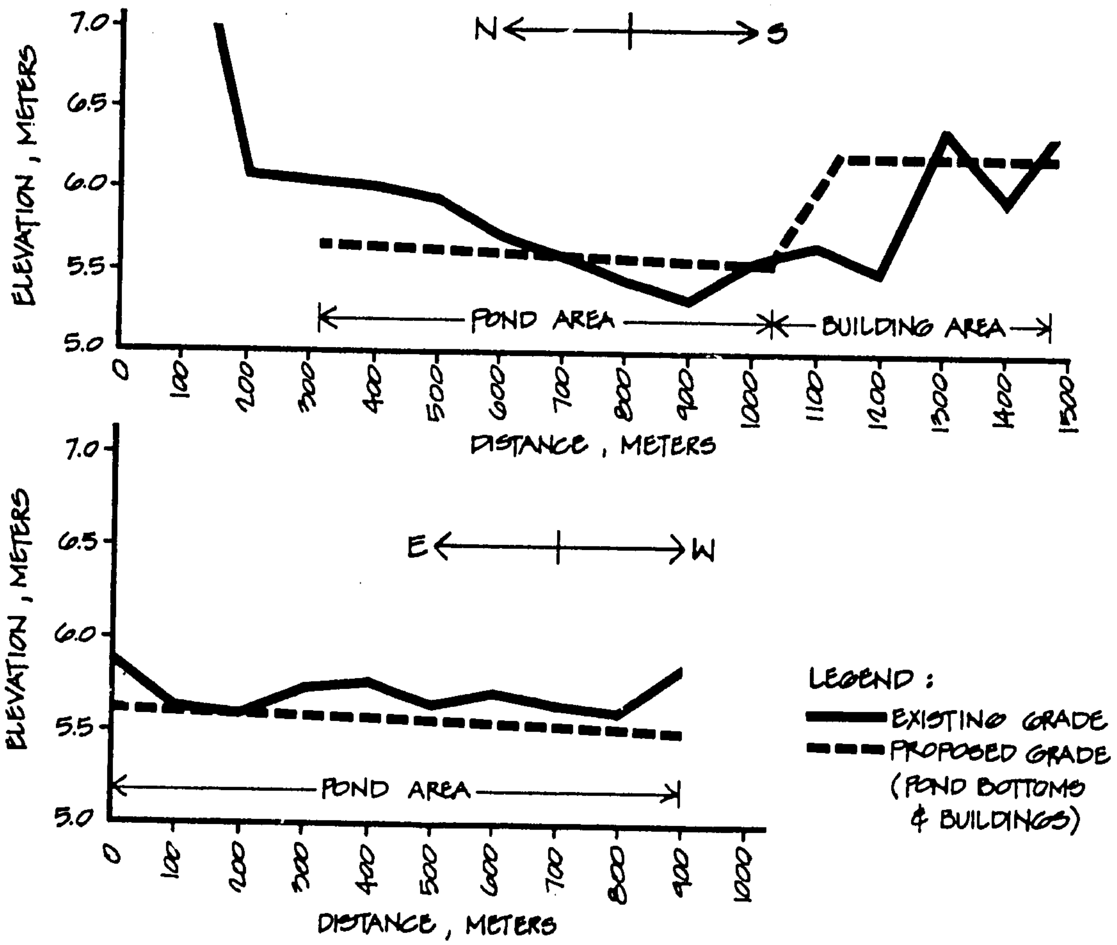
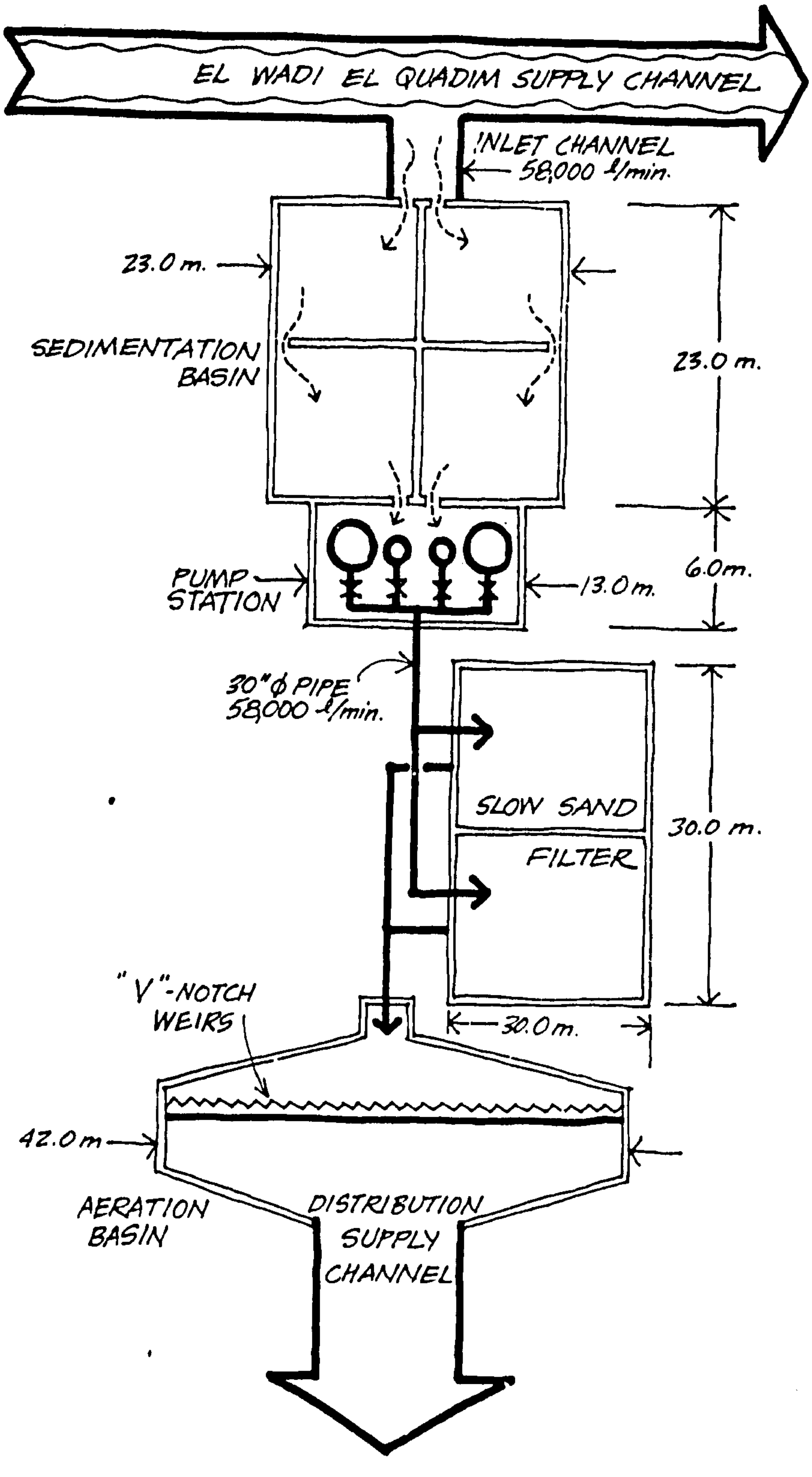


NAC Figure 6.9
Site Gradings



NAC Figure 6.10
Inlet Works Diagram

constancy of experimental conditions. Filtration to 10 to 20 microns should remove most of the harmful material before it enters the water distribution system. Additional filtration for the live food culture room and some laboratory tanks will be required to 1 micron unless well water is used.

Pumping will be required for all water in order to provide filtration which cannot be accomplished using existing hydraulic gradient. A cascade and splash-block aeration basin will be constructed immediately downstream of the filtration units to ensure constant high dissolved oxygen levels in the water supply. This is extremely important for all fish in the intensive ponds and for the egg incubation tanks. It must be noted that the combined NAC and MHC peak demands on the El Wadi El Quadim irrigation canal would be about 2.49 by m^3/sec. This maximum demand represents about 65 percent of the maximum discharge capacity of the canal which is 3.76 m^3/sec. In addition, Section 10.1 of the Irrigation Engineering Report indicates that the maximum demand for existing irrigation requirements is about 2.2 m^3/sec which indicates a possible maximum deficit of about 0.93 m^3/sec.

It is believed that pumped drawdown at the inlet works will compensate for this deficit in channel capacity by increasing the hydraulic gradient, thus making higher channel velocities possible. No modifications to the inlet from the Ismailia main carrier canal were therefore assumed in the cost estimate. It should be emphasized that the main carrier canals should be dredged to restore to original design capacity.

The present irrigation rotations of 4 to 5 days of high flows followed by 6 to 10 days of low flows are not compatible with operation of the NAC and will require review of projected demands by the Ministry of Irrigation (MOI) before the full project described herein proceeds to schematic design.

If the present risks for irrigation rotations on the El Wadi El Quadim canal to allow for continuous water flow remain, the following alternatives must be explored:

- Provide project water requirements directly from the main Ismailia Canal to the site via a private intake and conduit.
- Provide project water requirements though modifications to the existing intake and canal without interfering with the agricultural irrigation rotations.

The above alternatives would also require the approval of the MOI and would increase the total project cost.

6.4.4 Hydraulic Profile

Site grading will enable water distribution by gravity downstream of the aeration basin and gravity operation of the full drainage system. NAC Figure 6.11 is a simplified representation of the hydraulic profile of the water supply and drainage system for the outdoor ponds. It assumes a minimum water surface elevation (WS el) of 7.5 m at the El Wadi El Quadim supply canal and a maximum WS el of 5.0 m at the El Wadi Drain.

Water from the supply canal will flow by gravity through the inlet channel, into the baffled sedimentation basins, and to the pump station sump pit. From there it will be pumped and piped to the top of the sand filters and flow by gravity the rest of the way. Two sedimentation basins and two sand filters will be provided to allow for periodic removal and cleaning of settled and filtered material.

6.4.5 Water Distribution System

Water will flow by gravity from the main distribution canal along the eastern boundary of the site to the four lateral canals feeding the numerous outdoor ponds as shown in NAC Figure 6.12. Water flow rate into the ponds will be controlled by manually operated sluice gates on the channel side of the inlets to the ponds. The inlets will be suitably screened to prevent the escape of fish and will transmit water to the ponds by means of a buried pipe and differences in available head between the water distribution canals and the ponds. A total of 6,200 m of water distribution canals with bottom widths of 0.5 m will be constructed. The side slopes of all earthen ponds and canals will be 3:1 and will have vegetative cover for soil stabilization.

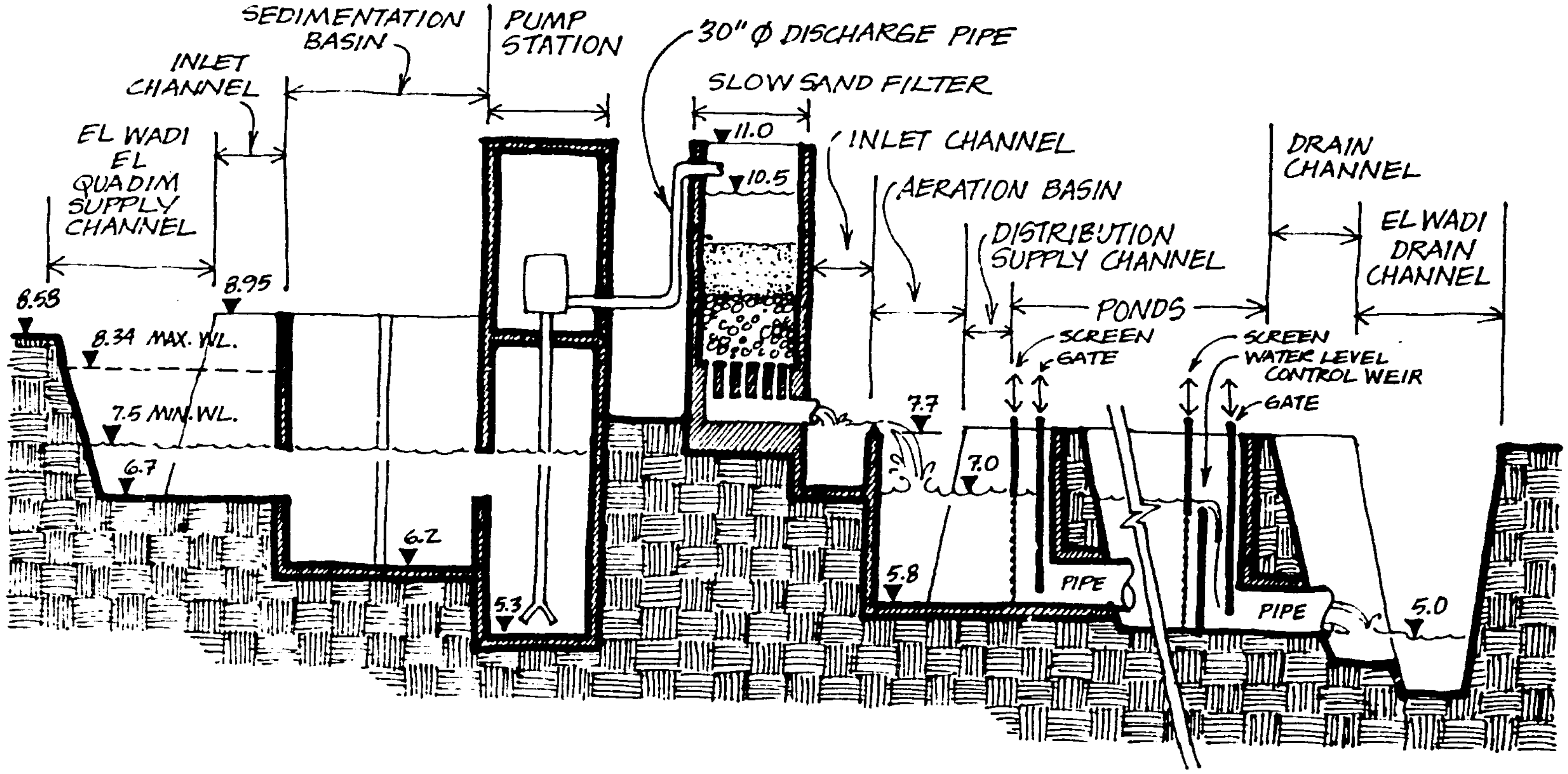
Inlets will be provided along the eastern bank of the main distribution canal to provide water to nine neighboring MHC ponds. Existing government fish farms will be supplied from the southernmost portion of the main distribution canal. Water depth in the distribution canals will range from 1.1 m to 1.2 m.

6.4.6 Drainage System

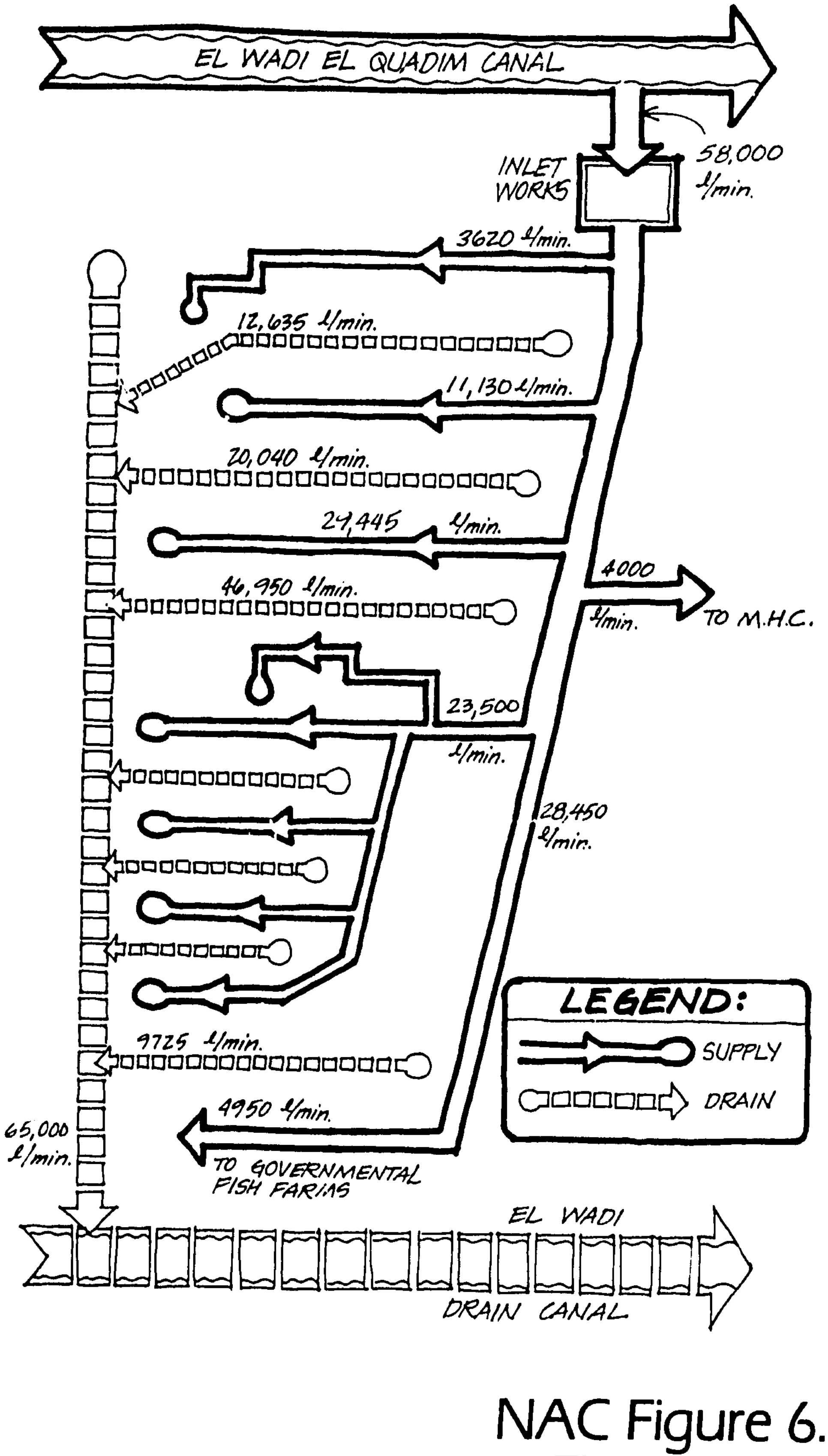
Discharge water from the outdoor ponds and other drainage will be conveyed by gravity to El Wadi Drain Canal by a system of drainage ditches as shown on NAC Figure 6.12. A total of 5,700 m of drainage ditches, ranging in bottom width from 0.5 m to 4.5 m, will be constructed within the site. This system will then merge with the drainage network from the MHC before reaching El Wadi Drain.

The peak discharge from NAC has been estimated to be about 65,000 l/min (1.08 m^3/sec). When this is combined with the estimated 6.08 m^3/sec peak discharge from the MHC and government fish farms, it becomes evident that the El Wadi Drain, whose original peak design capacity was about 7 m^3/sec, will require extensive channel modifications and/or increased pumping capacity at its discharge into El Mahsama main drain (El Qassasim pump station).

Available cross-sectional data of El Wadi Drain indicates that it is presently in serious need of maintenance as it is badly silted and overgrown with vegetation in the vicinity of the project. Reported occurrences of localized flooding at El Abbase confirm that the channel, in its existing condition, can only transmit a fraction of its original design discharge capacity. Additional drainage duty imposed by the proposed projects can only result in more frequent and prolonged flooding unless a major rehabilitation project is first undertaken.



NAC Figure 6.11
Hydraulic Profile



NAC Figure 6.12
Flow Diagram

If rehabilitation of El Wadi Drain is not carried out by the responsible agency, then the following alternatives should be explored:

- Construct an earthen perimeter dike, as necessary, to protect the site from outside flooding and provide a discharge pump station to pump out all drainage flows when the water level in El Wadi Drain exceeds elevation 5.0 m.

- Elevate the whole site approximately 0.5 m by importing an additional 400,000 m^3 of soil.

6.4.7 El Abbasa Way Road (AWR)

This road will be the principal access road to both the NAC and the MHC. It presently consists of an unpaved roadway about 6 m wide which extends about 5,800 m eastward from a bridge on Ismailia Canal, passes through a village, and terminates along the southern boundary of the NAC site. Portions of the road are unpassable or in bad condition at present.

The road will be widened and paved to facilitate access to and from the site. The improvements will consist of elevating the road above existing grade about 0.4 m including base and surfacing, widening the traveled surface to 8 m, and providing 1 m-wide soft shoulders and drainage ditches on both sides. In inhabited areas, the existing road grade will be maintained and shoulder width and drainage will be limited to the conditions encountered. American Public Works Association (APWA) standards will be adopted for this phase of the work.

The existing bridge across Ismailia Canal has a load rating of 5 tonnes and reportedly will be replaced with a structure of higher load rating. This will be crucial to the project as the expected weight class of vehicles servicing the sites will be about 12 tonnes. Construction equipment weighing upwards of 20 tonnes may be employed and will require a separate logistics solution.

6.4.8 Design/Code Standards

The only portion of the recommended civil systems discussed in this section that will incorporate design standards will be the road work. The APWA standards will be adopted for this work for both on-site requirements and El Abbasa Way access road.

6.4.9 Other Considerations

To guarantee that the water supply system for the outdoor ponds will function properly an adequate and reliable electrical power source must be provided. Continuous monitoring of pump performance and channel water surface elevations both upstream and downstream of the pump station must also be provided to prevent large fluctuations in water levels which could impair the effectiveness of the gravity feed system.

6.5 STRUCTURAL SYSTEM

6.5.1 Loads

For the design of all buildings of this project the dead loads, which arise from the weight of the structure itself, will be computed using the design dimensions and unit weights of the building materials. Live loads, those loads which are transient in nature such as wind loads or loads imposed due to the use or occupancy of the structure, will be taken as the minimum allowable load of the applicable building code (see NAC Section 6.5.5), unless the anticipated use of the structure requires that a large load be used. Various loading configurations will be examined to ensure that the structure will be capable of resisting the maximum probable stresses. Impact effects of all moving loads will also be included in the design of affected structural members.

6.5.2 Building Materials

The building materials selected for construction will be chosen to reduce cost and to enhance appearance and durability. The proposed building material for the majority of the structural members is cast-in-place (CIP) reinforced concrete. This has been selected rather than structural steel after study and research of local conditions which indicate the lower cost, greater availability, and contractor familiarity with CIP reinforced concrete. Concrete is also advantageous due to the reduced maintenance costs as compared to structural steel. Wall closures will vary with the architectural finish desired but will typically be of CIP concrete, red brick, or hollow concrete block.

6.5.3 Foundations

The final selection of foundation type and size depends on the results of soil tests which are not yet completed. Visual, surface inspection of the site indicates that the following types of foundations will be most probable.

Isolated spread footings, constructed of CIP reinforced concrete are recommended for use beneath concentrated loads such as those due to building columns or heavy equipment.

Continuous footings, also constructed of CIP reinforced concrete are recommended for use beneath all load-bearing walls and can also be placed beneath rows of building columns.

These footing types are well suited to the construction techniques and materials currently in local use. They can be adapted to a variety of soil conditions by simply varying their dimensions. Finally, they are compatible with the anticipated building framing system.

6.5.4 Building Framing System

The building framing system serves to support the load at the point of application and to transmit it to the foundation. The system chosen will depend largely on the architectural features selected to meet functional requirements. Also, the system chosen will reflect the construction techniques and materials available in Egypt which will enhance the quality and economy of the structure due to the contractor's familiarity with these techniques and materials.

The major portion of the building is anticipated to be a CIP reinforced concrete frame with masonry infill walls. This system is currently in use in Egypt and is readily adapted to a variety of floor plans. This does not preclude the use of other structural systems which might be required under special conditions; such as for long spans or where a given structural system, form, or configuration may economically solve several functional building requirements at one time. Such requirements may include lighting, cooling, spatial, acoustical, or other considerations.

6.5.5 Design Criteria

Structural design criteria will include the following considerations:

6.5.5.1 BUILDING CODE

KCM was directed by USAID and presently is proceeding on the basis that the 1979 Edition of the Uniform Building Code (UBC) (published by the International Conference of Building Officials) will be used as the structural design code. Deviation from the UBC will be undertaken in those instances where the construction techniques required to conform to the UBC are either unavailable or evidently inappropriate to the project.

6.5.5.2 EFFICIENCY

Functional efficiency is part of the structural concern; it includes such factors as the arrangement of the floor plan to group-related activities in the same area of the building. Structurally this will affect the location of building columns and walls, and the length of roof spans.

6.5.5.3 CONSTRUCTION ECONOMY

As noted previously, the use of materials and building techniques commonly used in Egypt will play an important role in cost control. Additional methods of reducing costs now under consideration include simplification and standardization of structural details. By standardizing cross-sectional dimensions, details, and building components, labor and material costs will be reduced.

6.5.5.4 EXPANSION

At this time, it is anticipated that all future expansion will extend horizontally. Structural members will not be designed to support loads due to vertical expansion.

6.6 SPECIAL SYSTEMS

6.6.1 Laboratory Firefighting Gas System

The firefighting systems within the NAC laboratories shall be a halogenated extinguishing agent gas system. This system will be fully automated and will be triggered by the fire alarm system.

The gas will be stored in pressurized cylinders adjacent to the laboratory areas and distributed through independent piping systems.

NATIONAL AQUACULTURE CENTER
CHAPTER 7
ESTIMATED COST OF CONSTRUCTION—SUMMARY

7.1 BASIS OF COST ESTIMATE

The conceptual construction cost estimate for the National Aquaculture Center - El Abbasa (NAC) is based on the concept design criteria researched and developed for this project as described herein as well as the currently understood project site conditions and limitations. All material, labor, and equipment costs are based on the joint professional knowledge and related construction experience for similar projects by the design team for both home and abroad.

Wherever possible, construction costs are based on native construction materials and current Egyptian construction practices. Construction is to be performed by local contractors. The cost of all American (U.S.A.) made material and equipment used in this cost estimate includes all expected handling and freight charges, F.O.B. Alexandria, Egypt, but does not include any United States export duties which may be levied against such goods.

All construction costs are shown in U.S. dollars as of February 1980, escalated to the projected mid-point of project construction (see NAC Figure 7.1).

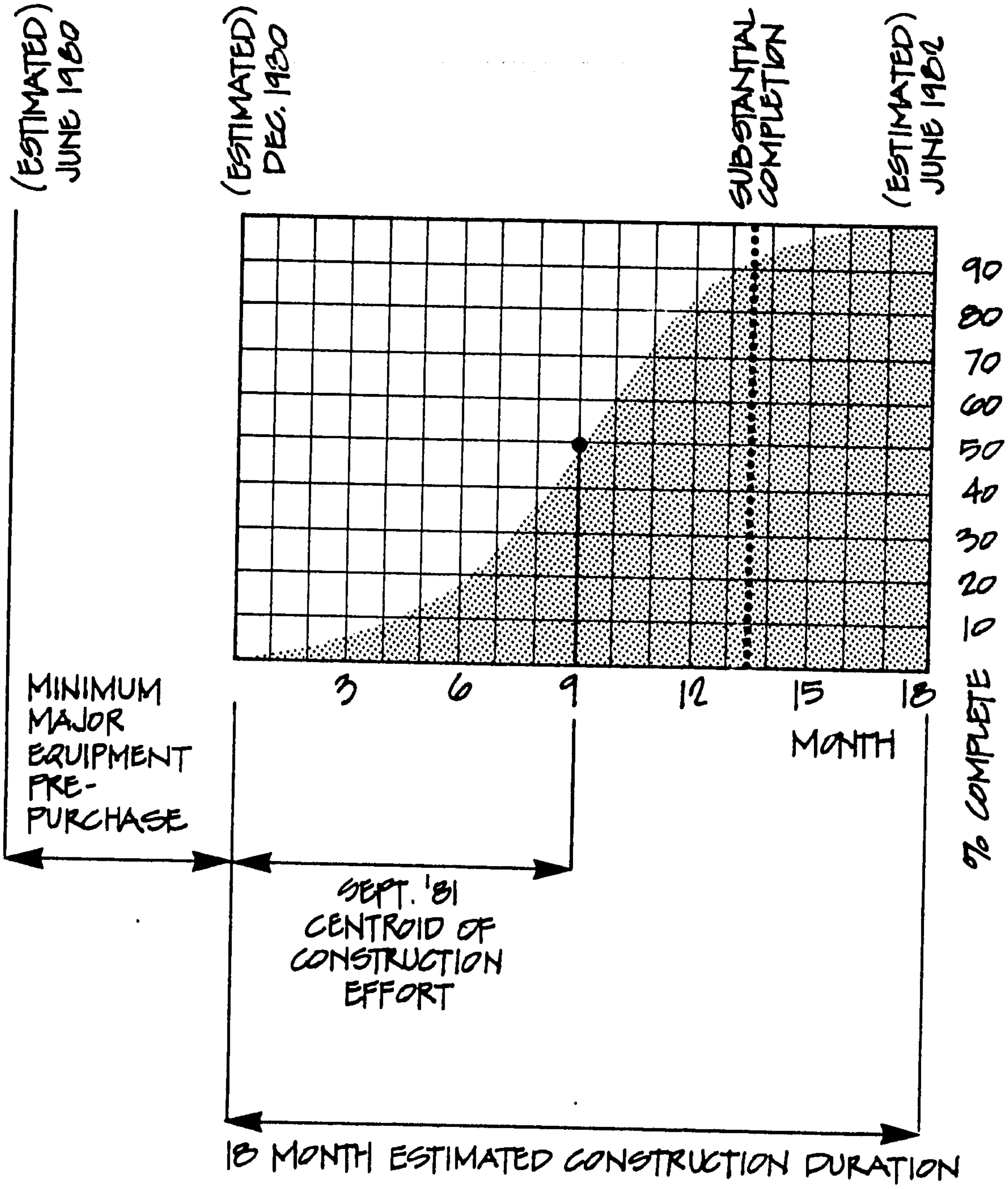
7.2 SCOPE OF WORK

The proposed project budget covers all work necessary to construct the NAC including the research/training/production (RTP) building(s), the NAC housing complex, feed storage, fish processing complex, the production ponds, research ponds, Model Homestead Complex (MHC) training farms, agriculture/aquaculture ponds, and all associated work including all site mechanical, electrical, and civil work as discussed herein within the limits of the proposed site boundaries.

The budget for the NAC does not include any work associated with El Abbasa Way Road (AWR) which crosses the southern boundary of the site. It is important to note the project limits for the canal water portion of work are defined by the water intake and drain interface with the public canal. In no case does the cost estimate reflect an expenditure for any work on the public canal.

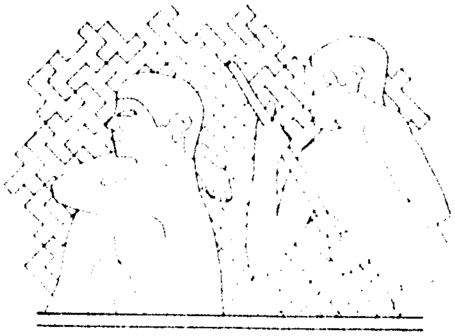
7.3 COST SUMMARY

7.3.1	NAC Site Work	US $ 3,016,000
7.3.2	NAC Research/Training/Production Building(s)	1,470,000
7.3.3	NAC Housing Complex	641,000
7.3.4	Cost Factors and Assumptions @ 10%	512,700
7.3.5	Construction Cost—Subtotal	US $ 5,639,700
7.3.6	Overhead and Profit @ 20% of Line 7.3.5	1,127,940
7.3.7	Mobilization @ 5% of Line 7.3.5	281,985
7.3.8	Remoteness @ 5% of Line 7.3.5	281,985
7.3.9	Construction Cost—Total (February 1980)	US $ 7,331,610
7.3.10	Contingencies @ 15% of Line 7.3.9	1,099,741
7.3.11	NAC Project Subtotal (February 1980)	US $ 8,431,351
7.3.12	Escalation to September 1981 @ 38% of Line 7.3.11	3,203,913
7.3.13	NAC Project Total Projected Cost	US $ 11,635,264
7.3.14	NAC Project Total Projected Cost Rounded	**US $ 11,635,000**



ALL COSTS ARE BASED ON A
PROJECTED MID-POINT OF CONSTRUCTION, SEPT. '81

NAC Figure 7.1
Construction Timetable Diagram



MODEL HOMESTEAD COMPLEX
EL ABBASA

MODEL HOMESTEAD COMPLEX
(MHC)

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CHAPTER 1
GENERAL PROJECT PROFILE

1.1 PURPOSE AND FUNCTION

One factor limiting the development of aquaculture in Egypt is a lack of technically qualified personnel and the infrastructure necessary to allow fish farmers to apply available technology. In order to help correct the situation, the Ministry of Agriculture (MOA) has planned an aquaculture development project consisting of a homestead farm phase and a small farm expansion phase which is not included in this scope of work and will be designed at a later date. The Model Homestead Complex (MHC) will consist of approximately 1,200 feddans that will complement the nearby NAC hatchery at El Abbasa.

The MHC will be comprised of 79 modules of about 16 feddans each, will serve as a demonstration and training facility for efficient and highly productive fish farming. The approximate size of these farm modules and the area to be developed into homestead farms was specified by the USAID mission. The homesteaders will be selected by MOA from recent agriculture graduates of the region who will be given in-kind loans to develop fish ponds and other farm facilities. The farmers will assume control of their farms when they are about to be stocked. Each of the model homestead fish farms will be allocated two 0.6-feddan fingerling ponds and four 3-feddan grow-out ponds. The remaining area will be used for housing, pond berms, ancillary activities and access roadways. Open space will also be provided for possible future integration with poultry or duck husbandry systems. It is anticipated that groups of farms will share certain facilities and act in cooperation to manage the ponds for greater design and operation efficiencies.

Fry for the ponds will come from several sources: 1) carp fry will be produced in the NAC hatchery and 2) mullet fry will be obtained from the mullet collecting stations. Tilapia fry will be obtained principally from the NAC ponds.

1.2 ADMINISTRATIVE PROFILE

The MHC will be administered by the governorate to the extent required to provide coordination of the individual and largely independent homestead farmers. This will be necessary to assure staging of pond and harvesting operations to achieve maximum benefit from available facilities.

1.3 EXPERIMENTAL/RESEARCH PROFILE

Although no research program is planned, the MHC is itself an experiment in the economic feasibility of small fish farms. In addition, it may be that modules or groups of modules will operate in concert to test new technology developed by the NAC.

1.4 EDUCATION PROFILE

The technology utilized by the farmers of the MHC represent the state of the art for aquaculture of this type. In addition to the training received at the NAC prior to operating a module at the MHC, farmers will remain in communication with the experimental and hatchery programs at the NAC. Thus, their own operations will reflect the current techniques practiced at the NAC.

1.5 EXTENSION SERVICES PROFILE

The MHC will serve as a training center for agriculture graduates assigned a model homestead. It will be an opportunity to apply the technology learned in an academic setting and at the NAC to an actual production effort upon which their livelihood will depend. As the MHC farmers move to other positions, they will take with them a thorough background in modern fish farm techniques, as well as an understanding of the potentials and problems of aquaculture.

1.6 PRODUCTION PROFILE

The MHC is expected to produce 800 tonnes of mixed species annually or about 10 tonnes of fish per homestead module. The mix will consist of tilapia (61 percent), mullet (31 percent), and carp (8 percent). Present plans call for the entire output of the project to be marketed in the Sharqiya/Ismailia area. Because of a persistent shortage of fish in the local markets, no problem is anticipated in absorbing the level of production envisaged. Zagazig, a major urban center of over 250,000, is quite close to the MHC project site. Other large cities including Ismailia, Port Said, and Cairo provide potential markets for any production overflow. The fish market to be constructed at Zagazig will include cold storage facilities, thus increasing the period during which fish produced can be held before sale.

The harvest will be spread over a six-month period, beginning in June and peaking in late November and December. Fifty percent of the fish will be harvested in the latter period. The long harvest period will facilitate marketing as well as increase total production and will provide the farmer with a steadier income flow than one-time harvesting. The farmer will harvest the fish with the assistance of family and hired labor. Some farmers may choose to contract the final harvest to local entrepreneurs who will also transport the fish to market. Such arrangements are possible in the project structure.

The fish produced will reach the final consumer through four channels, of which the private sector marketing network will be the most important. Private salesmen will collect the fish, prewashed, sorted, iced, and packed during the harvesting process, and transport them to markets. The output of the project can readily be handled by the present marketing network, which will be further strengthened by the Zagazig market and the availability of technical assistance from the NAC. Direct sales to the consumer will provide the second channel. Third, on-farm consumption including in-kind payments to laborers will absorb a small but significant portion of the output and will be a primary channel by which fish reach the rural poor. Such sales will include primarily smaller tilapia (less than 40 g), which have low marketability through other channels. The private sector will be the predominant marketing mechanism and it is not anticipated that distribution through public channels will exceed 25 percent of the total harvest.

1.7 SUPPORT PROFILE

Homestead farmers will be responsible for routine maintenance and repairs of module farm equipment and ponds. Facilities used in common will have to be operated and maintained under a cooperative agreement yet to be determined. This will include village housing, a fish processing facility for cleaning and icing fish on their way to market, as well as some netting and farm vehicles. Certain maintenance functions may be the responsibility of a designated office of the MOA.

1.8 FEED PROFILE

The fish ponds at the MHC will require nutrient inputs to produce fish as planned. Nutrient input may be in the form of cereal waste or animal waste fertilizers which stimulate natural biogrowth in the ponds which, in turn, will be consumed by the fish, or it may be in the form of a direct food ration for the fish. This approach is the most costly.

1.9 HOUSING PROFILE

Housing for the MHC fish farmers and their families will be provided in a village at one side of the pond complex.

1.10 STAFFING PROFILE

The MHC will be staffed by the homestead fish farmers themselves through training. Additional temporary labor may be hired during periods of peak activity such as harvesting and fish processing. A full-time manager will operate the fish processing facility. Sufficient cooperation among the farmers and the necessity of staging farm operations to use common facilities should provide adequate labor.

1.11 EL ABBASA WAY ROAD (AWR) PROFILE

The ponds and village of the MHC will be in close proximity to the AWR. All intersite traffic and much of the intrasite movement of fish, equipment, and supplies will utilize the AWR. Future expansion of the MHC is expected to parallel the AWR so as to make use of this main route. The AWR will be upgraded from the Ismailia Canal to the MHC village.

MODEL HOMESTEAD COMPLEX
CHAPTER 2
BIOLOGICAL PROCESS DESIGN FOR ONE FARM MODULE

2.1 FINGERLING PRODUCTION PROGRAM

The fingerling production program is designed to provide sufficient numbers of fingerlings to stock the grow-out ponds of every unit at the Model Homestead Complex (MHC).

2.1.1 Carp Production Goals

Carp fry (2 to 5 g) will be obtained from the National Aquaculture Center (NAC) nursery ponds for stocking the carp fingerling ponds. The fry will remain in the fingerling pond for 60 days until they reach individual weights of 40 g. Fry will be stocked at 36,000 per 0.6-feddan fingerling pond yielding at least 14,400 40-g fingerlings for use in stocking each unit's 12 feddans of grow-out ponds.

2.1.2 Mullet Production Goals

Mullet fry will be obtained from the mullet collecting stations (MCS) and will consist of two species: *Mugil capito* and *Mugil cephalus*. The fry will be grown to fingerling size in two cycles each year. Fry will be stocked at 42,000 fry per 0.6-feddan fingerling pond, yielding at least 20,400 fingerlings (40 g) each cycle.

2.1.3 Tilapia

Tilapia (*Tilapia nilotica*) will not require the use of fingerling ponds. Tilapia of 20 g to 40 g will be culled on a regular basis directly from the NAC tilapia spawning ponds and stocked in the MHC grow-out ponds. Some will also enter the ponds during pond filling because a certain amount of tilapia occur naturally in the water supply.

2.2 FINGERLING POND REQUIREMENTS

2.2.1 Carp Pond Requirements

Carp fingerling ponds will be 0.6-feddan rectangular ponds (200 m by 13.75 m by 1.5 m). Fingerling ponds will require 66 liters of water per minute and will have a catch basin. No other environmental controls will be needed. Fingerling ponds should be supplied with sufficient water to fill within 12 hours (3.8 m^3/min).

2.2.2 Mullet Pond Requirements

Mullet fingerling ponds will be 0.6-feddan rectangular ponds (200 m by 13.75 m by 1.5 m). Each fingerling pond will require 66 liters of water per minute for normal operations and a peak filling rate of 3.8 m^3 per minute. No environmental control will be needed. Fingerling ponds will have a catch basin and will be able to fill and drain independently.

2.2.3 Tilapia Pond Requirements

Tilapia fry culled from the NAC tilapia spawning ponds will not require the use of fingerling ponds but will be stocked directly into grow-out ponds.

2.3 FINGERLING POND TECHNIQUES

The procedures to be used in raising fish fry to fingerling size are discussed by species.

2.3.1 Carp Fingerling Techniques

Carp fingerling ponds will be prepared for stocking in stages over a period of four weeks. One month before stocking, water-soaked chicken manure will be spread over the dry pond bottom at 300 kg per 0.6-feddan pond. The water level will be raised in weekly increments to a depth of 50 cm. At stocking, 12 kg of superphosphate (15 percent) and 30 kg of manure will be applied per 0.6-feddan pond. The pond will then be slowly filled to capacity over a two-week period after which water replacement is to be about 66 liters per minute.

Pond productivity will be maintained at a high level through bi-weekly applications of 12 kg of superphosphate and 29 kg of manure per fingerling pond. If the natural biogrowth becomes inadequate, supplemental feeding with a 3:1 mixture of cottonseed cake and rice bran may be done at about 15 kg per day per fingerling pond.

When carp fingerlings reach approximately 40 g they may be harvested for distribution to grow-out ponds. The water level in the fingerling pond is slowly lowered forcing the fingerlings toward the drain and into the catch basin where they can be netted. Care should be taken in handling the fingerlings, but the final crowding into the catch basin and netting from the pond should be done as quickly as possible to avoid stressing the fish. The pond should then be thoroughly sun-dried before restocking for the next cycle.

2.3.2 Mullet Fingerling Techniques

M. capito and M. cephalus will be treated identically but because they have different spawning seasons they will be stocked in fingerling ponds at different times of the year.

Mullet fingerling ponds will be prepared for stocking in stages over a period of four weeks. One month before stocking, water-soaked chicken manure will be spread over the dry pond bottom at 300 kg per 0.6-feddan pond. The water level will be raised in weekly increments to a depth of 50 cm at time of stocking. At stocking, 12 kg of superphosphate (15 percent) and 30 kg of manure will be applied per 0.6-feddan pond. The pond will then be slowly filled to capacity over a two-week period after which water replacement is to be about 66 liters per minute.

Pond productivity will be maintained at a high level through biweekly applications of 12 kg of superphosphate and 29 kg of manure per fingerling pond. If the natural biogrowth becomes limiting, supplemental feeding with a 3:1 mixture of cottonseed cake and rice bran may be done at about 15 kg per day per fingerling pond.

When mullet fingerlings reach approximately 40 g, they will be harvested for distribution to grow-out ponds. The water level in the fingerling pond will be slowly lowered, forcing the fingerlings toward the drain and into the catch basin where they will be netted. Care should be taken in handling the fingerlings, but the final crowding into the catch basin and netting from the pond should be done as quickly as possible to avoid stressing the fish. The pond should then be thoroughly sun-dried before restocking for the next cycle.

2.3.3 Tilapia Fingerling Techniques

Tilapia fingerlings will be taken from the tilapia spawning ponds and stocked directly into the grow-out ponds without use of fingerling ponds.

2.4 GROW-OUT PRODUCTION PROGRAM

The grow-out production program is designed to produce at least 1,000 kg of mixed fish annually from each feddan of grow-out pond area. The approximate species composition of this yield will be tilapia (70 percent), mullet (20 percent), and carp (10 percent). According to this program, each model homestead fish farmer is expected to produce 10 to 12 tonnes of fish each year.

2.4.1 Carp Production Goals

Carp fingerlings (40 g) will be stocked in grow-out ponds at 1,200 fingerlings per feddan. At harvest time in early December, at least 500 carp (200 g) will be harvested per feddan of grow-out pond.

2.4.2 Mullet Production Goals

Mullet fingerlings (40 g) will be stocked in grow-out ponds at 1,700 fingerlings per feddan. At harvest in early December for *M. capito* and late June for *M. cephalus*, at least 1,000 mullet (200 g) will be harvested annually per feddan of grow-out pond.

2.4.3 Tilapia Production Goals

Tilapia fingerlings (20 g to 40 g) will be stocked in grow-out ponds at 10,000 fingerlings per feddan. At harvest in early December, at least 7,000 tilapia (100 g to 250 g) will be harvested annually per feddan of grow-out pond.

2.5 GROW-OUT POND REQUIREMENTS

2.5.1 Carp Pond Requirements

Grow-out ponds used for carp culture at the MHC will consist of four 3-feddan ponds (200 m by 63 m by 1.5 m). Each 3-feddan pond will require 330 liters of water per minute during normal operations and 13.1 m^3 per minute for filling the pond within a 24-hour period. The ponds will be able to fill and drain independently. No other environmental controls will be needed. The pond bottom will slope toward the drain.

2.5.2 Mullet Pond Requirements

Grow-out ponds used for mullet culture at the MHC will be the same used for the above described carp culture and will have the same requirements.

2.5.3 Tilapia Pond Requirements

Grow-out ponds used for tilapia culture at the MHC will be the same used for the above described carp and mullet culture and will have the same requirements.

2.6 GROW-OUT POND TECHNIQUES

The procedures used to raise fingerling fish to harvestable size in the MHC grow-out ponds are discussed by species.

2.6.1 Carp Production Techniques

Grow-out ponds will be prepared for stocking with carp fingerlings by applying fertilizers to the dry pond bottom and then slowly filling the pond. For the polyculture planned at the MHC, 8.75 kg of air-dried chicken manure and 150 kg superphosphate (15 percent) per feddan will be applied initially.

After stocking, ponds will be fertilized with 10 kg to 20 kg of superphosphate at one- to two-week intervals. In between superphosphate applications, air-dried chicken manure will be applied at 15 kg to 30 kg per feddan. Fertilizers will be broadcast over the water. Plankton turbidity checks, with a secchi disc, will be made regularly to determine frequency and amount of fertilization required.

Low-quality feed, such as rice bran or wheat bran, will be fed to the fish if natural food production cannot be maintained through fertilization alone. Fish will be fed at about three percent of their estimated body weight every other day.

In early December, when the carp have attained a marketable weight of about 200 g, the polyculture grow-out ponds will be lowered for harvesting. When the level nears the pond bottom, the rate of draining should be reduced to keep from stranding fish on higher portions of the pond bottom. As the water level decreases, the fish will be forced into the drain channels where they will be easily harvested using seines and dip nets.

Harvested fish may be taken by truck to the MHC fish processing facility located at the NAC. Here they will be washed with hoses to remove mud and pond debris and then sorted on the sorting tables. Sorted lots of fish will be iced using ice made at the ice plant at a rate of 500 g of ice per kilogram of fish.

After packing, the harvested fish may be trucked to the Zagazig or other fish markets or sold onsite to private entrepreneurs. Close coordination and cooperation will be required of all the MHC units in the use of the fish processing area facilities, to avoid overloading and to ensure a steady supply of fish to the market.

Grow-out fish ponds should be completely drained and sun-dried after harvesting is completed before fish are stocked for the next production cycle. Pond drying will help to prevent the establishment of disease organisms in the pond which might infect the next production cycle. If necessary, lime may be applied between pond cycles to control pathogenic organisms.

2.6.2 Mullet Production Techniques

Pond techniques used for polyculture of both species of mullet, M. capito and M. cephalus, will be the same as described for carp in MHC section 2.6.1. However, due to different spawning times, ponds will be stocked with M. capito in August while M. cephalus will be stocked in March. In both instances, the mullet will be stocked at 1,200 per feddan and require approximately four months to reach a harvestable size of about 200 g.

Pond preparation and pond management during the production cycle will be the same as described for carp. Harvesting will occur in early December for M. capito and in late June for M. cephalus. Processing and marketing operations will be the same.

2.6.3 Tilapia Production Techniques

Tilapia fingerlings will be harvested from spawning ponds at the NAC for stocking in MHC grow-out ponds at 10,000 per feddan. All pond production techniques described for carp and mullet production will be applicable to tilapia culture. Tilapia will be harvested with the other fish in early December at a weight of 100 g to 250 g. Harvesting, processing, and marketing functions are also the same.

2.7 PROGRAM OPERATION AND SCHEDULING

Scheduled pond operations are illustrated in MHC Table 2.1. MHC Table 2.2 provides a summary of MHC ponds and facilities as well as the capabilities and requirements of these areas.

2.8 ENVIRONMENTAL REQUIREMENTS

2.8.1 Water Quality

Pond water supplies will not be treated except to screen out fish and debris using a 2-mm mesh. Initial nutrient load, pH values, and temperature will reflect values found in the supply canal.

Water used to clean harvested fish and nets at the fish processing area will be well water. Only well water will be used to make ice at the ice plant.

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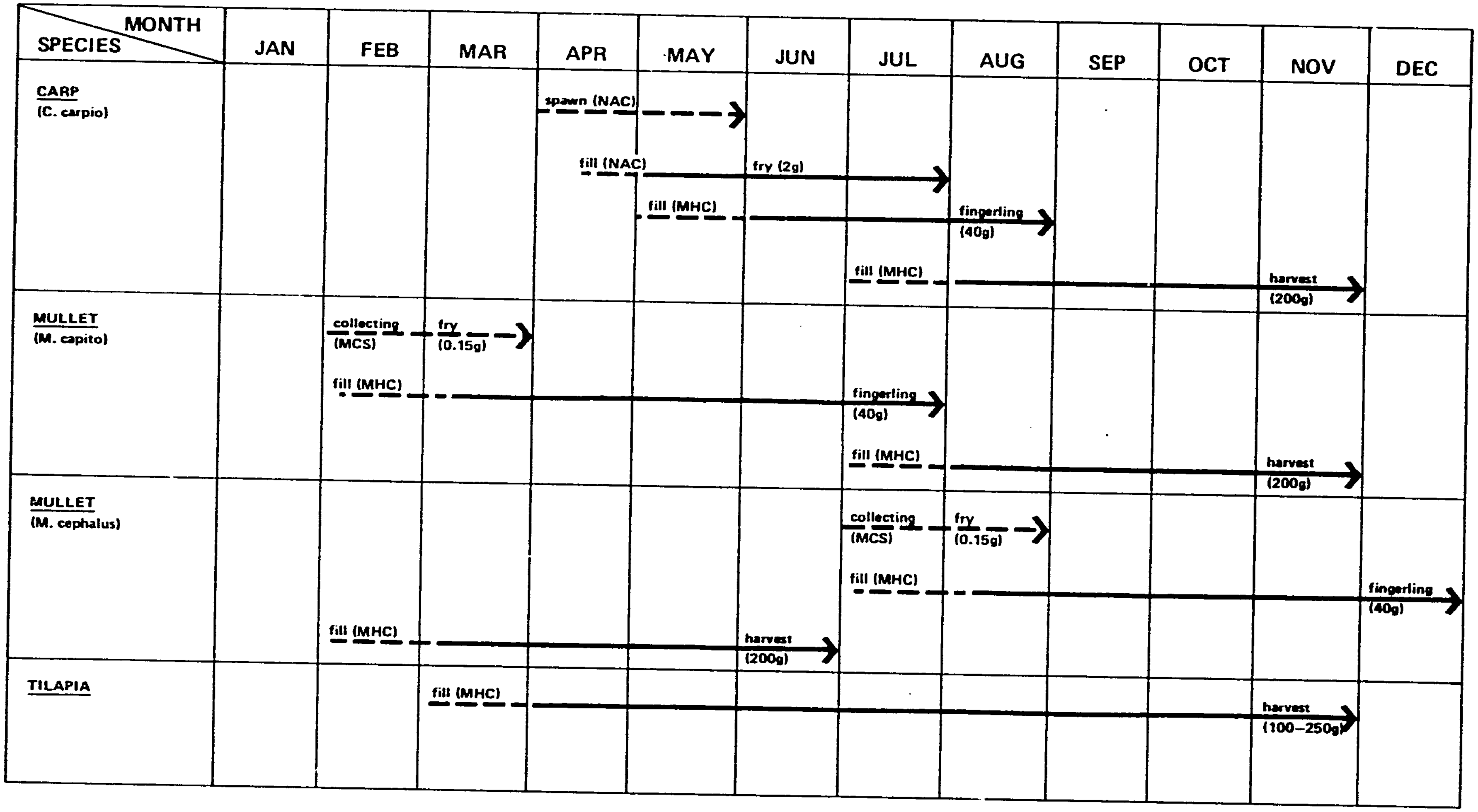
MHC TABLE 2.1
POND OPERATING SCHEDULE



MHC TABLE 2.2
FACILITIES REQUIREMENTS

Space/Facility	Suggested Area (M^2)	Capacity	Requirements
Fingerling pond (per unit)	252	(2) 0.6-feddan pond (200 x 13.75 x 1.5m), stock 30-50 fish/m^2, produces 34,000 fingerlings (40g)/feddan, 24-hour fill time	110 l/min/feddan screened water for normal operation, bottom sloped (0.5%) to drain, road access along one side, complete and independent draining
Grow-out pond (per unit)	12,600	(4) 3-feddan ponds (200 x 63 x 1.5 m), stock: carp - 1,200/feddan (grows to 200 g) mullet - 1,700/feddan (grows to 200 g) tilapia - 10,000/feddan (grows to 250 g) produces 12 tonnes fish/yr/unit, 24-hr fill time	110 l/min/feddan screened water for normal operation, bottom sloped (0.5%) to drain via drain channels (1.5 m wide x 0.5 m deep) road access to one side, complete and independent draining
Fish processing facility (common)	100	Process 36 tonnes harvested fish/day, 18 tonnes ice production/day, (maximum processing rate is fish from 3 units/day)	Ice plant (18-tonne), fish sorting and brailling tables, fish trays, scales, truck loading dock
Ancillary pond spaces (per unit)	600	Enclosed structure of 54 m^2 for storage. Platforms over ponds for unspecified number of animals	Net racks, equipment shed, manure bin, husbandry facilities, if incorporated

2.8.2 Water Temperature

No attempt will be made to control water temperatures at the MHC except for provision of shading to cool fingerling and fry transport containers and harvested fish on the way to market.

2.8.3 Water Exchange

Ponds will be supplied with peak water exchange at a rate of 110 liters per minute per feddan. During normal operations, each module at MHC will require 1,452 liters per minute to operate its ponds.

2.9 EXPANSION REQUIREMENTS

The MHC may eventually expand significantly at other sites. Only limited expansion is planned at the El Abbasa site. This expansion will mostly occur in areas designated for this purpose. Housing additions will remain in the MHC village.

As additions are made to the MHC, expansion of the ice plant capacity and fish processing site will be necessary. Ice will be needed at the rate of 500 g ice per kilogram of harvested fish per day. Water supplies will also increase correspondingly as more ponds are added to the complex.

2.10 TRANSPORTATION

2.10.1 Intrasite

Each module of the MHC is expected to produce 12 tonnes of fish annually. This harvest will have to be transferred by truck to the MHC fish processing area. At least two trucks of approximately 2-tonne capacity will be required for this purpose. Roads capable of supporting these trucks must have access to each grow-out pond and to each fingerling pond. These routes should connect the ponds to the El Abbasa Way Road for transport to the MHC village, MHC fish processing area, and to the NAC.

2.10.2 Intersite

The MHC should be connected to the NAC and beyond El Abbasa to the fish markets and supply locations. These routes should be good quality surface roads capable of supporting the heavy trucks described in MHC 2.10.1.

2.11 FISH PROCESSING REQUIREMENTS

Fish harvested from the MHC ponds will be taken by the farmer to the MHC fish processing facility at the NAC. The farmer has the option of utilizing the sorting and weighing facilities at this site, or he may simply obtain his required ice, or he may choose to bypass the fish processing facility altogether.

The fish processing facility will be sized, however, to accommodate the fish harvested from up to 12 grow-out ponds, or 36 tonnes of fish per day. This harvest may be represented by the harvest from as many as 12 different farmers or as few as three farmers. Therefore, the fish processing facility must be able to accommodate up to 12 different lots of fish per day for washing, sorting, and weighing purposes at an estimated three tonnes of fish per lot. Each lot must be kept separate from the others until after the sorting and weighing process is completed.

The basic fish processing operation is expected to require the use of hoses to wash down incoming baskets of fish. The fish will then be placed on a wet-type sorting table where the four fish species can be sorted into size groups. As many as eight different resulting lots of fish will then be weighed, iced, and packed for transshipment to market. Total ice requirements for this operation is estimated to be 18 tonnes of cube ice per day.

MODEL HOMESTEAD COMPLEX
CHAPTER 3
PROJECT SITE

3.1 EXISTING ENVIRONMENTAL CONDITIONS

The Model Homestead Complex (MHC) site is located adjacent to the site of the National Aquaculture Center (NAC) whose location was described in the previous section. A discussion of the possible negative and positive environmental impacts of the project can be found in NAC Section 3.1.

3.2 GENERAL DESIGN CRITERIA

3.2.1 Site Character

The MHC site lies within close proximity of the NAC, therefore refer to NAC Section 3.2.1 for a site character description. (See MHC Figure 3.1 for a site analysis.)

3.2.2 Future Expansion

The 79 farms programmed for the MHC fully utilize the available land at El Abbasa. It is unlikely that future expansion will occur unless other land is made available.

For limited expansion, the main water supply canal is designed to allow for widening the existing complex, and the existing road is oversized.

3.2.3 Flexibility

The flexibility of the farm modules is limited by the desire to maximize production of the available land. Because all available land will be used in the initial construction, no expansion space is allowed. The grow-out ponds and fingerling production ponds are adaptable to many changes and can be subdivided lineally. The modules are also designed with space for future animal husbandry sheds if the farmers wish to integrate poultry production with their farms.

3.2.4 Circulation

A great majority of the vehicle circulation at the MHC will consist of operations vehicles. Visitor vehicles will stay on the main access road, El Abbasa Way Road (AWR) when approaching the MHC village. A good deal of pedestrian and animal (donkeys, horses) circulation will occur at the MHC and will use the vehicle circulation system.

Vehicle access will be provided to every farm module; to the ends of all ponds within the module; and to the support area of each farm module to allow for delivery of feed, fertilizer, and operations equipment.

Walkways between all ponds will be a minimum of 2 m wide. The roads within each module will be a minimum 5 m wide. The access roads which connect all farm modules will be a minimum of 8 m. The main circulation spine, running adjacent to the main supply canal, which connects the farm modules to the village and the NAC, will be a minimum of 12 m wide.

3.2.5 Existing Conditions

The existing conditions which are listed previously become criteria for development of the site and must be considered as parameters.

One specific existing condition which influences the design is the fact that the site is quite low and poorly drained. Therefore it is often flooded by irrigation water. Design of the drainage system will allow for removal of water at a sufficient rate to keep the site dry.

3.2.6 Design/Code Standards

See NAC Section 3.2.6 for design and code standards.

3.2.7 State of the Art

See NAC Section 3.2.7 for the state of the art.

3.3 SITE DEVELOPMENT PROGRAM AND GUIDELINES

3.3.1 Introduction to Components

When creating a master plan for the MHC it is necessary to consider the functional relationship of all components that make up the project and then to relate them to the existing environment of the site in order to achieve the most beneficial and functional use of the site.

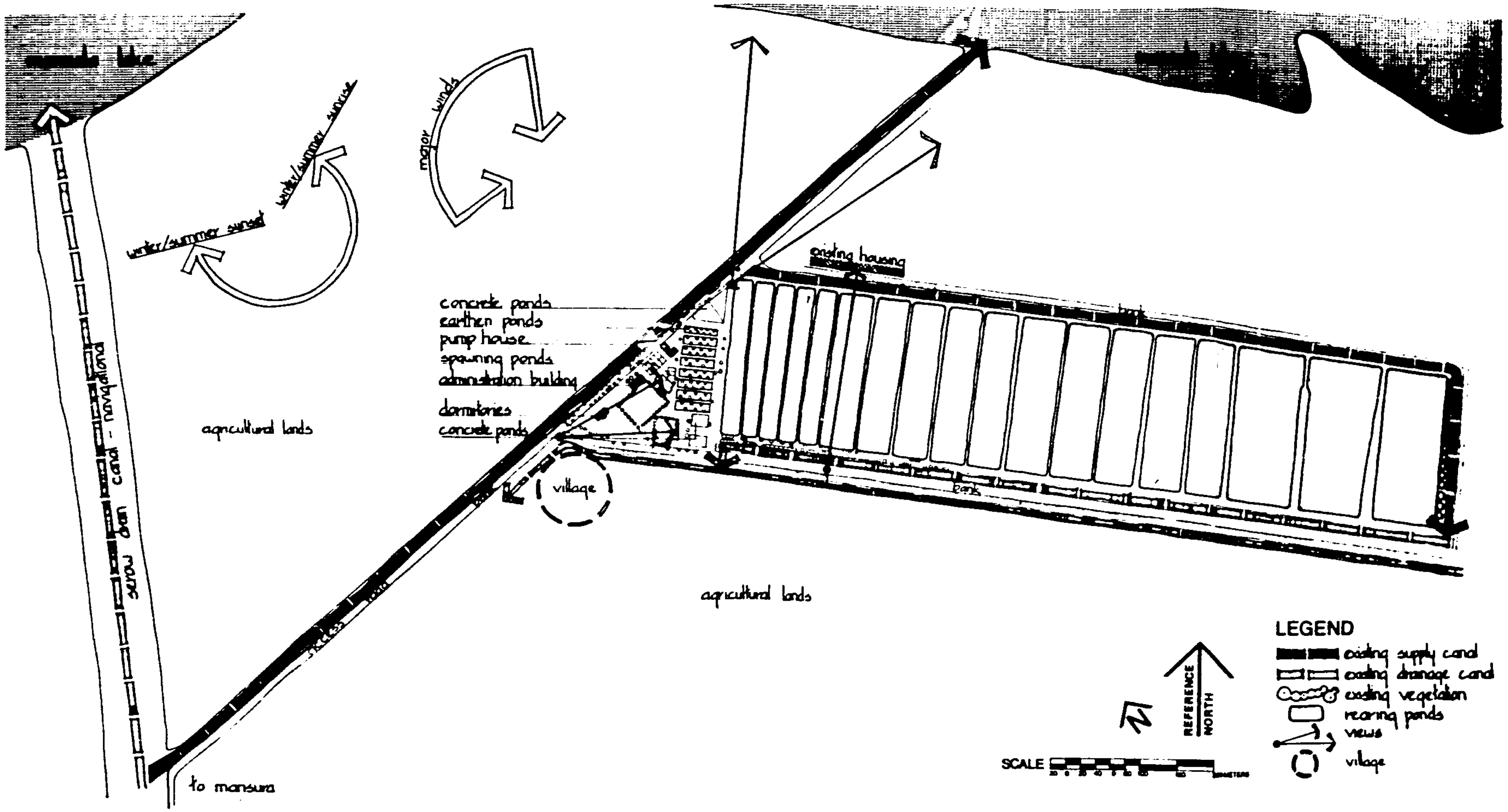
The project is made up of several components which are discussed in MHC Chapter 2. The major components which make up the MHC are categorized as follows:

- Grow-out ponds
- Fingerling production ponds
- Catch ponds
- Ancillary support facility
- Central feed storage area
- Fish processing area
- Housing
- Community center
- Mosque
- Shops
- Circulation system
- Water supply system

The relationships of each component to the other units will be discussed in this section. MHC Table 3.1 and MHC Figure 3.2 show the relationships of all the components.

3.3.2 MHC Module Component

Each MHC module or fish farm is made up of fish ponds, a support area, and the circulation system. (See MHC Figure 3.3.)



SFH Figure 3.1
Site Analysis

MHC TABLE 3.1
FUNCTIONAL RELATIONSHIP MATRIX

	GROW-OUT PONDS	FINGERLING PRODUCTION PONDS	CATCH PONDS	ANCILLARY SUPPORT FACILITY	CENTRAL FEED STORE AREA	FISH PROCESSING AREA	HOUSING	COMMUNITY CENTER	MOSQUE	SHOPS	CIRCULATION SYSTEM	WATER SUPPLY SYSTEM
GROW-OUT PONDS												
FINGERLING PRODUCTION PONDS	●											
CATCH PONDS	●											
ANCILLARY SUPPORT FACILITY	●	●	◉									
CENTRAL FEED STORE AREA	○	○		●								
FISH PROCESSING AREA	◉		◉	◉	○							
HOUSING	○	○	○	○	○	○						
COMMUNITY CENTER							●					
MOSQUE							●	○				
SHOPS					○		●	◉	○			
CIRCULATION SYSTEM	◉	◉	◉	●	●	●	◉	○	○	○		
WATER SUPPLY SYSTEM	●	●	◉								◉	

LEGEND

● VERY STRONG RELATIONSHIP

◉ INTERMEDIATE RELATIONSHIP

○ MINOR RELATIONSHIP

NO PARTICULAR RELATIONSHIP

X SOME DEGREE OF SEPARATION DESIRABLE

3.3.2.1 PONDS

An individual farm module includes four large grow-out ponds (66 m by 203 m) and two fingerling production ponds (15 m by 203 m). The function of these ponds is described in Chapter 2, Biological Process Design. The two types of ponds relate directly to each other and to the facility used to store manure, fertilizer, feed, and equipment which are necessary to manage the farm operations. The ponds also relate less directly to the NAC production component which supplies the fish fry and to the fish processing unit which is used to prepare the harvested product for market.

The four grow-out ponds are located adjacent to each other, two on each side of the supply canals. The fingerling production ponds are located to one side of the grow-out ponds, one on each side of the supply canal.

In addition to these six ponds, catch ponds are required for harvesting fish. Catch ponds are simply areas at the outlet end of each grow-out pond that are used to harvest the adult fish. These areas will be paved with concrete to allow for easy harvesting.

3.3.2.2 SUPPORT AREA

The support area of each farm module consists of a shed to store manure, fertilizer, feed, equipment, and nets. The storage shed will be sized to store a two month's supply of manure, fertilizer and feed. A central storage structure will be provided to store the supplies necessary for startup operations and for long-term storage made necessary by supply problems. The fish nets may be jointly owned and eventually transferred to the fish processing area for storage.

The support area relates directly to the grow-out and fingerling production ponds. Circulation is also important as trucks must have easy access to the shed to deliver supplies. A less direct relationship exists between the support area, the central store area, and the fish processing area.

3.3.2.3 ACCESS/CIRCULATION

AWR will be extended to the center of the MHC village. Access to the MHC modules will be provided by main roads running around the perimeter of the site and east-west along the drain canals between the modules. Along the north-south access, footpaths will separate the modules and main roads will be located at several points.

3.3.3 MHC Housing Village Component

3.3.3.1 PLANNED

The USAID working paper allows for construction of a housing unit for each farm module together with the utilities necessary to support each unit. These housing units relate to the farm module; however, because of cultural considerations they relate more directly to each other. Customarily the Egyptian farmers live in village groupings rather than in separate detached houses located on each farm. Therefore housing will be clustered to form a village.

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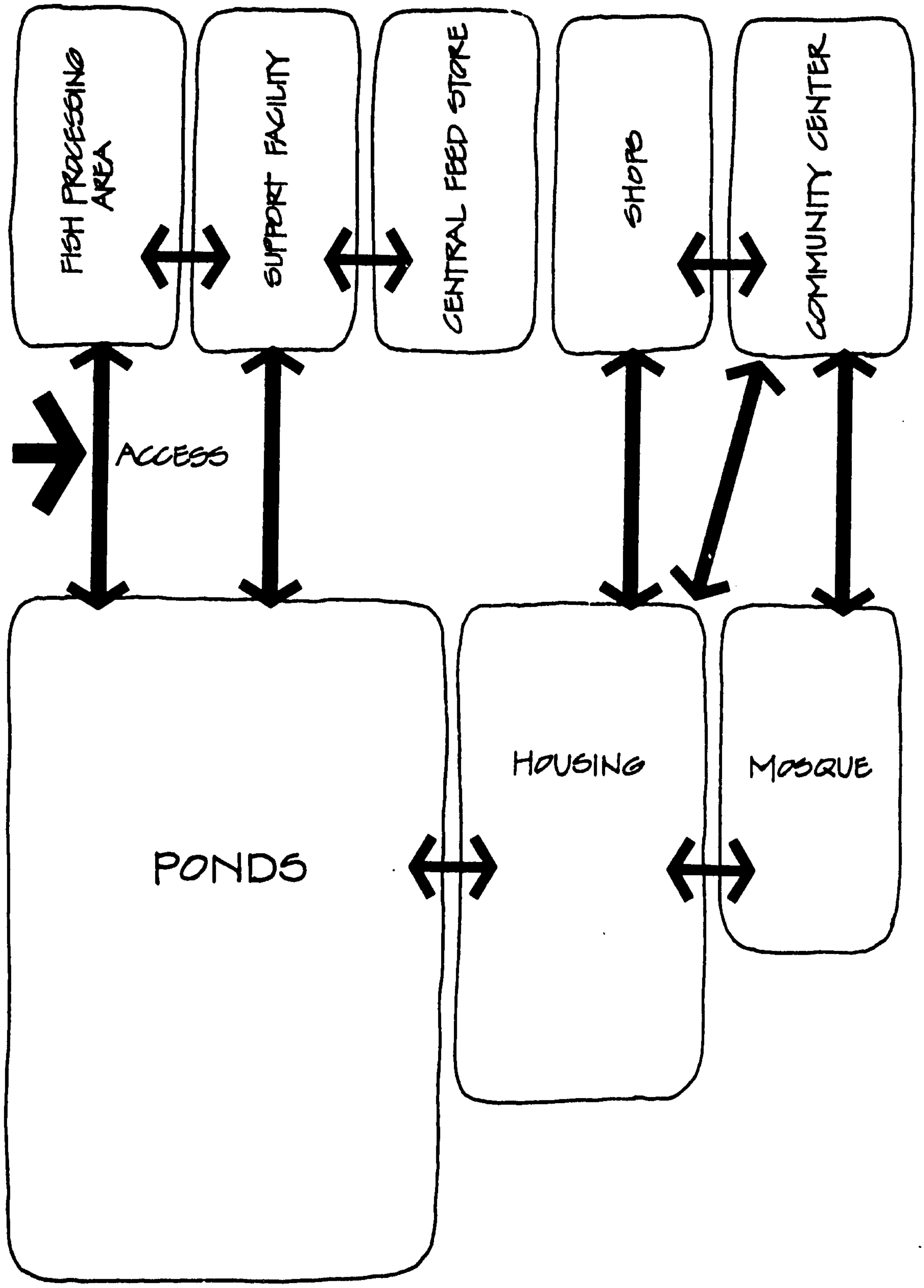
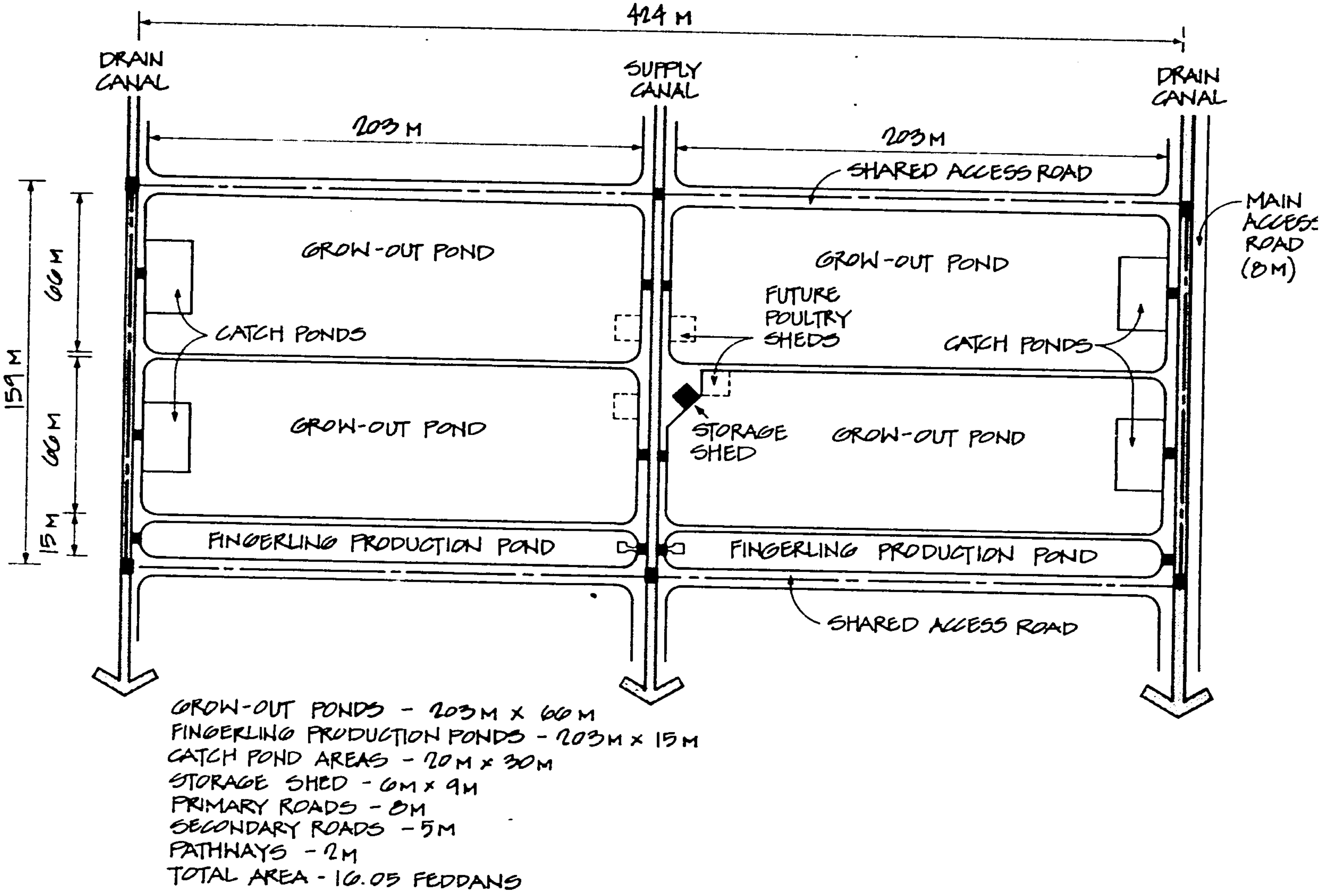


MHC Figure 3.2
Overall Functional Site Relationships



GROW-OUT PONDS - 203M X 66M
FINGERLING PRODUCTION PONDS - 203M X 15M
CATCH POND AREAS - 20M X 30M
STORAGE SHED - 6M X 9M
PRIMARY ROADS - 8M
SECONDARY ROADS - 5M
PATHWAYS - 2M
TOTAL AREA - 16.05 FEDDANS

MHC Figure 3.3 Homestead Module

3.3.3.2 EXPANDED

In addition to the housing units, the village will include a community center, a mosque, and shops. These units relate directly to the housing units and will form the core of the village.

3.3.4 MHC Fish Processing Component

As fish are harvested at the MHC they will be taken to a central fish processing area to be cleaned, sorted, graded, iced, and prepared for delivery to market. Because a similar facility is also required to handle fish harvested at the adjacent NAC, it is logical for the two facilities to share one fish processing area. This unit relates directly to the grow-out ponds and the production ponds at the NAC. In addition there is a direct relationship to the circulation system as the fish must be transported from each module to the processing area and then to the market at Zagazig or other markets in Egypt.

3.3.4.1 ICE FACILITY

Within the fish processing area, an ice facility will include ice-making equipment and area to pack and ice fish into shipping boxes. This unit relates directly to the sorting/grading area of the building.

3.3.4.2 SORTING/GRADING AREA

Fish entering the processing area from the farms will go into an area to be cleaned, sorted as to species, and graded for size and quality prior to being iced for shipment. This unit relates directly to the loading dock access and the ice facility.

3.3.4.3 OTHER CONSIDERATIONS

The fish processing area is supplied by trucks both in receiving and shipping, therefore it is necessary to provide loading docks for these vehicles. In addition to the processing aspect of the unit there will also be an area to hang and store nets which will be shared by the NAC and the MHC modules.

3.3.5 Circulation Component

The circulation component can be divided into access, circulation, and parking.

3.3.5.1 ACCESS

Access to the model homestead complex will be on AWR. The access road will pass the NAC and the duck hunting lodge before entering the MHC. AWR will be widened and paved in asphalt.

3.3.5.2 CIRCULATION

Circulation will be provided by a series of roads and footpaths running between all farm modules. The main roads will be paved in crushed stone, the roads within each module will be paved with compacted earth.

3.3.5.3 PARKING

Parking within each farm module will take place in the support area or along the road system. In the village, parking will be provided adjacent to each housing unit with limited parking at the community center area. Limited parking space will also be provided at the central feed store and the fish processing area.

3.3.6 Landscaping

Landscape treatment will be restricted to the village component of the MHC. The landscape will stress environmental control in addition to aesthetic concerns. Trees will shade walls and outdoor living spaces from the intense summer sun. Trees will not block valuable breezes and will have a beneficial impact on the cooling costs of buildings in the summer.

Indigenous plants such as eucalyptus and palms will be used. Vines such as Bougainvillea that can be made to grow on trellises and building structures will be planted to provide shade and color.

3.4 RECOMMENDED MHC PROGRAM EXPANSION

3.4.1 Introduction

During the planning of this project the USAID working paper defines the facilities that would be funded by the U.S. government grant. This grant provides a housing unit for each fish farm at the MHC which will be grouped into a central village of 79 families. However, as the detailed planning process has proceeded, several needed support facilities for this village have been identified by the design team and the ministry staff.

3.4.1.1 RATIONALE

In combining the MHC housing into one village, a community situation which requires certain infrastructure and support facilities has been created. These minimal support facilities include a mosque, a community center, and shopping space.

3.4.1.2 STATUS

The USAID mission in Cairo has agreed to have KCMI plan for facilities in the master plan for the village, however, the design and construction of the support facilities will have to be funded by the Government of Egypt.

To maintain visual unity of the village the design team strongly recommends that these units be designed by the same team under a separate contract directly between MOA and P. B. Sabbour, the Egyptian subcontractor to KCMI, with review by KCMI.

3.4.2 Site Summary

3.4.2.1 RECREATION FACILITIES

Seventy-nine families living together require space for outdoor recreation. As discussed in NAC Chapter 3 a large open grass area to be used for field sports such as soccer will be shared with the residents of the NAC.

3.4.2.2 OPEN SPACE

Open space will be used to provide separation, privacy, and public circulation. These green areas will also provide shade, wind control, oxygen generation, and cooling.

3.4.3 **Building Summary**

3.4.3.1 MOSQUE

A mosque will be provided for the daily prayers which are customary in the Moslem faith. This building is programmed as follows:

MOSQUE - 120 PERSONS

1.	Praying area	750 m^2
2.	Lavatory (4 toilets, 4 sinks, 8 taps)	15 m^2
3.	Storeroom	10 m^2
4.	Minaret	9 m^2
5.	Library	10 m^2
	TOTAL NET AREA	194 m^2
	Allowance for walls, structure 10 percent	20 m^2
	TOTAL GROSS AREA	214 m^2

3.4.3.2 COMMUNITY CENTER

A community center will be planned to house a social club, daycare facility, post office, health clinic, and a police facility. The program of this structure is as follows:

Community Center

1.	Social Club	
a.	Coffee shop	50 m^2
b.	Television room	20 m^2
c.	Buffet	5 m^2
	TOTAL NET AREA	75 m^2
2.	Daycare Facility	
a.	2 rooms for children	36 m^2
b.	Office	9 m^2
c.	Courtyard	30 m^2
	TOTAL NET AREA	75 m^2
3.	Post Office	18 m^2

4. Health clinic

a.	Waiting room	20 m^2
b.	Nurses room	9 m^2
c.	Examination room	12 m^2
d.	Pharmacy	12 m^2
	TOTAL NET AREA	53 m^2

5. Police facility

a.	Public foyer	15 m^2
b.	2 offices	24 m^2
c.	Crew room	12 m^2
d.	Holding area	10 m^2
	TOTAL NET AREA	61 m^2

TOTAL NET AREA FOR COMMUNITY CENTER	282 m^2
Allowance for walls, structure, restrooms, corridors - 15 percent	40 m^2
TOTAL GROSS AREA	362 m^2

3.4.3.3 SHOPS

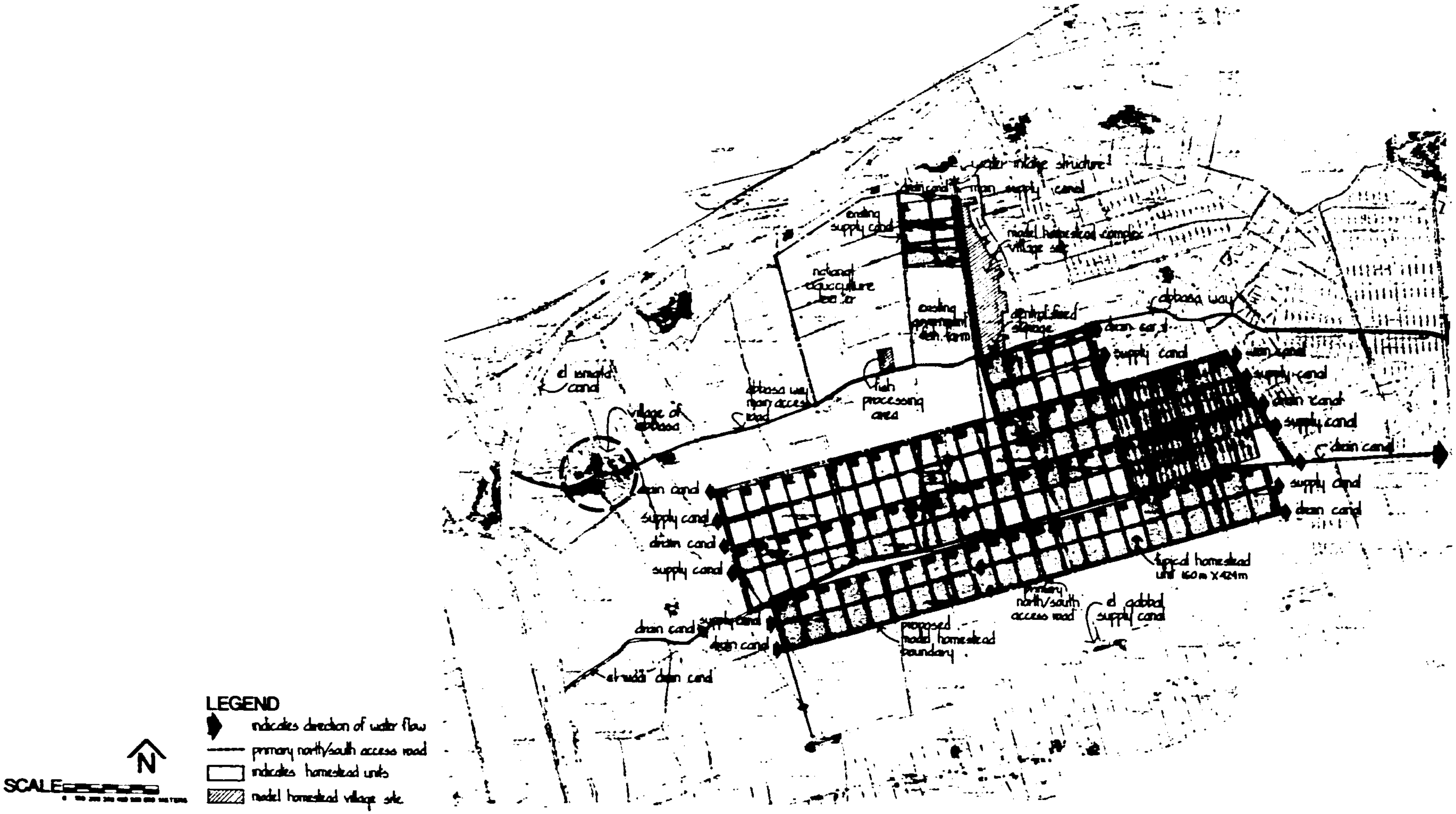
A structure of approximately 70 m^2 will provide space for merchants to sell goods and provide services. This general structure may be provided by the project or by private enterprise as seems appropriate.

3.5 RECOMMENDED SITE CONCEPT

3.5.1 Introduction of Concept

Access to the MHC will be via the AWR which crosses the Ismailia Canal and runs through the village of El Abbasa. It will run past the NAC, through the existing government fish farms and into the MHC village. A network of roads and footpaths will provide access to the individual farm modules. (See MHC Figure 3.4.)

The water supply system comes from two existing supply canals, the El Wadi supply canal on the north and the El Gabbal supply canal on the south. All water will be drained into the existing El Wadi drain canal. From the El Wadi supply canal, the water will run south through a major feeder canal in the center of the MHC complex which ends at the El Wadi Drain Canal. Supply canals will run east and west off of this major canal between the ponds in each farm module. Drain canals will run parallel to these supply canals on the opposite ends of each pond in the farm modules.



MHC Figure 3.4
Recommended Site Concept

A supply canal to feed the farm modules which are south of the El Wadi drain canal will run north from the El Gabbal canal on the west end of the MHC and will run east through the center of the farm modules south of the drain canal. A secondary drain canal will run east along the south side of these modules, and the ponds on the north side of the modules will drain directly into the El Wadi drain canal.

The farm modules are arranged close together for maximum productivity. Three modules are located near the north edge of the site and west of the major feeder canal. Seventy-six modules are located south of AWR on both the east and west sides of the major feeder canals.

The MHC village is located on available land just north of AWR and east of the major feeder canal. This site connects the north and south groupings of farm modules and is mid-way in the east-west arrangement of the farms. The central feed storage area is located adjacent to the village.

The fish processing area which will be shared with the NAC is located near the access road to the NAC which is located between the MHC and the fish markets that will purchase the fish.

3.5.2 Advantages

The close arrangement of the farm modules maximizes productivity on the available property and minimizes construction of canals. Placement of a central feed storage area reduces the space required for the support area of each module, again maximizing production.

Arrangement of the farm modules between the existing supply and drain canals reduces capital costs considerably while having no adverse effect on operating costs.

The village is located on land that is not wide enough to build farm modules and therefore does not take valuable production land.

3.5.3 Disadvantages

Because of the desire to maximize production on the property, certain facilities which should be located centrally are now located outside of the major production area but as close as possible to all individual units. It would have been desirable to locate the village, the central feed store, and the fish processing area in the center of all the farm modules.

In order to achieve the goal of providing 79 farm modules and to minimize the cost of building canals, it has been necessary to take land from the existing duck hunting lake and a limited amount of cultivated agricultural land.

MODEL HOMESTEAD COMPLEX
CHAPTER 4
MHC PROJECT BUILDINGS

4.1 FISH PROCESSING FACILITY

4.1.1 Introduction

The Model Homestead Complex (MHC) Fish Processing Facility will be operated cooperatively by the model homestead farmers. The purpose of the facility will be to wash, sort, weigh, and ice fish on the way to market. A full-time manager will care for the facility and supervise its use. Farmers themselves will wash, sort, weigh, and ice their own fish.

4.1.2 Building Program

A standard form is used in MHC Section 4.1.2.1 to provide information about each space required in the facility. In MHC Table 4.1 total estimated gross floor area is calculated from the net areas of the individual spaces.

4.1.2.1 BUILDING PROGRAM FORMS

The forms on the following pages provide detailed information on building spaces.

SPACE NO: PR **NAME:** Processing Area

FUNCTION: Harvested fish will be sorted, weighed, and iced for marketing. Six individual processing stations will be provided.

STAFFING: Maximum 6 fish farmers plus 6 helpers.

PRIMARY FUNCTIONAL RELATIONSHIPS: Ice plant.

QUALITY: Organized, functional, efficient.

AREA: 120 m^2 **DIMENSIONS:** **HEIGHT:** 3 to 4.5 m

ARCHITECTURAL FINISHES: Floor: Hardened concrete
Walls: plaster and paint or glazed tiles
Ceiling: Plaster or paint

LIGHT: Natural only.

SOUND CONTROL: None.

CASEWORK: Wall shelves @ 0.8 m wide.

FURNITURE: 6 stainless steel tables.

EQUIPMENT: 6 spring balances. Carts. Trays.

HVAC: Natural only.

PIPED SERVICES AND DRAINAGE: Water hose with sprayer at each station. Floor trenches for drainage.

SPECIAL REQUIREMENTS: Continuous loading dock is required adjacent to the stations.

SPACE NO: IP **NAME:** Ice Plant

FUNCTION: Provide ice (18 tonnes/day) to processing area and to fish farms.

STAFFING: 1 manager 20%.

PRIMARY FUNCTIONAL RELATIONSHIPS: Processing.

QUALITY: Functional.

AREA: 20 m^2 **DIMENSIONS:** 4 m by 5 m **HEIGHT:** 3 m to 4.5 m

ARCHITECTURAL FINISHES: Floor: Hardened concrete
Walls: Plaster and paint or glazed tiles
Ceiling: Plaster or paint

LIGHT: No windows. Artificial area light 430 to 640 lux.

SOUND CONTROL: None.

CASEWORK:

FURNITURE: None.

EQUIPMENT:

HVAC: Refrigeration system.

PIPED SERVICES AND DRAINAGE: Water for ice floor drain.

SPECIAL REQUIREMENTS: Future expansion.

SPACE NO: OF **NAME:** Office

FUNCTION: Office space for manager

STAFFING: Manager 70%

PRIMARY FUNCTIONAL RELATIONSHIPS: Storeroom and processing

QUALITY: Private, comfortable

AREA: 15 m^2 **DIMENSIONS:** 3 m by 5 m **HEIGHT:** 2.70 m to 3.50 m

ARCHITECTURAL FINISHES: Floor: Resilient or cement tiles
Walls: Plaster and paint
Ceiling: Plaster and paint

LIGHT: Window 1.2 to 3 m^2 with sun control. Area lighting 540 to 1100 lux.

SOUND CONTROL: Should be in quiet zone.

CASEWORK: Wall shelves, drawers, file drawers and cabinet.

FURNITURE: Desk and chair.

EQUIPMENT: None.

HVAC: Natural.

PIPED SERVICES AND DRAINAGE: None.

SPECIAL REQUIREMENTS: Visual control of overall facility.

SPACE NO: SR **NAME:** Storeroom

FUNCTION: Storage for general building supplies, scales, trays, etc.

STAFFING:

PRIMARY FUNCTIONAL RELATIONSHIPS: Office, processing.

QUALITY: Organized

AREA: 15 m^2 **DIMENSIONS:** 3 m by 5 m **HEIGHT:** 2.70 m - 3.50 m

ARCHITECTURAL FINISHES:
Floor: Hardened concrete
Walls: Plaster and paint
Ceiling: Plaster and paint

LIGHT: Window 1 to 3 m^2. Area lighting 430 to 640 lux.

SOUND CONTROL: None.

CASEWORK: Wall shelves and cabinets.

FURNITURE: None.

EQUIPMENT: None.

HVAC: Natural.

PIPED SERVICES AND DRAINAGE: None.

SPECIAL REQUIREMENTS: Security.

MHC TABLE 4.1
CALCULATION OF ESTIMATED GROSS FLOOR AREA

Code	Spaces	Net Area m^2
PR	Processing	120
IP	Ice Plant	20
OF	Office	15
SR	Storeroom	15
Total Net Area		170
30% Added to Net Area to Obtain Gross Area		51
Total Gross Area		221

*Percentage is added to account for walls, structural elements, restrooms, pipe spaces, corridors, etc.

4.1.3 Recommended Building Concept

MHC Figure 4.1 is the recommended conceptual floor plan for the fish processing facility.

Truck access is provided on the west, east, and south sides so that trucks can approach each of the six processing stations and the ice plant. The office is located to take advantage of the breezes and the north light. The storeroom is adjacent so that the manager will have good control of the balances and other equipment.

4.2 MHC HOUSING FACILITIES

4.2.1 Introduction

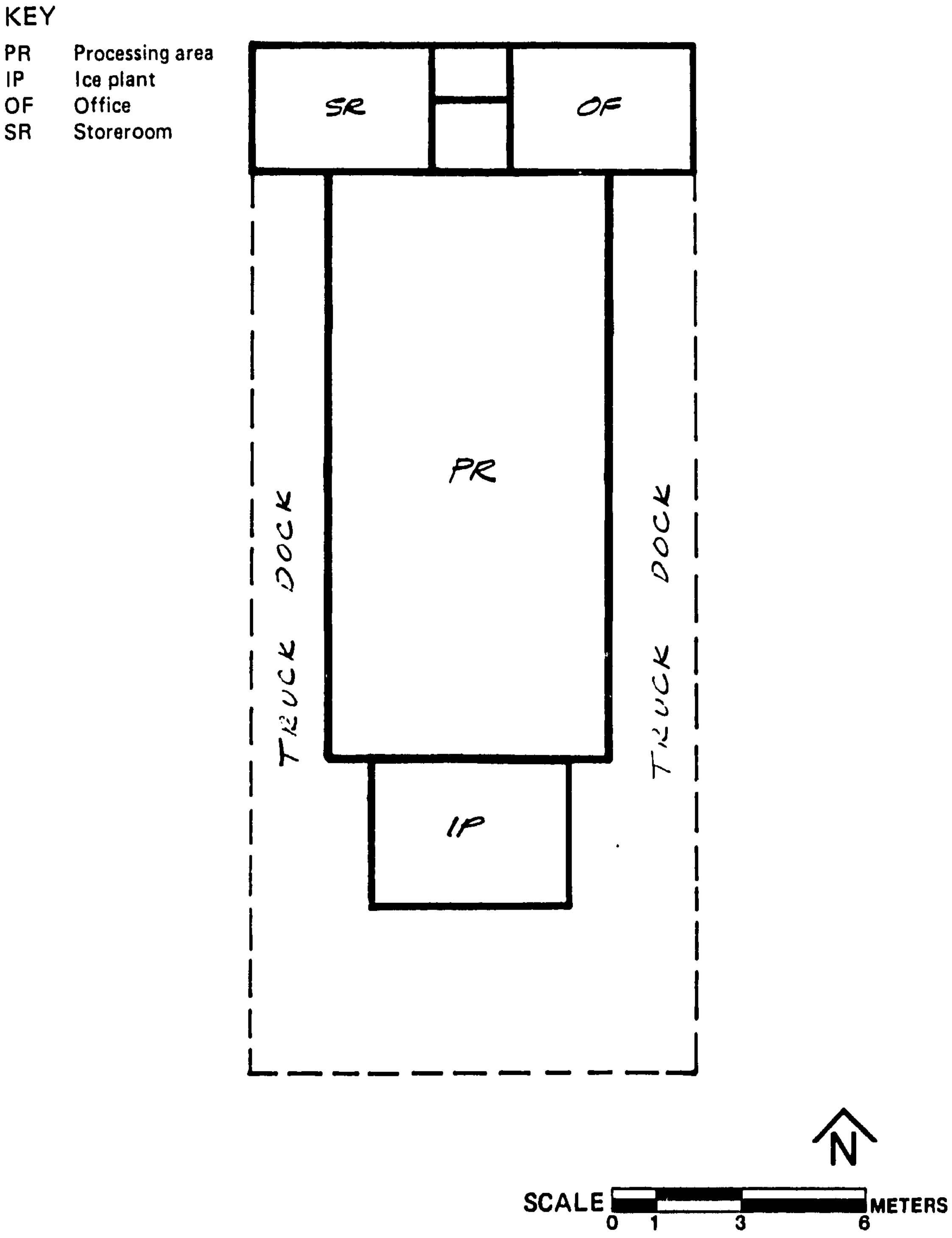
Because of the intimate relationship between a house and its culture, its design should be carried out by individuals informed and sensitive to the issues involved. Therefore, P. B. Sabbour has taken responsibility for design of the housing and Kramer, Chin & Mayo International, Inc (KCMI) has developed a concept for the related site layout. (See MHC Chapter 3.)

4.2.2 Building Program

The MHC housing will provide shelter for model home farmers. The program usually provides for 79 units. Appendix B.2, Building Program-MHC Housing, enlarges on the proposed program and related design criteria.

4.2.3 Status

On November 15, 1979, P. B. Sabbour submitted to the Ministry of Agriculture (MOA) the proposed MHC housing program report; the report was approved by MOA the same day.



MHC Figure 4.1
Conceptual Floor Plan

On December 2, 1979, members of the design team presented to MOA the Preliminary Design Scheme reflecting the contents of the program report. Alternative A of the submittal was subsequently approved by MOA.

In the Schematic Design Phase, the Preliminary Housing Scheme Alternative A will be sited and refined. Refinements will include modification of the core element to support a proposed roof-mounted solar-heated domestic hot water tank.

MODEL HOMESTEAD COMPLEX
CHAPTER 5
ENGINEERING SYSTEMS

5.1 RECOMMENDED MECHANICAL SYSTEM

The mechanical process systems are the backbone of Model Homestead Complex (MHC) facilities which will include a fish processing facility, housing, and home farm pond systems. Fish harvested from the farm pond will be sorted for marketing and then chilled to preserve quality. The majority of engineering problems are related to the farm pond systems and include water intake, treatment, distribution and disposal. The concepts developed for solving major engineering problems are presented in this chapter, but it should be noted that these are only engineering concepts and that the actual systems may vary during the schematic design phase. This preliminary definition, however, provides a basis for planning and a preliminary cost estimate.

5.1.1 Process Water Supply System

Only fresh water is needed to meet the biological process requirements at the MHC. The total process water requirement for MHC is estimated to be around 142,000 l/min. Process water for MHC will be obtained from two sources: a) El Wadi El Quadim Canal and b) El Gabbal Canal. The El Quadim canal will supply 100,000 l/min water for 56 home farm units while El Gabbal Canal will supply 42,000 l/min for the remaining 23 units, as shown in MHC Figure 5.1.

5.1.1.1 EL WADI EL QUADIM CANAL

This canal will supply water at a peak rate of 100,000 l/min for 56 home farm units. The MHC will have its own water intake canal. Water drawn from the canal will be aerated and gravity fed to the farm units. Sand filtration is not needed but a 2-mm mesh is needed for each farm unit to screen out fish and debris.

5.1.1.2 EL GABBAL CANAL

This canal will supply water at a peak rate of 42,000 l/min for the remaining 23 farm units. The canal water after aeration will flow by gravity to the farm ponds. The canal water will not receive sand filtration but a 2-mm mesh is needed for each farm unit to screen out fish and debris.

5.1.2 Service Water Supply System

MHC potable water will be supplied from the same source as the NAC and stored in the elevated storage reservoir for fire protection, domestic consumption and service water needs. This concept is schematically shown in MHC Figure 5.1. Service water is intended primarily for cleaning the harvested fish from ponds at MHC fish processing facility. The needed service water is estimated to be 15 l/min for 8 hours every day.

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5.1.3 Fire Water Supply System

As shown in MHC Figure 5.1, the elevated storage reservoir will provide water for fire protection for the MHC housing and fish processing facilities. Fire water flow requirements will be determined using the recommendation established by the National Board of Fire Underwriters (USA).

5.1.4 Domestic Water Supply System

The elevated storage reservoir will provide water for domestic consumption at the MHC housing and fish processing facilities and for making ice at the ice plant. The daily required domestic water demand is estimated to be 55 l/min while water needed for making ice is estimated at 21 l/min.

5.1.5 Tempered Water Supply System

Tempered water supply system is not needed for MHC facilities.

5.1.6 Process Wastewater Treatment System

Process wastewater after farm pond use will be discharged directly to the El Wadi drain canal without treatment, as shown in MHC Figure 5.1. Water quality after pond use will be adequate for direct discharge to the drain canal.

5.1.7 Service Wastewater Treatment System

Service wastewater generated from the MHC fish processing facility will be treated prior to discharge to El Wadi drain canal, as shown in MHC Figure 5.2. The treatment for service wastewater includes sedimentation and aeration. The settled sludge in the sedimentation basin will be trucked away for disposal.

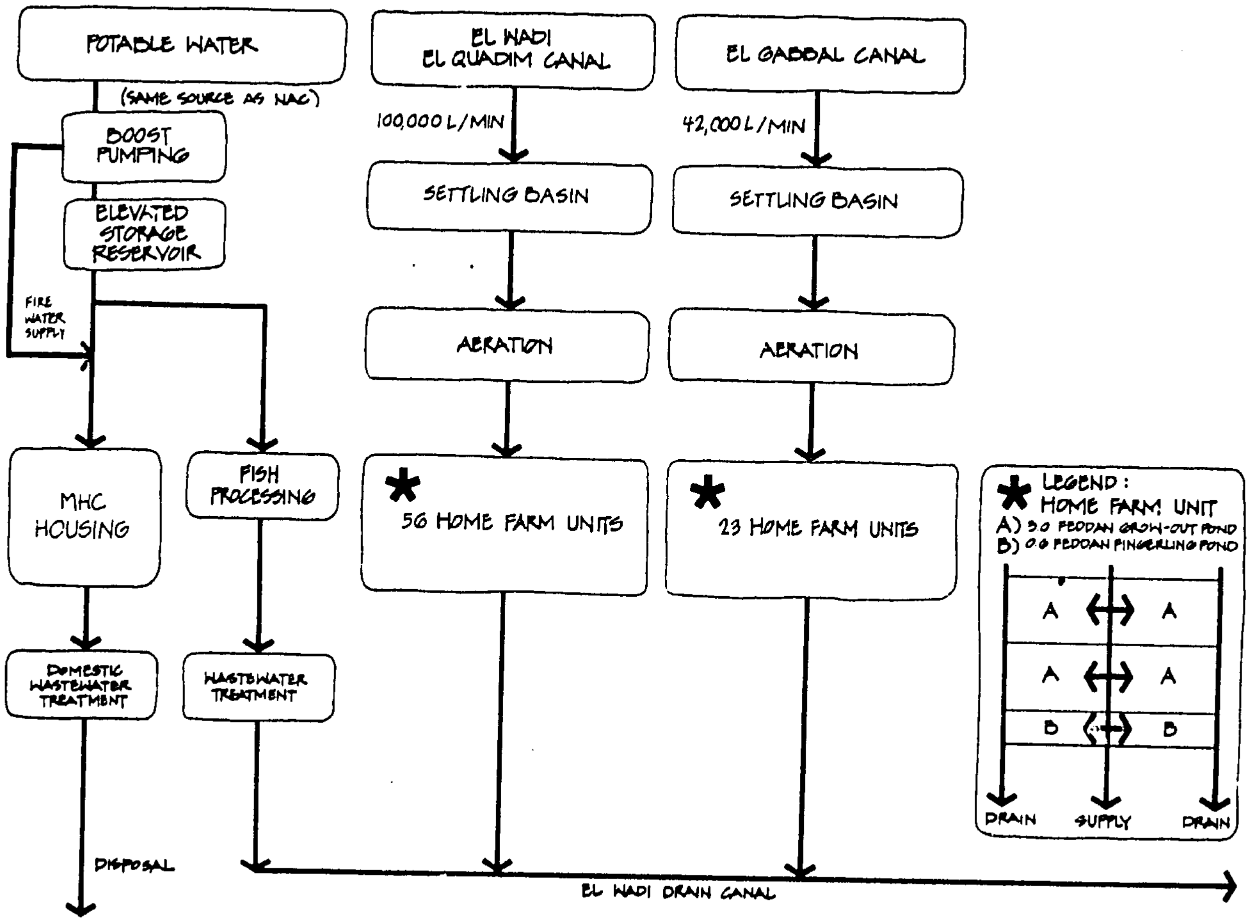
5.1.8 Domestic Wastewater Treatment System

Domestic wastewater from MHC housing and fish processing facilities will be aerated, stored and trucked away for disposal. The total domestic wastewater will be about 44,000 l/day. Septic tanks and drainfields may be used depending on soil conditions. The final decision on the disposal of domestic wastewater will be made when soil report becomes available.

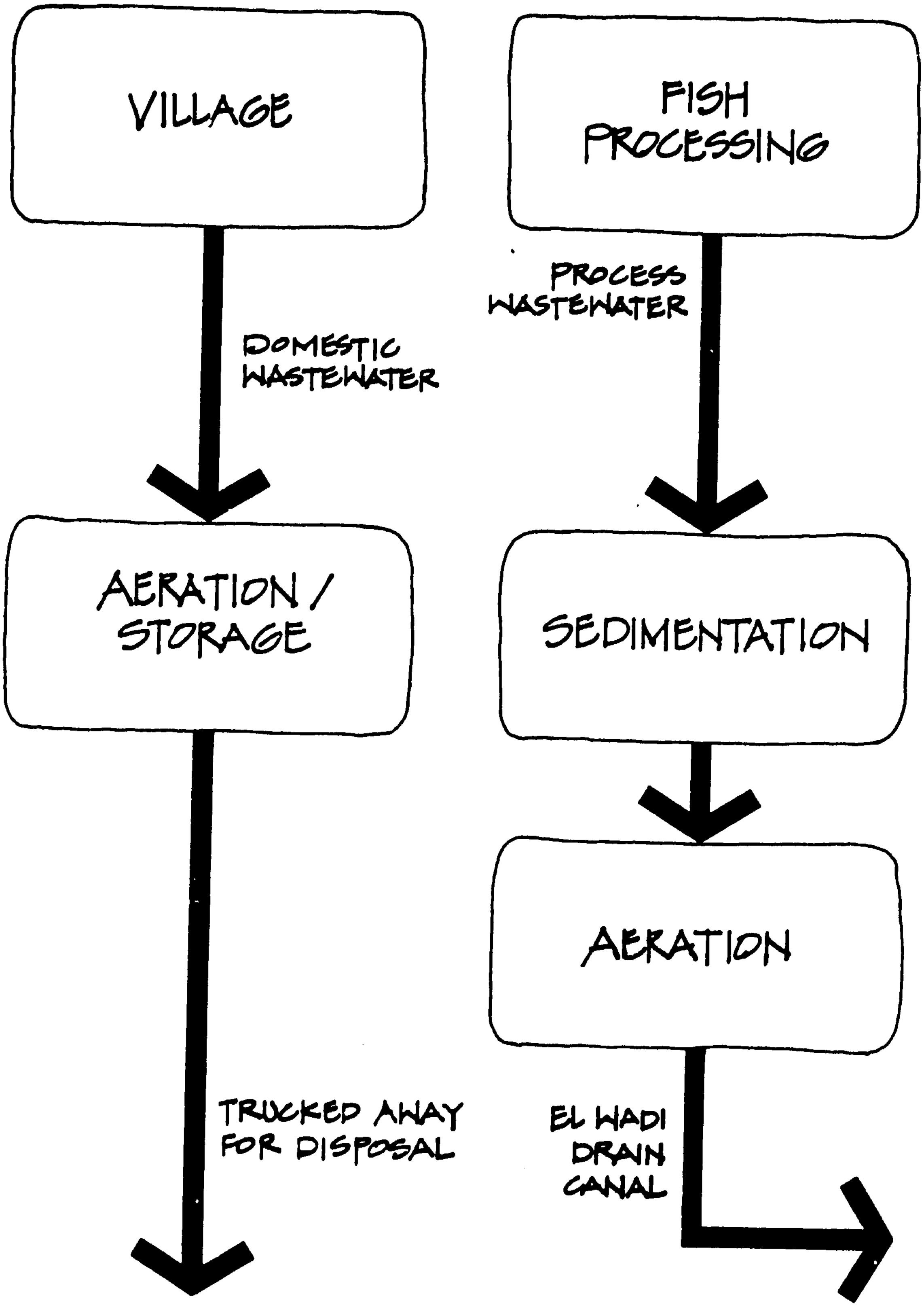
5.2 RECOMMENDED HVAC SYSTEMS

5.2.1 Ventilating System

The only ventilation needed at the MHC will be for the office at the fish processing facility. This will probably consist of a roof-mounted centrifugal exhauster with sufficient capacity to provide eight air changes per hour.



MHC Figure 5.1
Water Flow Diagram



MHC Figure 5.2
Domestic and Process Wastewater Treatment System

5.2.2 Refrigeration System

Refrigeration units will be needed to make ice from potable water. The ice will be used for packing the fish to preserve freshness.

Two or more factory-assembled, complete-package ice-making machines with a capacity to produce a total of 18 tonnes of flake ice per day will be required. These machines will require approximately 5 hp load each and will be interlocked with the standby generator. This interlock will enable the machines to produce and provide ice even during power outages in order to prevent the loss of fish due to spoilage.

The ice-making machines will be either water- or air-cooled and have motors suitable for local voltages and frequencies.

5.2.3 Design/Code Standards

Design/code standards described in NAC 6.2.5 will apply also at the MHC.

5.2.4 State of the Art

The state of the art discussed in NAC Section 6.2.6 will also apply at the MHC.

5.3 RECOMMENDED ELECTRICAL SYSTEMS

5.3.1 Lighting System

Lighting at this facility will be the same as for the NAC. Lighting in residential units will be standard incandescent fixtures.

5.3.2 Power System

The power distribution and utilization system for this area will be designed essentially as described for the NAC. Residential units will be supplied by means of an overhead line and pole-mounted transformers. Secondary service to each unit will be standard 220-volt, single-phase. Each residence unit will be equipped with one circuit-breaker-type lighting and distribution panel. Emergency power, as described for the NAC, will be provided for the fish processing facility but not for the individual residential units.

5.3.3 Communications Systems

A conventional telephone system, designed on the basis described for the NAC, will be installed in the fish processing facility.

5.3.4 Ice Monitor/Alarm System

Alarms will be provided in all wet wells and storage facilities, as described for the NAC. In addition, alarms will be provided on the ice-making equipment itself to indicate motor trip or other malfunctions.

5.3.5 Design/Code Standards

Design and code standards will be those described for the NAC.

5.3.6 State of the Art

The state of the art envisaged for this facility will be the level described in NAC.

5.3.7 Other Considerations

The parameters discussed for the NAC will apply to this site as well, where applicable.

5.4 RECOMMENDED CIVIL SYSTEMS

This section of the report is devoted principally to the description of site grading and open-channel water distribution and drainage systems for the outdoor pond areas. Grading will consider energy conservation, economy of construction, and protection from flooding. Water system considerations include:

- Peak transmission rates
- Quality
- Energy conservation
- Operation and maintenance requirements

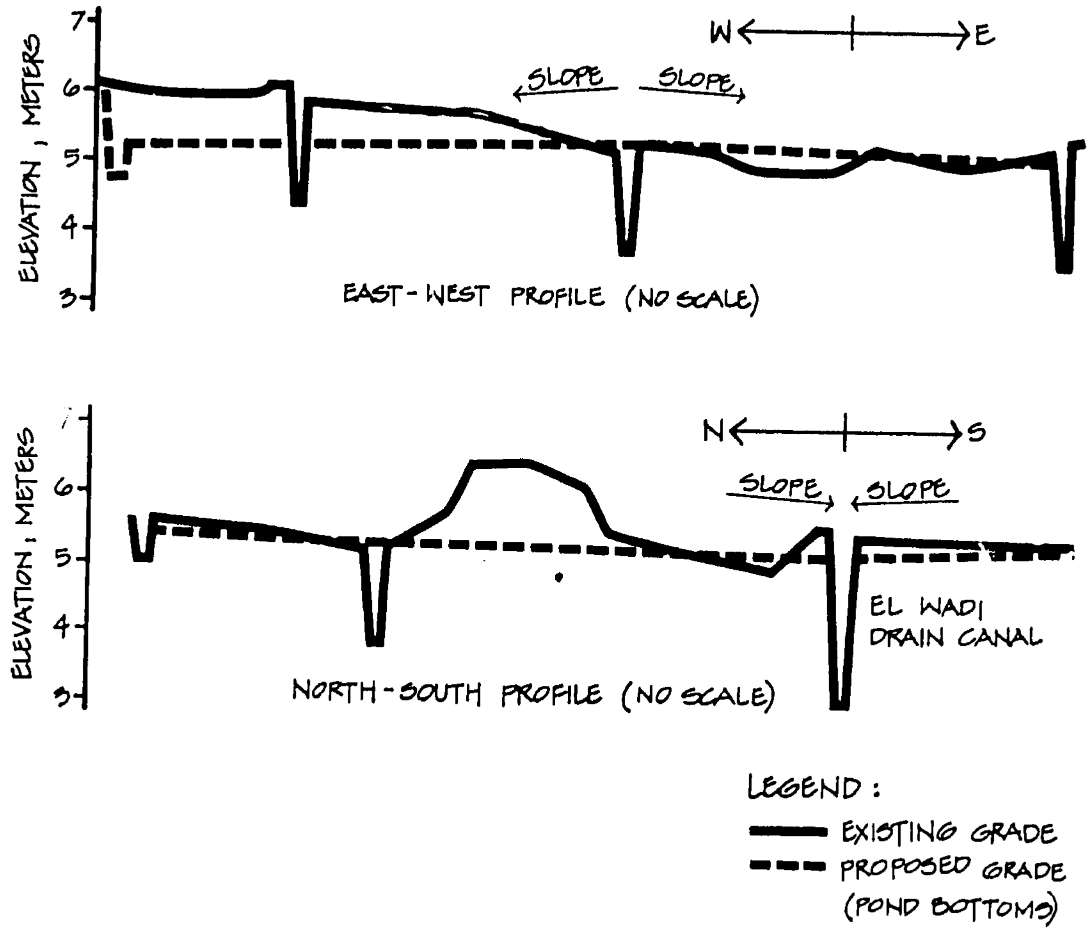
Preliminary construction cost estimates for the systems described in this section are summarized in MHC Chapter 6 and detailed further in Appendix B.

It must be emphasized that the following descriptions are for conceptual schemes which will either be refined or modified and possibly changed during design development. The conceptual schemes, however, provide a basis for planning and for the preliminary cost estimate.

5.4.1 Site Grading

Grading of the site will be such that both the water distribution system and the drainage system will operate totally by gravity. The proposed grading scheme partly illustrated in MHC Figure 5.3 will also result in a nearly-balanced cut and fill requirement, thus minimizing construction costs. The area where the village complex is to be located will be elevated 0.25 m above the maximum expected water level in the drainage system.

The generous dimensions of the drainage system combined with the slightly elevated siting of buildings will ensure the prevention of flooding. This concept, however, is based on the assumption that the El Wadi main drain will be cleaned out to at least the design conditions shown in the Irrigation Engineering Report and/or that additional pumping be provided at El Qassasim pump station. This topic is discussed further in MHC Section 5.4.6.



MHC Figure 5.3
Site Grading

The quantities of excavation and fill listed in Appendix B for the MHC site grading are based on 3:1 side slopes for all earthen ponds and water-carrying canals. These relatively flat slopes do increase excavation and fill requirements, but should reduce maintenance needs and improve water quality by preventing embankment failures during the normally saturated soil conditions encountered.

Care must be exercised during final grading of all pond and canal systems in order to seal all areas which expose sand. This can be accomplished through extra excavation and replacement with suitable clay or silty soils.

5.4.2 Paving

The main collector system of roads which connect the farm modules will be paved in crushed stone; all roads within the farm modules will be constructed of compacted earth. The compaction and thickness of crushed stone base will vary based on the largest weight class of vehicles expected to travel on the surfaces. Footpaths atop the pond embankments will not be paved nor are they expected to require soil stabilization measures such as crushed stone. Concrete sidewalks will not be provided at the village complex.

5.4.3 Process Water Intakes

The water requirements for the outdoor ponds at the MHC site will be supplied from two existing irrigation canals: El Wadi El Quadim canal which flows from west to east a few hundred meters to the north of the village complex, and El Gabbal canal which flows in the same direction about 700 m to the south of the site. Both canals originate at the Ismailia main carrier canal a few kilometers to the west. Two separate water sources will be utilized because the site is bisected from east to west by El Wadi drain canal which will constitute the main drainage way for both the MHC and NAC sites.

El Wadi El Quadim canal will supply a peak water requirement of about 100,000 l/min to 56 home farm units located to the north of El Wadi drain canal. The remaining 23 home farm units will be supplied at a peak rate of about 42,000 l/min from El Gabbal canal. Such peak water demands are expected to occur during the month of July and would last about two weeks. Continuous total demands of about 100,000 l/min have been estimated for most months of each year when the full complex becomes operational.

The inlet works for each supply canal are shown on MHC Figure 5.4 and include sedimentation basins and aeration basins. The amount of suspended material in the water can be greatly reduced by 10 minutes of detention according to available data. The sedimentation basin dimensions will provide such detention during peak demand conditions and will thus reduce maintenance of the canals. Aeration may be required to ensure that water entering the ponds contains adequate levels of dissolved oxygen. From the limited data available it is unsure if nighttime dissolved oxygen levels are even close to those reported (and assumed taken during daytime). Nighttime pond dissolved oxygen levels are critical.

Filtration will not be provided because the volumes of water are too great to be filtered economically. The main objective is to remove fish

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eggs and aquatic animals and debris from the supply water. This can be accomplished effectively by screening at the pond inlets because a great portion of this material will exceed 3 mm in minimum dimension. Because filtration will not be provided, pumping will not be necessary and the water distribution system will operate by gravity as long as the minimum supply canal water surface elevations shown on MHC Figure 5.5 can be maintained.

It must be noted that the combined NAC and MHC peak demands on the El Wadi El Quadim irrigation canal would be about 2.49 m^3/sec. This maximum demand represents about 65 percent of the maximum discharge capacity of the canal which is 3.76 m^3/sec. In addition, Section 10.1 of the Irrigation Engineering Report indicates that the maximum demand for existing irrigation requirements is about 2.2 m^3/sec which indicates a possible maximum deficit of about 0.93 m^3/sec. It is believed that this deficit can be reduced or eliminated by constructing either a weir or other channel constriction immediately downstream of the MHC inlet in order to slightly elevate the hydraulic profile upstream. This may or may not require raising of the upstream channel berms which will be determined during design development. No modifications to the inlet from the Ismailia main carrier canal were assumed in the cost estimate.

For El Gabbal canal, the MHC peak requirements of 0.7 m^3/sec when combined with the maximum irrigation requirements of about 2.0 m^3/sec (see Section 10.1 of the Irrigation Engineering Report) exceed the maximum design discharge capacity of the canal by about 0.9 m^3/sec. Some modifications to the canal, including raising the crest level of the existing weir immediately downstream of the proposed intake, will therefore be necessary and are included in the cost estimate. Modifications to the inlet from the Ismailia main carrier canal are not believed necessary, however.

The present irrigation rotations of four to five days of high flows followed by six to ten days of low flows are not compatible with operation of the MHC and will require review of projected demands by the Ministry of Irrigation before the full project described herein proceeds to schematic design.

If the present rules for irrigation rotations on the El Wadi El Quadim canal to allow for continuous water flow remain, the following alternatives must be explored:

- Provide project water requirements directly from the main Ismailia canal to the site via private intakes and conduits.
- Provide project water requirements through modifications to the existing intakes and canals without interferring with the agricultural irrigation rotations.

The above alternatives would also require the approval of the Ministry of Irrigation (MOI) and would increase the total project cost.

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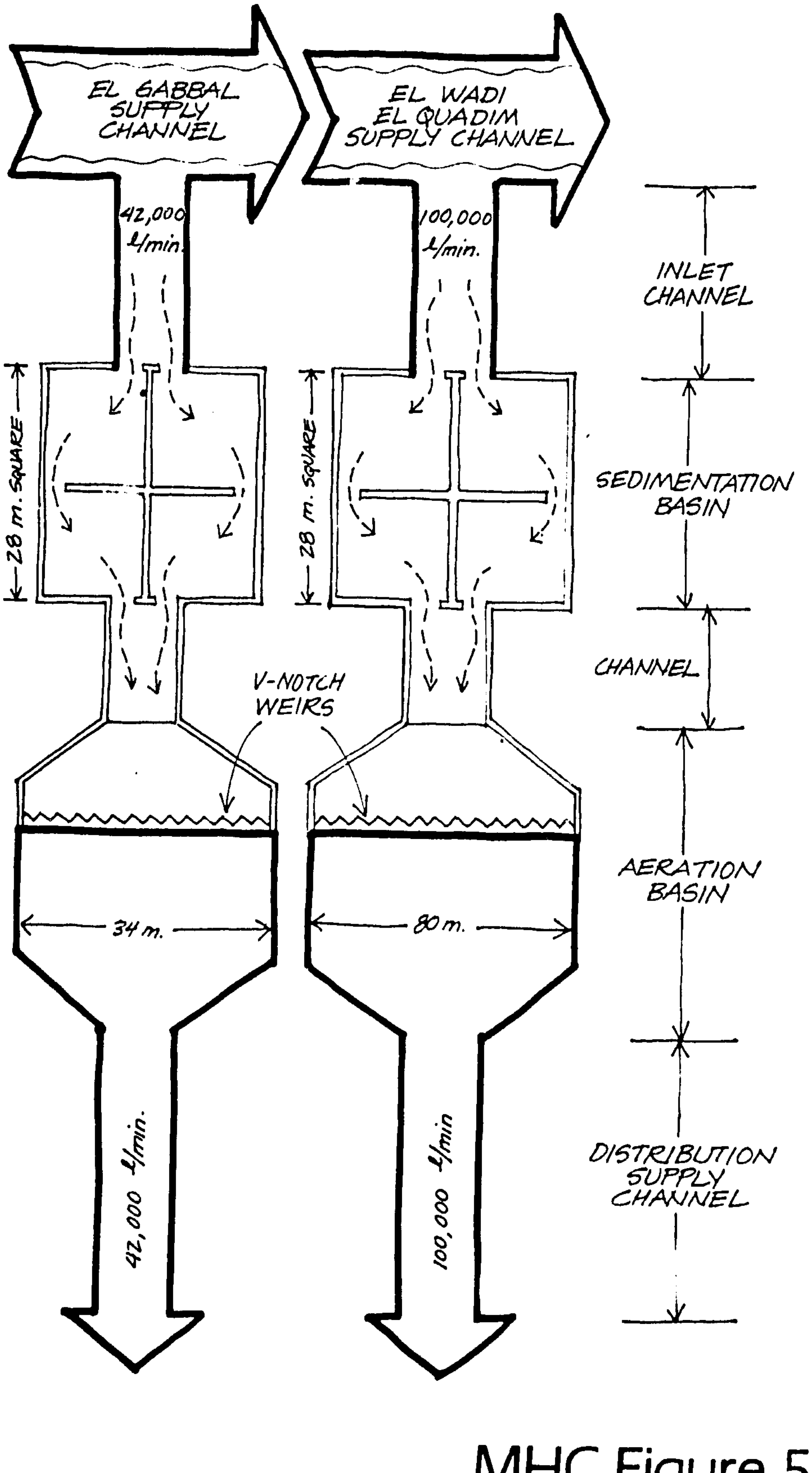

MHC Figure 5.4
Inlet Works Diagram

5.4.4 Hydraulic Profiles

Site grading will enable water distribution and drainage by gravity throughout the system. MHC Figure 5.5 is a simplified representation of the hydraulic profiles of the water supply and drainage systems for the outdoor ponds. The profiles assume a minimum water surface elevation (WS el) of 7.5 m at the El Wadi El Quadim supply canal and 7.8 m at El Gabbal supply canal. The maximum WS el at the El Wadi Drain is assumed to be 5.0 m.

Water from the supply canals will flow by gravity through the inlet channels, into the baffled sedimentation basins, and through the operation basins and distribution supply channels. Two sedimentation basins will be provided at each intake so that while one is being used, the other can be cleaned and settled material can be removed.

5.4.5 Water Distribution System

Water will flow by gravity from the main distribution canals to the lateral canals feeding the numerous outdoor ponds as shown in Figure MHC 5.6. Water flow rate into the ponds will be controlled by manually operated sluice gates on the channel side of the inlets to the ponds. The inlets will be suitably screened to prevent the escape of fish and entry of organisms and will transmit water to the ponds by means of a buried pipe and available head between the water distribution canals and the ponds. A total of 17,000 m of water distribution canals with bottom widths ranging from 0.5 m to 1.0 m will be constructed. The side slopes of all earthen ponds and canals will be 3:1 and will have vegetative cover for soil stabilization.

Inlets will be provided along the eastern bank of the adjoining main NAC distribution canal to provide water to nine MHC ponds. Water depth in the distribution canals will range from 1.1 m to 1.2 m and will be controlled by gates located at the inlets and outlets to the sedimentation basins.

5.4.6 Drainage System

Discharge water from the outdoor ponds and other drainage will be conveyed by gravity to El Wadi drain canal by a system of drainage ditches as represented by the dashed system on MHC Figure 5.6. A total of 19,300 m of drainage ditches ranging in bottom width from 0.5 m to 11.0 m will be constructed within the site. A portion of this system will also serve the NAC and government fish farms.

The peak discharge from the MHC and government fish farms has been estimated to be about 6.08 m^3/sec. When this is combined with the estimated 1.08 m^3/sec peak discharge from the NAC, it becomes evident that the El Wadi drain, whose original peak design capacity was about 7 m^3/sec, will require extensive channel modifications and/or increased pumping capacity at its discharge into El Mahsama main drain (El Qassasim pump station).

Available cross-sectional data of El Wadi drain indicate that it is presently in serious need of maintenance as it is badly silted and overgrown with vegetation in the vicinity of the project. Reported occurrences of

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localized flooding at El Abbasa confirm that the channel, in its existing condition, can only transmit a fraction of its original design discharge capacity. Additional drainage duty imposed by the proposed projects can only result in more frequent and prolonged flooding unless a major rehabilitation project is first undertaken.

If rehabilitation of El Wadi drain is not carried out by the responsible agency, then an earthen perimeter dike should be constructed as necessary to protect the site from outside flooding and provide discharge pump stations to pump out all drainage flows when the water level in El Wadi drain exceeds elevation 5.0 m.

5.4.7 El Abbasa Way Road (AWR)

Refer to NAC Section 6.4.7, for a discussion of the AWR.

The existing bridge across El Ismailia canal has a load rating of 5 tonnes and reportedly will be replaced with a structure of higher load rating. This will be crucial to the project as the expected weight class of vehicles servicing the sites will be about 12 tonnes. Construction equipment weighing upwards of 20 tonnes may be employed and will require a separate logistics solution.

5.4.8 Design/Code Standards

The only portion of the recommended civil systems discussed in this section that will incorporate design standards will be the road work. The APWA standards will be adopted for this work for both onsite requirements and AWR access.

5.4.9 Other Considerations

Continuous monitoring of water surface elevations both upstream and downstream of the inlet works must be provided to prevent large fluctuations in distribution channel water levels which could impair the effectiveness of the gravity feed system.

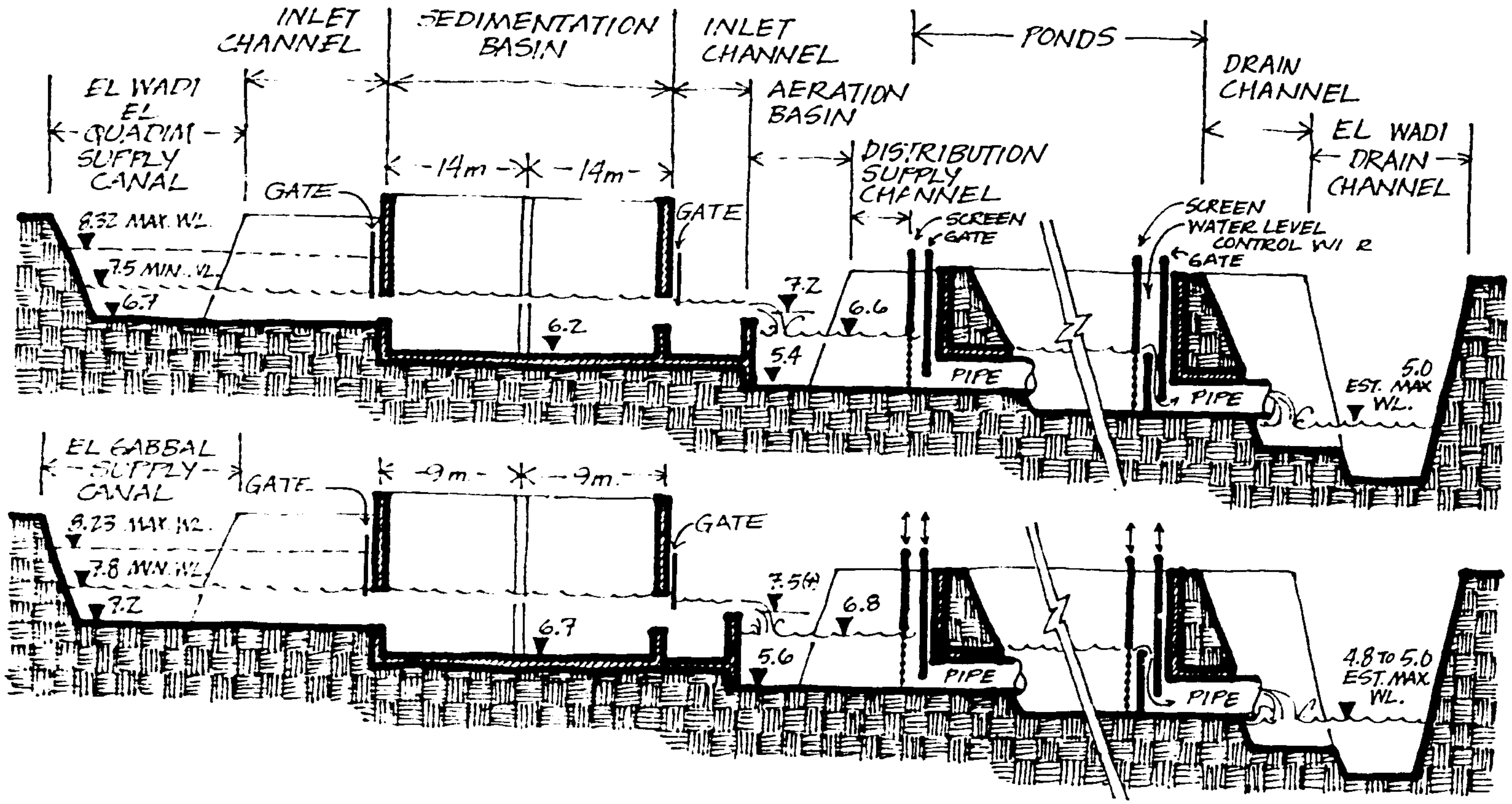
5.5 STRUCTURAL SYSTEM

5.5.1 Loads

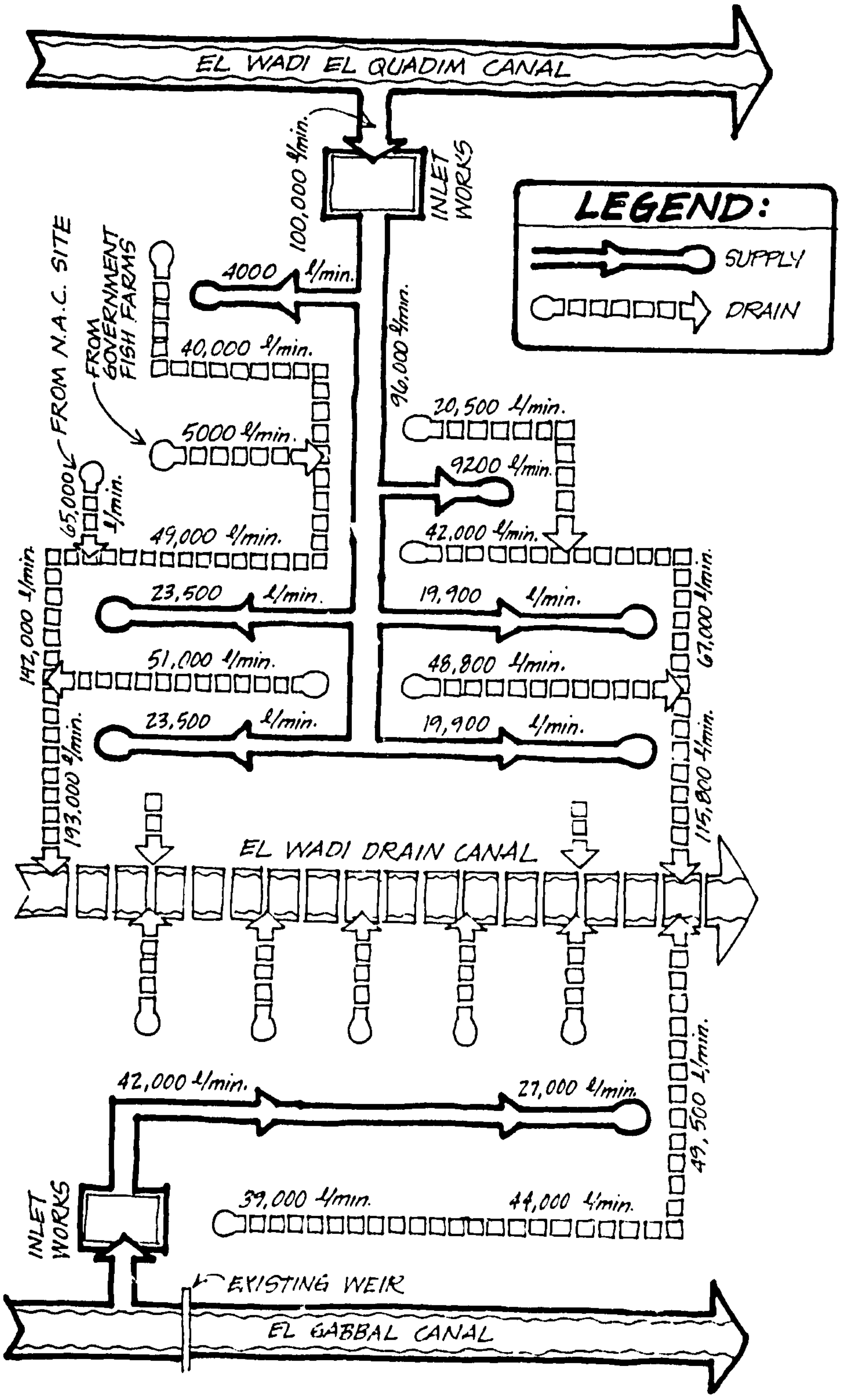
The design loads for the MHC Fish Processing Facility will be determined in the manner discussed in NAC Section 6.5.1.

5.5.2 Building Materials

Cast-in-place (CIP), reinforced concrete is the recommended building material for construction of structural members of the MHC fish processing facility. Red brick or hollow concrete block is the recommended material for exterior wall construction. See NAC Section 6.5.2 for a discussion of these building materials.



MHC Figure 5.5
Hydraulic Profile



MHC Figure 5.6
Flow Diagram

5.5.3 Foundations

The building foundations for the MHC fish processing facility may be either isolated spread footings or continuous footings as described in NAC Section 6.5.3. The final selection will be made after receipt of the results of soil tests performed at this site.

5.5.4 Building Framing System

A CIP, reinforced concrete frame with masonry infill walls is the recommended structural system for the MHC fish processing facility. A description of this framing system can be found in NAC Section 6.5.4.

5.5.5 Design Criteria

The design criteria for the MHC fish processing facility are much the same as those for the NAC, although a greater emphasis will be placed on functional characteristics. See NAC Section 6.5.5 for a description of these design criteria.

MODEL HOMESTEAD COMPLEX
CHAPTER 6
ESTIMATED COST OF CONSTRUCTION - SUMMARY

6.1 BASIS OF COST ESTIMATE

The conceptual construction cost estimate for the Model Homestead Complex (MHC) is based on the concept design criteria researched and developed for this project as described herein as well as the currently understood project site conditions and limitations. All material, labor, and equipment costs are based on the joint professional knowledge and related construction experience for similar projects by the design team for both home and abroad.

Wherever possible, construction costs are based on native construction materials and current Egyptian construction practices. Construction is to be performed by local contractors. The cost of all American (U.S.A.) made material and equipment used in this cost estimate includes all expected handling and freight charges, F.O.B. Alexandria, Egypt, but does not include any United States export duties which may be levied against such goods.

All construction costs are shown in U.S. dollars as of February 1980, escalated to the projected mid-point of project construction (see MHC Figure 6.1).

6.2 SCOPE OF WORK

The proposed project budget covers all work necessary to construct the MHC at El Abbasa; including the fish processing facility, MHC housing facilities, MHC support sheds, and all associated work including all site mechanical, electrical, and civil work as described herein within the limits of the proposed site boundaries.

Also included is work associated with El Abbasa Way Road (AWR) from the bridge at El Ismailia Canal, through the National Aquaculture Center to and including the MHC as described herein. It is important to note the project limits for the canal water portion of work is defined by the water intake and drain interface with the public canal. In no case does the cost estimate reflect an expenditure for any work in the public canal.

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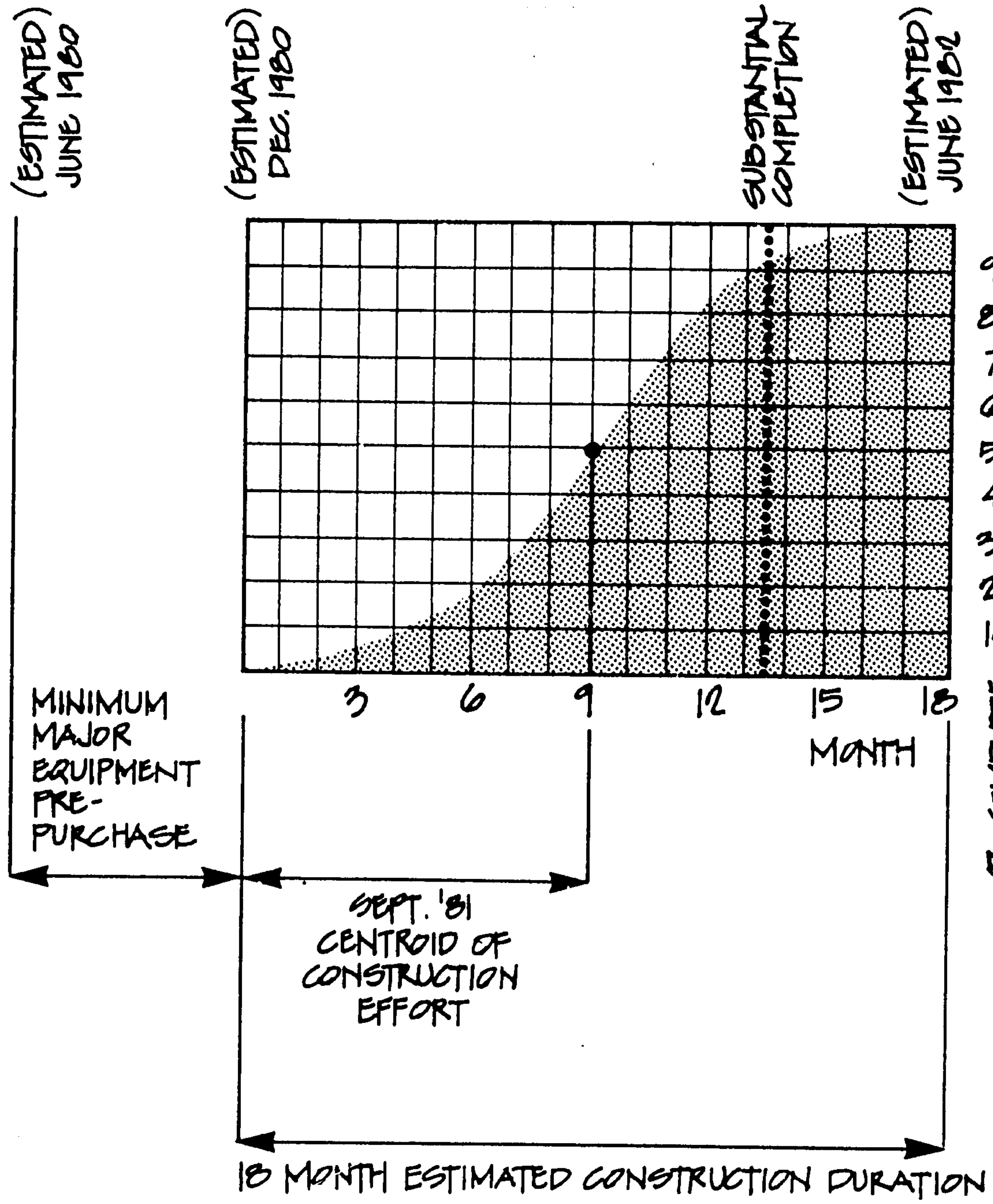
6.3 COST SUMMARY

6.3.1	Site Work	US $ 8,196,000
6.3.2	MHC Fish Processing Facility	55,000
6.3.3	MHC Housing	907,000
6.3.4	MHC Support Buildings	368,600
6.3.5	Cost Factors and Assumptions @ 10%	952,660
6.3.6	Construction Cost - Subtotal	US $10,479,260
6.3.7	Overhead and Profit @ 20% of Line 6.3.6	2,095,852
6.3.8	Mobilization @ 5% of Line 6.3.6	523,963
6.3.9	Remoteness @ 5% of Line 6.3.6	523,963
6.3.10	Construction Cost - Total (February 1980)	US $13,623,038
6.3.11	Contingencies @ 15% of Line 6.3.10	2,043,456
6.3.12	MHC Project Subtotal (February 1980)	US $15,666,494
6.3.13	Escalation to September 1981 @ 38% of Line 6.3.12	5,953,268
6.3.14	MHC Project Total Projected Cost	US $21,619,762
6.3.15	MHC Project Total Projected Cost Rounded	**US $21,620,000**



ALL COSTS ARE BASED ON A
PROJECTED MID-POINT OF CONSTRUCTION, SEPT. '81

MHC Figure 6.1
Construction Timetable Diagram

SEROW FISH HATCHERY

SEROW FISH HATCHERY
(SFH)

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SFH TABLE OF CONTENTS (Continued)

SFH TABLE OF CONTENTS (Continued)

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SEROW FISH HATCHERY
CHAPTER 1
GENERAL PROJECT PROFILE

1.1 PURPOSE AND FUNCTION

Egypt has developed plans to increase its inland fish pond area to more than 50,000 feddans. Such an effort will require an increase in seed-producing facilities and the upgrading of some existing facilities to make them compatible with new aquaculture technologies. In keeping with these goals, the Ministry of Agriculture (MOA) plans an expansion and modification of the Institute of Oceanography and Fisheries (IOF) carp hatchery at Serow. The primary purpose of the Serow Fish Hatchery (SFH) is to provide carp seed for Egypt's aquaculture projects, particularly in the Serow region. During the off-season, SFH facilities may be used to conduct applied research on fish spawning and rearing of other species.

Current carp fry production at Serow is about 1.5 million annually, but with the planned improvements, the SFH is expected to produce 15 million carp fry annually in two spawning cycles. Fry will be produced in outdoor kakaban spawning ponds and indoors in an intensively-operated carp hatchery. Carp will be raised to 2-g fry in 30 to 40 days and then distributed to private farms for further growth in fingerling and grow-out ponds.

Site development at Serow will rely heavily on the use of existing earthen ponds, water distribution systems, and existing buildings.

1.2 ADMINISTRATIVE PROFILE

The SFH is currently owned and operated by the IOF. There will be close administrative ties between SFH and the NAC to ensure carp production at these two facilities are coordinated with annual demand.

1.3 EXPERIMENTAL/RESEARCH PROFILE

The primary function of the SFH is the production of carp seed for fish farms. During off-season periods and when there is no conflict of activities during the spawning season, directed research may be conducted using SFH facilities. Research areas might include spawning and rearing techniques as well as nutritional considerations.

1.4 EXTENSION SERVICES PROFILE

The SFH may function as an extension services office for NAC personnel on either a full-time or intermittent basis. As such, the SFH may be able to help local fish farmers with problems they may encounter and with the application of fish farming innovations or improvement in aquaculture technologies.

1.5 PRODUCTION PROFILE

The SFH is expected to produce 15 million 2-g carp fry annually. This will be accomplished in successive spawning cycles from late spring through early summer of each year. Of this production, approximately one third, or 5 million fry, will be spawned and reared in the intensive culture conditions of a hatchery facility. The remaining two thirds, or 10 million fry, will be produced in outdoor kakaban-type spawning ponds and reared in extensive earthen rearing ponds. Two-g carp fry will be distributed to local fish farmers for further growth.

1.6 SUPPORT PROFILE

It is expected that much of the regular maintenance required for the SFH facilities and equipment will be done onsite by the state. To facilitate this, a garage with shop space is necessary.

1.7 FEED PROFILE

The extensive rearing ponds, donor pond, recovery pond, and segregation ponds will require certain nutrient inputs to support fish growth or development as planned. Nutrients will be supplied in the form of cereal wastes and animal waste fertilizers which will stimulate the natural biogrowth in the ponds. The biogrowth, in turn, will supply most of the required fish food. Nutrient input will be supplemented manually in the form of a direct high-protein food ration for growing carp fry.

1.8 HOUSING PROFILE

Existing IOF housing at the SFH site should be sufficient for staff housing. No housing assignments have been made at this time and no additional housing is planned.

1.9 STAFFING PROFILE

The SFH will be staffed by 14 persons employed in three capacities. Two senior staff members will be responsible for activities and programs at the SFH. They will direct the efforts of 4 technically qualified support staff members who will perform much of the normal hatchery and pond management operations. The professional staff will be supported by 8 laborers who will also serve as security personnel for SFH facilities and fish stocks.

SEROW FISH HATCHERY
CHAPTER 2
BIOLOGICAL PROCESS DESIGN

2.1 CARP PRODUCTION PROGRAM

2.1.1 Production Goals

The major function of the fish hatchery is to produce 15 million 2-g carp fry annually for distribution to regional fish farms. Since 2-g fry are too small to be stocked directly into grow-out ponds, some fry will be reared to 40-g stocking size for those farms which have no facilities for fingerling production.

2.1.2 Production Techniques and Facilities

The maximum annual production of carp fry will be 15 million at 2 g each. It is anticipated that these will be produced in two to three cycles during the spring and early summer of each year. Two methods of production will be used: (1) induced spawning with intensive rearing and (2) natural spawning with extensive rearing. Approximately one third of the total production will be from intensive culture and the remainder from extensive culture. Each method is detailed on the following pages. In addition to the production facilities described, a general wet and dry laboratory for routine monitoring analyses and six quarantine outdoor ponds are required.

2.1.2.1 INDUCED SPAWNING/INTENSIVE REARING

The methodology used under this type of production is as follows:

- Brood selected from segregation pond
- Brood placed in breeding tanks
- Brood injected with pituitary from carp in donor pond
- Brood manually spawned and returned to recovery pond
- Eggs placed in Zuger jars for incubation
- Newly hatched fry placed in fry holding tanks
- Button-up fry placed in intensive rearing ponds for three to four weeks until 2 g

The entire hatchery process is estimated to require an average of eight days. A maximum of four females can be spawned on any day. Incubation and fry holding tanks have been provided to accommodate the logistical needs resulting from spawning four females per day. The estimated survival rate from egg to swim-up fry is 90 percent.

The hatchery facilities are shown in SFH Table 2.1. The summary of the criteria for sizing the intensive rearing ponds are shown in SFH Table 2.2.

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SFH TABLE 2.1
SUMMARY OF HATCHERY FACILITIES

	Minimum Number Required	Recommended
Hypophysation tank (5 m^2)	1	2
Spawning tanks	4	6
Zuger jars	18	30
Fry holding tanks (100 liters)	6	10

SFH TABLE 2.2
SUMMARY OF INTENSIVE REARING CRITERIA

No. of 2 g fry required	4,800,000
Survival from hatchery to harvest (%)	25
Total fry required from hatchery	19,200,000
No. of crops	3
Fry required per crop	6,400,000
Area per pond (m^2)	500
Fry stocking density per pond	250,000
No. of ponds	26
Total surface area (feddans)	3

2.1.2.2 NATURAL SPAWNING/EXTENSIVE FRY PRODUCTION

Eggs required for extensive pond fry production will be supplied from natural spawning ponds containing kakabans. One female of at least 3 kg and one to three males will be stocked in each pond. Although it is normal for spawning to be completed within 24 hours after stocking, a maximum of five days before restocking has been allowed in the production programming. After spawning, the egg laden kakabans are placed in the prepared extensive ponds at a stocking rate of 600 eggs per square meter. A 15 percent survival rate to a size of 2 g (30 days old) is estimated. SFH Tables 2.3 and 2.4 summarize extensive spawning and rearing criteria.

SFH TABLE 2.3
SUMMARY OF EXTENSIVE SPAWNING PONDS

No. of eggs required (estimated)	68,000,000
No. of annual cycles (maximum)	12
No. of eggs/pond	300,000
No. of days/cycle	5
Size of ponds (m^2)	25
No. of ponds	20
No. of days in operation	60

SFH TABLE 2.4
SUMMARY OF EXTENSIVE REARING CRITERIA

No. of 2.0 g fry required	10,200,000
Survival from egg to 2.0 g (%)	15
Stocking rate (eggs per m^2)	600
No. of eggs required	68,000,000
No. of annual cycles	2
Surface area required (feddans)	13.5

*Additional existing ponds should be used if available, up to 22.5 feddans.

2.1.2.3 HATCHERY

The hatchery will consist of a spawning room and incubation room. Both will have outside access to accommodate fish transfer. The spawning room will consist of tanks to contain the adult fish, work benches, large sinks, and storage space.

Adjacent to the spawning room will be the incubation room containing racks of Zuger jars and 100-liter larval rearing tanks. Work benches, sinks, and storage space will also be required. A small glass-enclosed office should be located in the spawning room to facilitate record keeping and management of the spawning operation. There should be a doorway connecting the spawning room with the incubation room. Both rooms should be windowless.

2.1.2.4 GENERAL LABORATORY

A general purpose wet laboratory will be provided as part of the SFH. This laboratory should be equipped with a series of ten small (about 50 l) aquaria with air (2 l/sec) and water (25 l/min) available to each tank. A stainless steel sink with wet counter space will be used for post mortem fish examinations. Standard laboratory work counter space is required for histological sectioning and staining as well as bench space for light microscopy. Wall cabinets and shelf space will be necessary for chemical and specimen storage. A standard desk with file cabinet and chair should be included. Water entering the lab for aquarium use should be mechanically filtered to 1 micron and care should be taken that laboratory effluent not come in contact with other water supplies.

2.2 BROODSTOCK

2.2.1 Resources and Facilities

To meet the production goals of the Serow facility, approximately 200 adult carp will have to be handled each year. To ensure the facility staff has a sufficient population from which to select, four ponds of approximately 2.5 feddans each are recommended. Each will accommodate approximately 50 3-kg carp.

The intensive spawning programs will require a supply of carp pituitaries. One 2.5-feddan donor pond yielding a total of 300 donors annually will be provided. Two additional 2.5-feddan ponds will be used to segregate males from females prior to spawning and one 1.3-feddan pond will serve as recovery pond following spawning. In order to reduce the difficulty associated with handling adult carp, all brood facilities should be located together and preferably be proximate to both the intensive and extensive spawning facilities.

2.3 FOOD REQUIREMENTS

2.3.1 Type and Quantities

Larval feeds will be supplied first to swim-up fry on about day three or four after hatching. This first food source will consist of a hard-boiled duck or hen egg yolk homogenized in 100 ml of water. Two milliliters of this suspension will be fed to every 100,000 hatchlings every two hours.

As soon as the hatchlings all begin to feed, as evidenced by a yellow gut coloration due to ingested egg yolk, the hatchlings will be changed to a diet of live food organisms. The live feeds regime is discussed in SFH Section 2.1.2.3 and is maintained for a period of about 10 days or until the fry are capable of ingesting artificial food particles.

First feed recommended is finely milled soy flour or cereal brans dissolved in water. This mixture is dispersed around each rearing pond four times daily at 0.4 kg per feddan per feeding. Throughout the rearing period, it is important that the natural pond productivity is maintained at a high level.

After the first 10 days of feeding the fry must be fed a high protein feed containing 36 percent protein, of which 21 percent is animal protein. Fat content should be about 7 percent. This feed should be fed ad-lib for best results, but it is estimated that the average nursery pond feeding rate at the proposed stocking densities will be about 12 kg of feed per feddan per day. This amounts to about 7,500 kg of feedstuffs per season. Pond and live food culture fertilizers are extra.

Extensive carp nursery ponds will require 625 kg of superphosphate, 50 kg chicken manure, and 150 kg of feed per feddan per 30-day cycle.

Intensive rearing ponds will require the use of inorganic fertilizers in the form of ammonium nitrate and superphosphate. Some manure will also be required to provide a good balance of nutrients in the rearing ponds. The application rate of ammonium nitrate is 500 kg per feddan and superphosphate is 150 kg per feddan per cycle. Manure and feed at 150 kg each per feddan will be needed each of the three cycles as well.

Total fertilizer and feed requirements for the SFH are summarized in SFH Table 2.5. Included in this table are requirements for brood and algal production units.

2.3.2 Methods of Production

Most of the fish food resources consumed will be in the form of natural biogrowth in the ponds. Feedstuffs consumed directly will only constitute a small portion of total nutritional requirements of the fish stocks. The bulk of nutrient input to the ponds will be in the form of fertilizers t stimulate food production through photosynthetic activity and naturally occurring food chains within the pond.

SFH TABLE 2.5
ESTIMATED ANNUAL FERTILIZER REQUIREMENTS (Kg)

Facilities	Chicken manure	Super-phos-phate	Feed	Trace nutrient supplement	Ammonium nitrate
Extensive rearing ponds	1,900	450	1,250	--	--
Intensive rearing ponds	450	450	1,250	--	1,500
Algal culture tanks	--	130	--	--	60
Brood/donor/segregation ponds	1,900	450	1,250	--	--
Total	3,700	17,905	6,550	25	1,560

2.3.3 Facilities Requirements

Bulk storage for 3,700 kg of manure, 17,905 kg of superphosphate, 6,550 kg of feed, and 1,600 kg of ammonium nitrate will accommodate an estimated year's requirements. Smaller drum-type units will suffice for remaining nutrients. Storage bins should be kept dry and free of vermin, particularly the feed stores. Storage facilities should be located close to both the intensive and extensive rearing ponds as well as the intermediate and large-scale algal culture tanks.

2.3.4 Larval Food Production

Larval feeds will be grown in culture for use in rearing the carp through their early larval stages. These organisms will consist of the phytoplankton, Chlorella spp., the rotifer, Brachionis plicatilis, as well as indigenous cladoceran populations of Moina and Daphnia. These larval food organisms will be fed to the larvae beginning on about the fourth day after hatching and one day after first feeding with boiled egg yolk. The fry will be transferred to outdoor ponds as soon as they begin to accept live food. From this point until about day 14, the density of larval food organisms in the intensive rearing ponds will be maintained at constant levels to provide the density of food particles necessary to support the larvae through this critical rearing period. Extensive larval rearing ponds will be seeded with rotifers on day three to promote a vigorous natural bloom. This bloom will be maintained during the larval rearing period through repeated applications of fertilizer.

The larval food organisms used to support the carp larvae will be obtained from a multistage culture system. Small test-tube and flask-type cultures of phytoplankton, such as *Chlorella* spp. and *Nannochloris* spp., will be maintained in a culture room having a closely-controlled environment. Temperature settings within a range of 23 to 27°C plus or minus 1°C are required. Adjustable photoperiod control is also necessary. Water and air supplied to this room should be mechanically filtered to a nominal pore size of 1 micron using a series of cartridge filters. Shelves to hold twelve 16-l glass carboys and twelve 100-l translucent fiberglass cylinders must be supplied with air and cool-white fluorescent tube illumination with a light intensity of 5,000 lux at the culture vessel surface. This room should have minimal traffic, but close access to the large-scale phytoplankton culture area.

Phytoplankton grown in the culture room will be transferred to larger algal culture tanks via centrifugal pumps. This phytoplankton will serve as an inoculum to produce greater quantities of phytoplankton which, in turn, will be used to feed the carp larvae and the zooplankton food components.

Extensive rearing ponds will be seeded with rotifers upon inundation and manuring. Rotifer populations are expected to reach sufficient densities in five to six days to support good growth and survival of carp fry in these ponds. Repeated manurings at 5 kg of manure in solution per feddan are made every two days in the morning hours to maintain zooplankton densities. Cladocerans, such as *Moina* and *Daphnia*, are seeded in the ponds when the carp hatchlings are first stocked. This permits the fry to grow large enough to feed upon these organisms by the time they become numerous.

Carp hatchlings grown in the intensive rearing units will be supplied with five rotifers/ml when they begin feeding. This density will be maintained until the fry can be switched to an artificial diet. Flour or bran particles of 100 to 500 microns diameter will be fed *ad-lib* beginning three to four days after stocking.

Rotifers will be produced in six tanks (12 m by 5.3 m by 1 m deep). These tanks must be able to drain completely and be supplied with aeration. Inocula for these tanks will be produced in three tanks (4 m by 1.5 m by 1 m) that are also aerated and must drain completely. *Chlorella* will be used as food for the rotifers as well as small cultures of cladocerans. Twenty percent of the rotifer culture volume (75 m^3) will be replaced with fresh phytoplankton culture (2 x 10^6 cells/ml) daily to culture rotifer densities of 200 rotifers/ml. *Chlorella* will be cultured in another eight tanks (12 m by 4.7 m by 1 m) using vigorous aeration. Intermediate-scale algal inocula will be produced in four additional tanks (4 m by 1.5 m by 1 m) which will be aerated and must drain completely.

2.4 PROGRAM OPERATION AND SCHEDULING

Spawning and rearing operations at the SFH will peak in late spring and early summer. Most of the production cycles will be completed within a three-month period. Preparation for this activity, however, will require up to three additional months and some activity will continue year-round. This would include the maintenance of broodstocks, algal inocula, rotifer inocula, and any grow-out activities. The SFH operating schedule is summarized in SFH Table 2.6.

2.5 ENVIRONMENTAL REQUIREMENTS

2.5.1 Water Quality

Two types of water will be used at SFH: untreated canal and aerated filtered canal water. Untreated canal water will be used in the outdoor earthen ponds. Proper pond management will be necessary to maintain good quality water in these ponds. A regular monitoring program of all ponds and tanks at the SFH is required to properly maintain water quality. This program should include dissolved oxygen levels, pH, suspended solids as well as periodic microscopic examination of the biota. Much of this monitoring will take place in the general laboratory.

Process water used in larval food production activities and the hatchery will be aerated and filtered to 10 to 20 microns. Cartridge filters to 1 micron will be required for all water used in culturing algal inocula.

2.5.2 Water Temperature

Water temperature in the extensive rearing ponds, and the broodstock and donor ponds will be allowed to come to ambient levels.

To provide flexibility in operation, the capability of heating water from November through February to 24°C is needed for the intensive spawning, incubation, and intensive fry rearing tanks. Calculated demand for process water tempered to 22°C in the hatchery is 150 l/min. This volume will be sufficient to operate the hatchery's breeding tanks, Zuger jars, fry hardening troughs, and the larval food production system at about one-third of total capacity during the winter months. Water and air temperatures for the summer months are presented in SFH Table 2.7. All water should be aerated to 80 percent saturation prior to use.

2.5.3 Flow Rates

Water flow criteria and requirements are summarized in SFH Tables 2.8 and 2.9. In addition, approximately 80 l of potable water per day per full-time staff member will be required.

2.5.4 Emergency Support

Compressed air will be required on a regular basis in the laboratory, larval food production, and hatchery facilities. In the event of water pump failure, compressed air will be supplied to the intensive rearing tanks as well.

SFH TABLE 2.6
TYPICAL OPERATING SCHEDULE FOR A SINGLE SPAWNING CYCLE*

FACILITY \ MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
induced breeding			preparation of spawning facilities	spawning ■■■	nursing ■■■ >	(30–40 days) ■■■ >	harvest @ 5 g					
intensive rearing units						harvest @ 5 g ■■■ >						
extensive spawning ponds			dry	kakaban ■■■	■■■ >							
extensive nursery ponds			dry	manure, fill, inoc. cladocerans & rotifers, Dipterex	manure, supplemental feeding	■■■ >						
brood ponds	sort breeders and segregate ■■■	■■■ >	supplemental feeding	■■■	■■■ >	drain all but brood ponds	■■■	■■■	■■■	■■■	■■■	■■■ >
culture room	scale up production ■■■	■■■	■■■	■■■	■■■	scale down production ■■■	■■■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■ >
medium-size algae tanks		inoculate ■■■	■■■	■■■	■■■	■■■ >						
large algae tanks		inoculate ■■■	■■■	■■■	■■■	■■■ >						
rotifer inoculation		inoculate ■■■	■■■	■■■	■■■ >							
rotifer production		inoculate	■■■	add to nursing ponds ■■■	■■■ >							
cladoceran production	inoculate ■■■	■■■	■■■	■■■	add to nursing ponds ■■■	■■■ >						

*There are 12 cycles per year

SFH TABLE 2.7

MAXIMUM, MINIMUM, AND BIMONTHLY AVERAGES OF AIR AND WATER TEMPERATURE OF THE NAVIGATION CANAL DURING THE PERIOD OF STUDY IN 1974

(ALL MEASUREMENTS WERE TAKEN AT 1:00 P.M.)

Period	Air Temperature °C			Water Temperature °C		
	Average	Maximum	Minimum	Average	Maximum	Minimum
April	22.6	24	21	24.4	25	24
1 - 15/5	23.9	25	22.5	24.9	26	23
16 - 31/5	27.0	33	24	28.4	31	26
1 - 15/6	29	30	27	31.1	32.5	30
16 - 30/6	30	33	28.5	30.9	35	29.5
1 - 15/7	31.1	32.5	30	32.1	34	31
16 - 31/7	31.25	34	30	32.5	34	31
1 - 15/8	31.3	34	30	31.3	32.5	30
16 - 31/8	32.8	34	31	32.5	32	29
1 - 15/9	30.7	32	29.5	28.8	30.5	28
16 - 30/9	29.9	33	27.5	26.5	30.5	25.5

Source: Dr. M. M. Ishak; data contained in a letter to KCM outlining information obtained at the Institute of Oceanography and Fisheries; Cairo, Egypt.

SFH TABLE 2.8
SUMMARY OF WATER SUPPLY CRITERIA

Extensive ponds	110 l/min/feddan
Incubation jars	2 l/min/jar
Breeding tanks	15 l/min/tank
Natural spawning ponds	15 l/min/pond
Intensive,fry rearing ponds	25 l/min/pond or tank
Fry swim up troughs and jars	5 l/min/50 liter vol.

SFH TABLE 2.9
OPERATING WATER REQUIREMENT SUMMARY
(LITERS/MINUTE)

Species/Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Zuger Jars	60	60			60	60						60
Breeding Tanks	120	120			120	120						120
Fry Holding Tanks	60	60			60	60						60
Intensive Rearing Ponds	650	650	650		650	650	650					650
Spawning Ponds					300	300						
Extensive Rearing Ponds					2,475	2,475	2,475					
Brood Holding	1,100	1,100	1,100	1,100	1,100	1,100	1,100	1,100	1,100	1,100	1,100	1,100
Donor Pond	275	275	275	275	275	275	275	275	275	275	275	275
Segregation Pond	550	550			550	550						550
Recovery Pond	140	140			140	140						140
Quarantine Ponds	125	125	125	125	125	125	125	125	125	125	125	125
Larval Feed Room	60	60	60	60	60	60	60	60	60	60	60	60
Larval Feed Tanks	350	350	350	350	350	350	350					350
TOTAL	3,490	3,490	2,560	1,910	6,265	6,265	5,035	1,560	1,560	1,560	1,560	3,490

2.6 EXPANSION REQUIREMENTS

There is sufficient land beyond the extensive rearing pond area to double the capacity of the SFH. Also, adjacent to the planned hatchery building is space to expand the hatchery to stock this expanded rearing area. Water supply and drain limitations may, however, limit expansion plans.

2.7 TRANSPORTATION

2.7.1 Intersite

Supplies and fish transport between the SFH and other locations will be carried on surface road by truck. Good quality routes will be necessary to transport carp fry to outlying ponds within a safe transport time.

2.7.2 Intrasite

Transportation of supplies and fish stocks within the SFH will require surface roads connecting the hatchery building with the tanks and ponds at the SFH. Each pond must have truck access to at least one side. It is expected that at least two trucks capable of carrying live tanks will be necessary to support the activities of the SFH.

SEROW FISH HATCHERY
CHAPTER 3
PROJECT SITE

3.1 EXISTING ENVIRONMENTAL CONDITIONS

The Serow Fish Hatchery (SFH) is situated near Lake Manzala, approximately 165 km northeast of Cairo, Egypt, and 45 km northeast of Mansura, the capital of the Governorate of Daqahliah. The site is also 15 km south of Damietta and 10 km from the village of Serow.

The preliminary design review and site analysis indicate that there will be no significant environmental impacts from this project. This conclusion is from a relatively cursory review as no detailed environmental impact assessment has been made.

3.1.1 Climatic Conditions

The Serow site is located in a relatively arid climate tempered by the water masses of Lake Manzala and the Mediterranean Sea. Irrigation water is delivered to the site by a system of canals which connect the Nile River with Lake Manzala. The site is located on the Serow Canal and is approximately 4,000 meters from the lake (see SFH Figure 3.1).

Rainfall is very light with a mean annual total of 63.6 mm over the last 30 years. The highest monthly mean rainfall is in December at 15.1 mm with the months of June and July showing no rainfall or only a trace. The relative humidity is moderate to moderately high on the site, running from a mean low in June of 55 percent to a mean high in December of 84 percent.

The predominant winter winds at Serow are from the west and north with the predominant summer winds from the northwest off of Lake Manzala and the Mediterranean Sea. The summer winds are important because they provide ventilation when buildings are properly located. The winds are mild with the mean wind speeds varying from 3.7 knots in July to 5.5 knots in March from data kept over the last 30 years.

The temperatures are mild in winter and become quite warm during the summer months. The lowest mean day temperature of 13.3°C is in January with the maximum mean day temperature of 26.4°C in August. The minimum monthly mean temperatures occur in December, January, and February, which are respectively 9.7°C, 7.4°C, and 7.9°C. The maximum monthly mean temperatures occur in June through September and run from 30.4°C to 32.4°C. The coldest temperature recorded on the site since 1927 was 0°C in February of 1958 and the hottest temperature was 46.8°C in June of 1933.

Day length does not vary radically throughout the year because of Egypt's position in relation to the equator. The shortest day lengths occur in February with a monthly total of approximately 215 actual hours of sunlight. The longest day lengths occur in July with a monthly total of 360 actual hours of sunlight.

3.1.2 Topographic Features/Soils

The Serow site is extremely flat with no noticeable change in elevation. The site is currently used for carp production with a natural spawning area and earthen ponds. The greatest elevation change from the bottom of the drain canal to the highest level of land is 5.09 m The surface elevation differs a maximum of 1.66 m on the site.

Detailed soils investigations have not been completed prior to this report, however, preliminary work was done for the project feasibility study. This study indicates that heavy clays exist to depths of at least 2 m. Observation of existing pond banks at Serow indicates that the slopes are highly unstable and are easily eroded by wave action, this would indicate that future slopes should be held to a maximum of 3:1.

3.1.3 Flora/Fauna

The vegetation at the existing hatchery includes trees approximately 20 years of age. A species of long needle pine shades the ponds near the administration building as well as along the drain canal on the south side of the site. The area nearest the administration building and dormitory is shaded by eucalyptus and palm trees, and shrubby deciduous ornamentals also form a hedge around the adjacent yard. Most of the driving and walking surfaces are void of any vegetation while various water grasses and reeds are growing in the shallows along canals and ponds. Most pond banks are too steep to support any vegetation. The cultivated area around the hatchery produces a variety of vegetable crops and cotton.

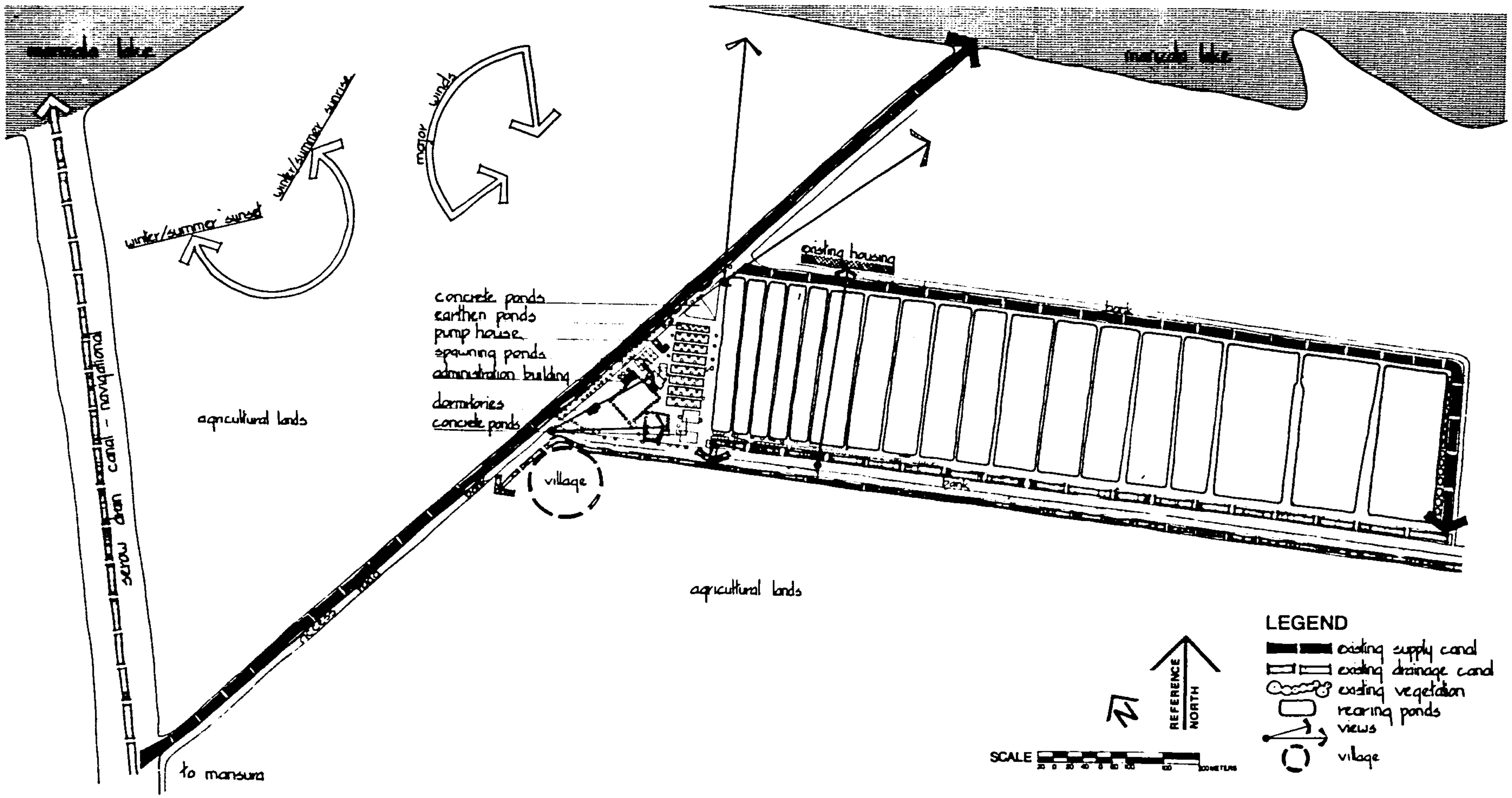
Wildlife is relatively rare on the site with the exception of rodents, songbirds, and waterfowl. Domestic animals include donkeys, goats, camels, cows, chickens and ducks.

3.1.4 Water Supply System

Two water supply systems exist at the site: potable and production. Potable water is limited to a small storage tank which is periodically refilled from an undetermined source. Production water consists of a pumped and an open-channel system. The pumped system draws raw water from the navigation canal and distributes it by pipe to several facilities in and around the hatchery complex. The much larger open-channel distribution system draws water from the navigation channel by means of a gravity fed inlet. This water is transmitted to the ponds by gated inlet structures and conduits through the road berm.

3.1.5 Drainage System

Discharge from the hatchery area is transmitted to the main drain by a network of small ditches. Outflow from the large rearing ponds is by means of gated outlets which discharge directly into the main drain along the southern boundary of the site. All water is then discharged into Rady drain which also serves a large agricultural area. Rady drain flow is eventually pumped into a Serow primary drain which flows into Lake Manzala to the northwest of the site.



SFH Figure 3.1
Site Analysis

3.1.6 Utilities

The existing utilities at the site consist of the rudimentary potable water system described above, a generator-supplied electrical power system, and a septic tank sanitary system.

3.1.7 Other Considerations

The navigation channel adjoining the site is the only source of production water for the existing complex. Its water source is Serow agricultural drain canal which is also the recipient of Rady drain flows. There are indications that this system could result in partial recirculation of Rady drain outflow by way of the navigation canal. The proposed water system is based on this assumption which will be verified before proceeding into the next design stage.

3.2 GENERAL DESIGN CRITERIA

3.2.1 Site Character

The site of the SFH located near Lake Manzala is quite typical of the agricultural lands of the Nile Delta. Elevation changes are almost nonexistent except for the existing ponds at the hatchery.

The existing hatchery is visually dominated by a dense grove of evergreen trees which have been planted around the hatchery building complex and along the south and west ends of the rearing ponds. The buildings at the hatchery are quite typical of local buildings; rectangular in form, made of brick covered with plaster and painted pastel colors. The hatchery is connected to the village at Serow by a narrow dirt road.

3.2.2 Future Expansion

The government currently owns sufficient land on the west end of the existing rearing ponds to double the present capacity. The existing ponds have excess capacity for the program which is defined in SFH Chapter 2, Biological Process Design, and therefore production can be expanded considerably without additional rearing ponds.

Open space will be left adjacent to the hatchery compound to accommodate future expansion of the spawning and intensive rearing ponds.

3.2.3 Flexibility

It is possible that in the future some of the existing ponds can be subdivided to add more flexibility to the site. Existing ponds in the building area that are not required by the program will also be retained. These ponds can be used for research or production which add flexibility to the complex.

3.2.4 Circulation

Basic circulation at Serow will be provided on existing roadways. It may be desirable to provide easy truck access to one side of the hatchery building while locating a pedestrian circulation spine at the opposite side.

3.2.5 Existing Conditions

The existing conditions listed in SFH Section 3.1 are criteria for development of the site and must be considered as parameters. Because the site is already developed as an operating fish hatchery the parameters set by existing conditions are much more rigid and it is necessary to fit new facilities within available space.

3.2.6 Design/Code Standards

Design/Code Standards will be the same as those outlined in NAC Section 3.2.6.

3.2.7 State of the Art

Refer to NAC Section 3.2.7 for the state of the art which will also be represented at SFH.

3.3 SITE DEVELOPMENT PROGRAM AND GUIDELINES

3.3.1 Introduction to Components

In creating a master plan for the site, it is necessary to consider the functional relationship of all the components which make up the SFH as they relate to the existing environment. The most beneficial and functional use of the site can then be achieved. Because there is an existing complex at Serow, the best possible relationships must be accomplished within the structure of the existing facilities.

The project is made up of many components which are discussed in Chapter 2, Biological Process Design. The building functions will be described in detail in the following chapter and will only be discussed as operational units which relate to the other site functions. The major components which make up this complex are categorized as follows:

- Existing administration building
- Hatchery building
- Existing housing
- Existing dormitory
- Food storage building
- Extensive spawning ponds
- Broodstock holding ponds
- Broodstock donor ponds
- Broodstock segregation ponds
- Broodstock recovery ponds
- Intensive rearing tanks
- Extensive rearing ponds
- Rotifer production ponds
- Quarantine ponds
- Septic tank/drainfield
- Parking

In this section, the relationships of all the components will be discussed, as well as illustrated in a matrix that shows diagrammatically the degree of relationship of each specific unit in the components. (See SFH Table 3.1 and SFH Figure 3.2.)

3.3.2 Project Building Component

3.3.2.1. SFH PRODUCTION FACILITY

The major building which will be constructed at Serow will be a production fish hatchery which will be used to produce carp fry. This building will relate directly to the existing administration building which will continue to house administrative offices for the hatchery. A less direct relationship will exist between the new facility and the houses and dormitory which support the, hatchery staff.

The hatchery relates most directly in terms of function to the spawning and broodstock ponds. In the intensive spawning operation, fish are carried from the broodstock segregation ponds to the hatchery for spawning and are then returned to the broodstock recovery ponds. In the extensive spawning operation these broodstock ponds have a similar relation to the extensive spawning ponds.

3.3.2.2 OTHER STRUCTURES

In addition to the hatchery building at Serow, a separate feed storage building will be constructed to store manure, superphosphate, ammonium nitrate, and other smaller quantity food sources in drums. The food from this building will be used to feed the ponds, particularly the rearing ponds. This structure should be located as close as possible to the ponds while retaining a relationship with the access and circulation roads.

A small structure will also be built to enclose the pumps in the water supply system. This building will relate to the hatchery, where the majority of the filtered water will be used and to the main supply canal.

3.3.3 Ponds Component

The ponds at Serow can be divided into five functional groups: (1) spawning ponds, (2) broodstock ponds, (3) rotifer production ponds, (4) rearing ponds, and (5) quarantine ponds. The functional matrix relates the function of each of the nine specific types of ponds which make up these functional components.

3.3.3.1 FUNCTION

The function of each specific pond is described in SFH Chapter 2, Biological Process Design. Within each of the five functional groups, the individual ponds relate fairly closely to each other; however, individual pond types relate much more directly to the hatchery and their siting close to the building will be given priority. The spawning and broodstock ponds have the

SFH TABLE 3.1
FUNCTIONAL RELATIONSHIP MATRIX

	HATCHERY BUILDING	ADMINISTRATION BUILDING*	FEED/FERTILIZER STORAGE	DORMITORY*	HOUSING*	EXTENSIVE REARING PONDS	EXTENSIVE SPAWNING PONDS	BROODSTOCK HOLDING PONDS	BROODSTOCK DONOR PONDS	BROODSTOCK SEGREGATION PONDS	BROODSTOCK RECOVERY PONDS	INTENSIVE REARING TANKS	ROTIFER PRODUCTION TANKS	QUARANTINE PONDS	SEPTIC TANK/DRAINFIELDS
HATCHERY BUILDING															
ADMINISTRATION BUILDING*	●														
FEED/FERTILIZER STORAGE	○	○													
DORMITORY*	○	◉													
HOUSING*	○	◉		◉											
EXTENSIVE REARING PONDS	○	○	●	○	○										
EXTENSIVE SPAWNING PONDS	●	○	◉			○									
BROODSTOCK HOLDING PONDS	◉	○	◉			○	◉								
BROODSTOCK DONOR PONDS	●	○	◉			○	◉	●							
BROODSTOCK SEGREGATION PONDS	●	○	◉			○	◉	●	●						
BROODSTOCK RECOVERY PONDS	●	○	◉			○	◉	●	●	●					
INTENSIVE REARING TANKS	●	○	●			○	◉	◉	◉	◉	◉				
ROTIFER PRODUCTION TANKS	○	○	●			●						●			
QUARANTINE PONDS	○	○	◉			◉	○	◉	◉	◉	◉	◉			
SEPTIC TANK/DRAINFIELDS	◉	◉		○	○										

LEGEND

● VERY STRONG RELATIONSHIP

◉ INTERMEDIATE RELATIONSHIP

○ MINOR RELATIONSHIP

NO PARTICULAR RELATIONSHIP

X SOME DEGREE OF SEPARATION DESIRABLE

*EXISTING STRUCTURES

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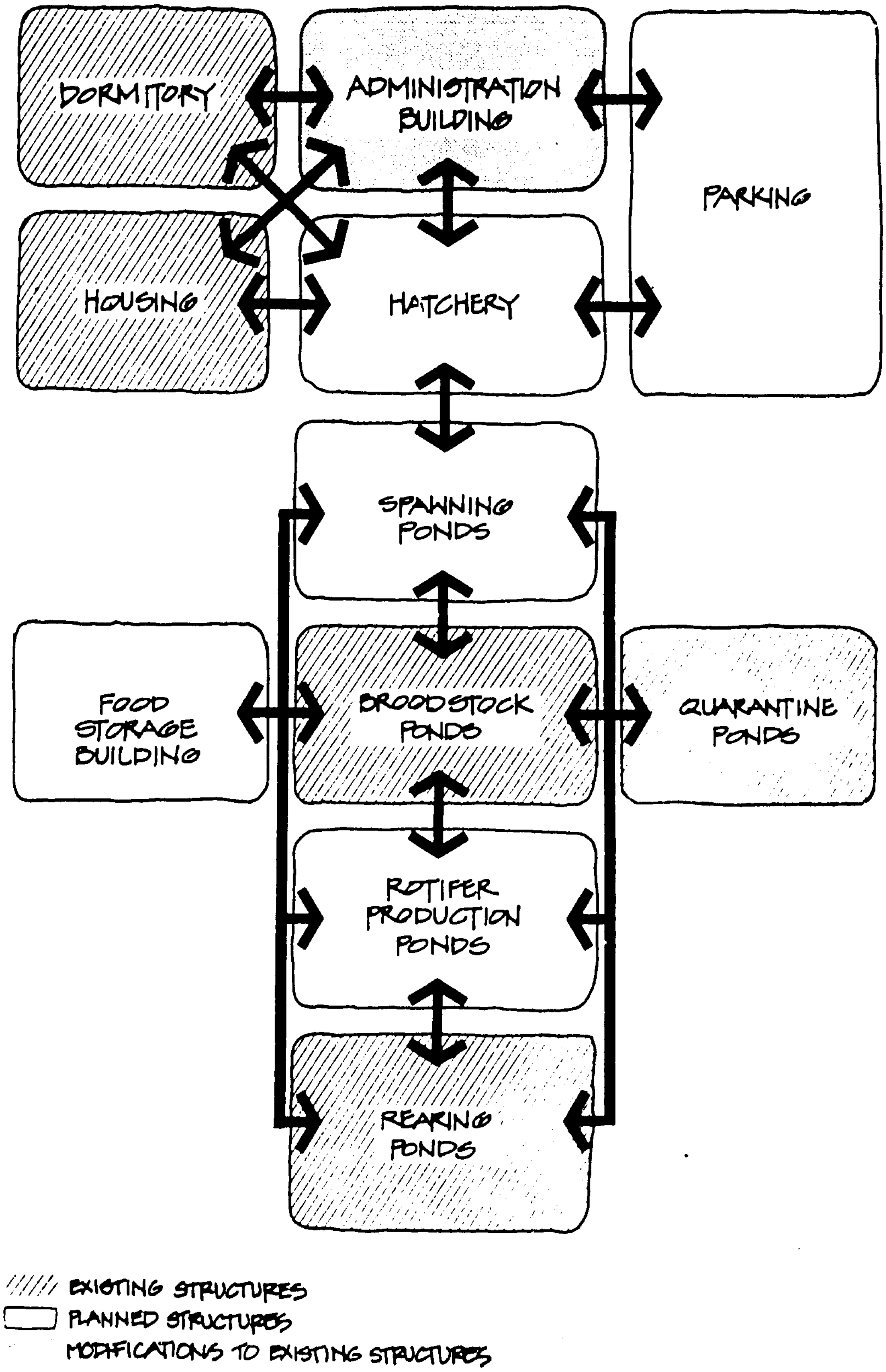


SFH Figure 3.2
Overall Functional Site Relationships

closest relationship to the hatchery building, while the extensive rearing ponds do not need to be near the building and will be located farthest away. The rotifer production ponds are used to produce live food for the rearing ponds and relate directly to them. The quarantine ponds relate to all of the ponds as they will be used to isolate fish taken from any of the pond groups.

3.3.3.2 AREA

The specific area requirement of each pond is described in Chapter 2, Biological Process Design. The existing ponds at Serow have a greater capacity than required by the new program; therefore, the design objective will be to utilize these ponds and minimize construction costs.

3.3.4 Circulation Component

3.3.4.1 ACCESS

Access to the facility is via a compacted earth road from the village of Serow, located south of the hatchery. (See SFH Figure 3.1.) Operations vehicles can enter the complex on an east/west road located on the southern boundary of the complex or can proceed past the complex and enter via a roadway running along the northern boundary of the existing fish ponds. An additional access may be desirable for pedestrians entering the complex near the administration building.

3.3.4.2 CIRCULATION

Vehicles will approach the hatchery building from the south side, on the southern access road. Vehicle circulation to the fish ponds will be provided via an existing road which encircles the pond system.

3.3.4.3 PARKING

Parking for vehicles will be provided on the southside of the new hatchery building. Operations vehicles will be parked in garage space in the hatchery building.

3.3.5 Landscaping

Landscaping at SFH will be limited to the immediate area around the new hatchery building. The preservation of the existing stand of trees which has been established around the hatchery complex is considered important, because they provide valuable shade and wind control and are a pleasing visual element.

3.4 RECOMMENDED SITE COMPLEX

3.4.1 Introduction of Concept

After analyzing the biological criteria with the existing environmental conditions and the design criteria, a recommended site concept was formulated. Every effort has been made to preserve the existing facilities to minimize construction costs. (See SFH Figure 3.3.)

Access and circulation will remain as they exist with the primary vehicle access on the south side of the site. The hatchery, feed storage, and parking will occupy the vacant land immediately west of the existing administration and dormitory buildings. Access to these facilities will be from the south of the primary access road.

The four existing earth ponds nearest the building will be filled to make room for the 26 intensive rearing ponds, the 20 extensive spawning ponds, and accommodate future expansion. The remaining earth ponds will remain unchanged and redesignated to uses compatible with the new program. The remaining 14 ponds located to the west have been designated as follows. The first pond will be used as a broodstock recovery pond; second and third ponds as broodstock segregation ponds; fourth pond as broodstock donor ponds; fifth through eighth ponds as broodstock holding ponds; and the ninth through fourteenth ponds as extensive rearing ponds. No construction will be done on these ponds, except that inlet and outlet gates will be replaced so they are functional again.

The six existing brick-walled ponds located on the southwest corner of the buiding area to the east of the rearing ponds will be designated for use as quarantine ponds. The rotifer and inocula production tanks will be located adjacent to the hatchery and feed storage buildings.

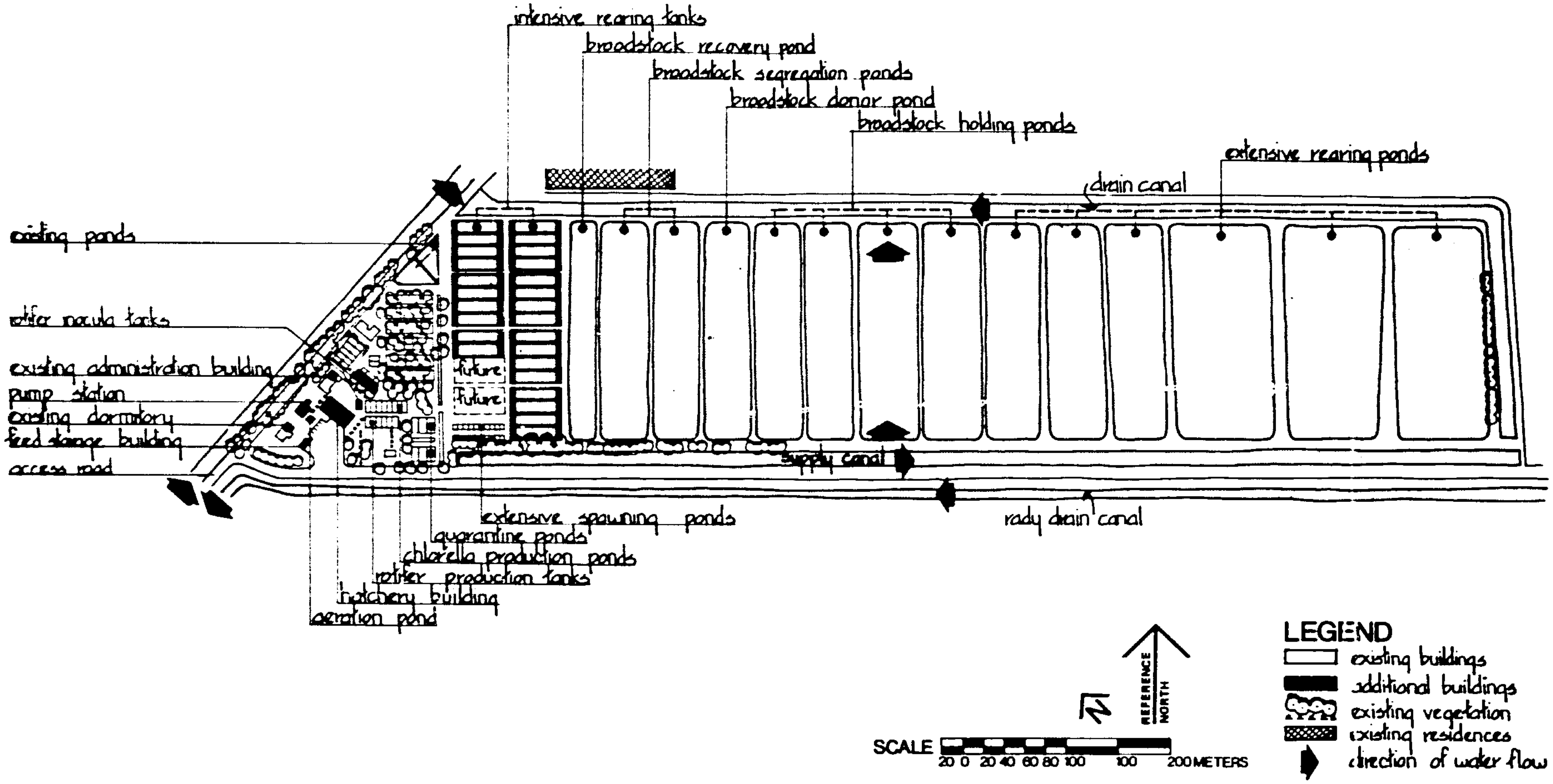
A major potential problem exists with the water supply system at Serow because rearing water is recirculated through the hatchery system. If a disease should start in one pond, it could quickly spread throughout the entire project. Currently, the drain water exits to the south end of the ponds into the Rady drain canal which flows south to the major canal which in turn feeds the navigation canal which is used as a water source. The Rady drain canal should be isolated from the hatchery system and the flow of the on-site supply and drain canals reversed. To accomplish this, the water will be pumped from the navigational canal at the southeast corner of the hatchery and transported by pipe to the canal which runs along the south end of the rearing ponds. The Rady drain canal will then change from a drain to a supply canal. Water will run through the ponds from south to north and will exit to the east in the canal which runs along the north end of the ponds. The water will then flow from the navigation canal into Lake Manzala, eliminating any chance of recirculating disease problems. The hatchery water supply system will originate at the same pump house and will be filtered prior to entering the hatchery building.

All undesignated ponds in the building area will be left intact and may be used for increasing production or minor research. These ponds will continue to use their existing water system.

3.4.2 Advantages

Making use of the existing facilities wherever possible will minimize construction costs. The fact that all existing ponds exceed the requirements of the program provides a built-in expansion capability.

Location of the proposed hatchery building in the existing building complex takes advantage of the relationship to the existing administration building and makes use of the existing trees which provide valuable shade and wind control.



SFH Figure 3.3
Recommended Site Concept

Reversing the flow of water in the complex will eliminate a disease problem which has the potential of destroying an entire year's production.

3.4.3 Disadvantages

Fitting facilities into the existing complex does not allow the best possible functional relationships; however, within this given structure, a viable arrangement has been achieved. It is also difficult to get proper vehicle circulation between the existing facilities.

Changing the water flow direction will require pumping, which will increase both the capital and operating costs.

SEROW FISH HATCHERY
CHAPTER 4
PRODUCTION FACILITY

4.1 DESIGN PARAMETERS

4.1.1 Introduction

Design parameters—climate, building technology for the region, energy conservation requirements, governing building codes—are the factors that collectively provide the basis of the design for a building. In this section, all important design parameters for the Serow Fish Hatchery (SFH) buildings are discussed. Parameters are classified in seven major groups: function, expansion, site and existing conditions, building technology, character, culture, and codes. Reference is made to other chapters of the Egypt Aquaculture Project (EAP) and other sections of SFH Chapter 4 where the parameters are discussed in this section are expanded upon.

4.1.2 Function

The SFH buildings will house the following functions:

- o Aquaculture production to support fish farming throughout Egypt
- o Production of carp fry for the outdoor rearing ponds
- o Production of live food for carp fry
- o Office space for staff

For detail, see SFH Chapter 1, General Project Profile, and SFH Chapter 2, Biological Process Design. Designing a building that will accommodate these functions is the primary objective, and must be accomplished without overdesigning. The facilities proposed will be adequate to encourage development of strong programs in production without rooms or sections of buildings being underutilized.

SFH Section 4.2, Building Program, presents a detailed analysis of space requirements for the SFH. Section 4.3, Relationships, analyzes various types of relationships between the spaces developed in the building program. These two sections are the basis for developing a functional design.

In the initial stages of analyzing space requirements, the areas were classified as office/administration-type spaces and hatchery/production-type spaces. The need for close connections between these areas can be achieved by retrofitting the existing administration building and building a new hatchery-laboratory building in close proximity. The retrofit project will require future onsite investigations into the condition of the structure.

4.1.3 Expansion

The SFH site has sufficient land for large-scale expansion, however, water may limit expansion potential.

4.1.4 Site and Existing Conditions

Topography, climate, vehicular access, soils, native vegetation, existing buildings and site development heavily influence the design of a building.

The climate and the existing site development are undoubtedly the site factors that will most heavily influence design of the SFH laboratory-hatchery building. SFH Section 3.1.1, Climatic Conditions, outlines the climate at Serow. The general principals for responding to the climate are outlined in NAC Section 4.1.4 and will be followed at the SFH. SFH Section 3.3, Site Development, and SFH Figure 3.3, Recommended Site Concept, indicate the relationship of new structures to the existing site development.

4.1.5 Building Technology

Refer to NAC Section 4.1.5 for a discussion of building technology.

4.1.6 Character

The new SFH laboratory-production building will conform to the existing environment at the site. The existing buildings are brick covered in plaster, generally two-story, and rectangular. Any new structures will be finished with plaster and in the pastel color range of the existing structures. The administration building will not change in form but will undergo painting, plaster work and some changes in entrance access. The new laboratory-hatchery building will be situated to take advantage of shading provided by existing trees. The building complex at the west end of the site will retain the cool oasis character that presently exists.

4.1.7 Cultural Imperative

NAC Section 4.1.7 describes the cultural imperative which will be followed for the SFH project.

4.1.8 Design/Code Standards and State of the Art

The state of the art and the design/code standards of the SFH will be the same as those outlined in NAC Section 4.1.8.

4.2 BUILDING PROGRAM

4.2.1 Introduction

The building program described in this section was developed based on the information provided in SFH Chapter 1, General Project Profile, and SFH Chapter 2, Biological Process Design.

SFH Section 4.2.2 summarizes the building program detailed in Appendix C.1. Each space is identified by name and number and the net area (actual floor area measured inside the walls) given. A description of the purpose or function of the space is also provided.

Appendix C.1 consists of a standardized form which provides complete basic information about each space. The form was designed to be comprehensive and yet flexible enough to work for the variety of spaces involved. Appendix C.1 is the heart of the building program and is the basis for the Relationships Analysis (SFH Section 4.3) and the Recommended Building Concept (SFH Section 4.4).

4.2.2 Building Program Summary and Notes

4.2.2.1 OFFICE SPACES

(To be located in existing administration building after retrofit.)

Reception/Clerical

Space No: R/C Area: 30 m^2

Function: Lobby/reception area will serve as entrance to hatchery. Any clerical staff could be located here and also act as receptionist.

Conference Room

Space No: CO Area: 30 m^2

Function: Provide conference room, library space for hatchery staff and visitors.

Director's Office

Space No: D Area: 20m^2

Function: Office for director/senior staff person.

Senior Staff Office

Space No: SEN Area: 15 m^2

Function: Office space.

Support Staff Offices

Space No: SS Area: 40 m^2

Function: Office space for technical support personnel.

Crew Room

Space No: CR Area: 20 m^2

Function: Temporary accommodations for overnight or off-hours. Provide for sleeping, eating, and praying.

Kitchenette

Space No: K   Area: 4 m^2

Function: Provide coffee and drinks for staff.

Storage

Space No: ST   Area: 6 m^2

Function: Provide storage space for office supplies.

Janitorial Storage

Space No: JS   Area 4 m^2

Function: Provide storage space for building, cleaning, and maintenance equipment.

4.2.2.2 LABORATORY-HATCHERY

(To be a new structure located in close proximity to office building.)

General Laboratory

Space No: LAB Area: 30 m^2

Function: Support staff perform hatchery monitoring functions, involving samples from ponds. Some applied research will be done in off season.

Media Preparation

Space No: M   Area: 6 m^2

Function: Wet room provides work space for staff to prepare cultures which are then transferred to culture room.

Culture Room

Space No: C   Area: 15 m^2

Function: Staff initiates phytoplankton cultures.

Algal Inocula

Space No: AI   Area: 80 m^2

Function: Algae multiply in tanks for use in larval food production.

Algal Production (outdoors)

Space No: AP

Function: Algae multiply in tanks for use in rotifer production and for food for carp fry.

Rotifer Inocula (outdoors)

Space No: RI

Function: Rotifers multiply in tanks for use in rotifer production.

Rotifer Production (outdoors)

Space No: RP

Function: Rotifers multiply in tanks as feed for carp fry.

Spawning

Space No: SP **Area:** 80 m^2

Function: Staff and laborers induce carp to spawn and gather the eggs. Carp are brought from segregation ponds, returned to recovery ponds. Eggs are transferred to incubation room. Process carried out over period of 6 months. Senior staff person maintains office.

Incubation

Space No: IN **Area:** 50 m^2

Function: Staff and laborers hatch carp eggs. Eggs are brought from spawning, washed and counted, deposited in Zuger jars where they hatch, into hardening troughs where they begin feeding, then taken to intensive rearing ponds. Process carried out for 6 months.

Food Storage

Space No: FS **Area:** 8 m^2

Function: Storage of cereal-type foods and frozen food components for ponds.

Garage/Shop

Space No: G/S **Area:** 28 m^2

Function: Open shelter for 2 vehicles and shop space for general repair work.

Ponds Storage

Space No: PS Area: 25 m^2

Function: Storage space for nets, buckets, general maintenance equipment.

4.3 PATTERNS AND RELATIONSHIPS

The SFH is made up of many components which are described in detail in Appendix C. In addition parameters such as sun, wind, and sound influence the proposed building program. The following matrix and diagrams illustrate the different relationships which must be considered in developing a recommended building concept.

The functional matrix, SFH Table 4.1, illustrates the degree of connections between the programmed spaces. In SFH Figure 4.1, Functional Relationships, the spaces have been grouped in two areas: office-administration and laboratory-hatchery. This separation reflects the client's desire to use the existing administration building and to maintain functional difference between these spaces. If a strong link is provided between those spaces and if the distance between the spaces is not too great, the separation of office from lab-hatchery proves a workable concept. Since the staff is small, personnel will be performing a variety of functions. This necessitates easy flow from office to spawning, incubation, general laboratory, and exterior ponds. The majority of this movement will be pedestrian. SFH Figure 4.1 is to scale to illustrate dimensional relationships.

The new structure will be one-story with the majority of functions requiring a 3 to 4 m height. All the following figures use the functional diagram as a base; in this way agreements and dissonances with functional needs are readily apparent.

SFH Figure 4.2 illustrates rooms which require natural light and rooms which ideally are naturally ventilated. For natural ventilation, the spaces should take advantage of the northwest winds, which are predominant in the summer, and should have cross-ventilation (openings on two room faces). For natural lighting, north and east light are best as this light does not transfer the outdoor heat coming from direct sunlight. West light is also usable, if proper shading is provided. The algal inocula area is the only exception in that this area requires a constant light so that tanks will never be in shade.

SFH Figure 4.3 illustrates sound relationships. One of the most important is the need for quiet in the spawning room.

As discussed in SFH Section 4.1, there is a definite need for future expansion space in the structures. SFH Figure 4.4 notes rooms which would require expansion if the hatchery undergoes the proposed increase in production.

SFH TABLE 4.1
FUNCTIONAL RELATIONSHIP MATRIX

	INCUBATION	SPAWNING	ROTIFER PRODUCTION	ROTIFER INOCULA	ALGAL PRODUCTION	ALGAL INOCULA	CULTURE	MEDIA PREPARATION	GENERAL LABORATORY	PONDS STORAGE	GARAGE/SHOP	FOOD STORAGE	CREW	JANITOR STORAGE	UPPORT STAFF OFFICES	SENIOR STAFF OFFICES	DIRECTOR'S OFFICE	KITCHENETTE	STORAGE	CONFERENCE	RECEPTION/CLERICAL
INCUBATION																					
SPAWNING	●																				
ROTIFER PRODUCTION																					
ROTIFER INOCULA			●																		
ALGAL PRODUCTION			◉	●																	
ALGAL INOCULA					●																
CULTURE			◉	◉	◉	●															
MEDIA PREPARATION			◉	◉	◉	●	●														
ENERAL LABORATORY	◉	◉					◉	◉													
PONDS STORAGE																					
GARAGE/SHOP										◉											
FOOD STORAGE									○												
CREW																					
JANITOR STORAGE																					
PORT STAFF OFFICES	◉	◉					◉	◉	◉												
ENIOR STAFF OFFICES	○	○					○	○	○						◉						
DIRECTOR'S OFFICE									○						◉	●					
KITCHENETTE													●								
STORAGE															○	○	○				
CONFERENCE															◉	◉	●	●			
ECEPTION/CLERICAL															●	●	●		◉	●	

LEGEND

● VERY STRONG RELATIONSHIP
◉ INTERMEDIATE RELATIONSHIP
○ MINOR RELATIONSHIP
NO PARTICULAR RELATIONSHIP
X SOME DEGREE OF SEPARATION DESIRABLE

4.4 RECOMMENDED BUILDING CONCEPT

4.4.1 General Description

After analyzing the site and studying patterns evolving from the building program (see SFH Figures 4.1 - 4.5), a general building concept has developed. An important element of this concept is the preservation of the existing facilities such as structures, vegetation, and ponds. As a result, the actual building site becomes pinpointed to a quadrangle south and west of the existing administration building. This site then becomes limited by the new algal production area which must be to the south, for full sun, and must have a connection to the building and the algal inocula.

The existing administration building has entrances to the east and west and one stair/entry to the north. After studying the building program and the existing building layout, the decision was made to locate the director's office, two senior staffpeople, and conference room on the upper floor.

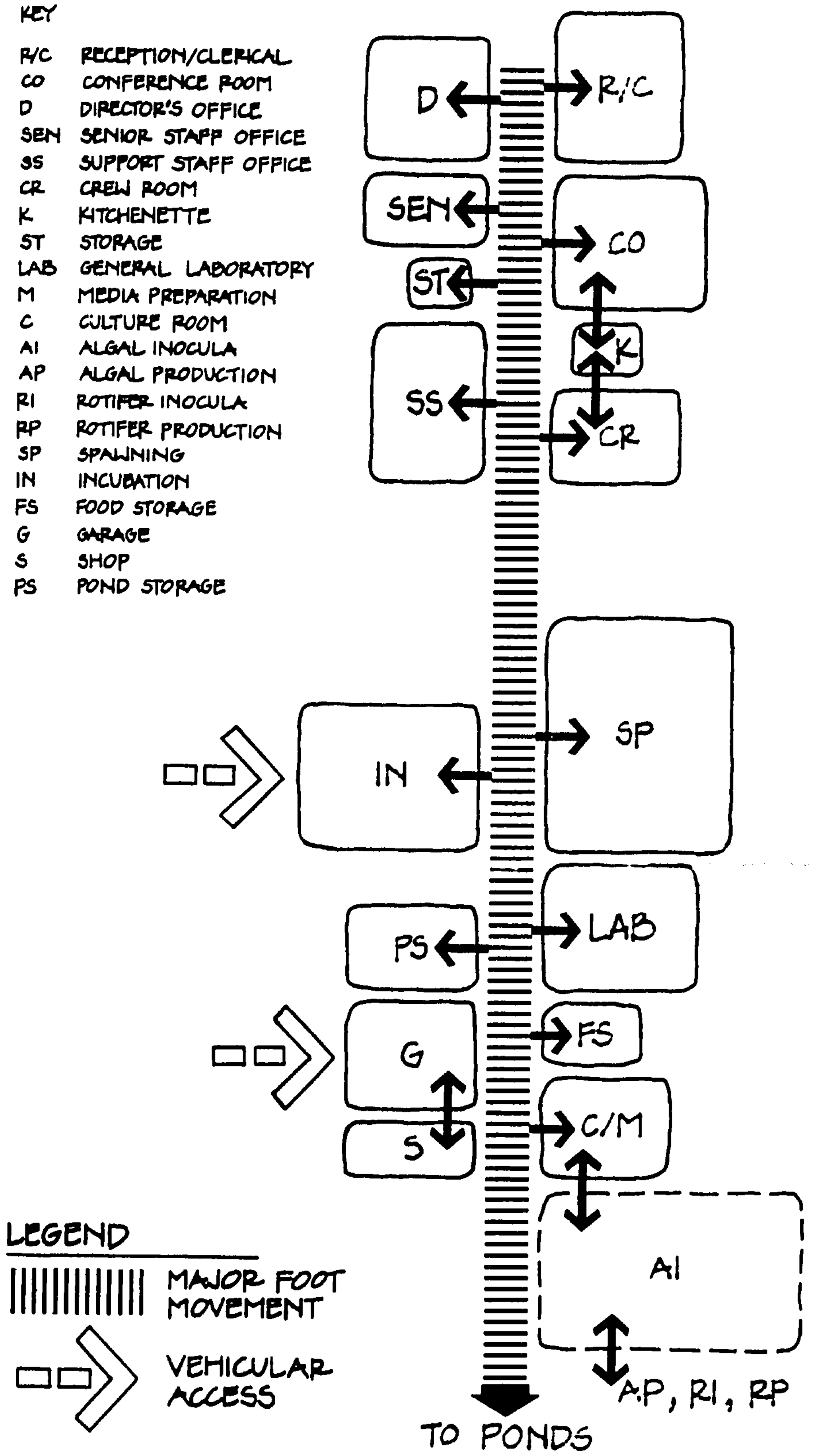
This creates a quiet office environment on the upper floor. The lower floor is then available for a centrally located reception area and support staff offices and services. A link will be created between the two floors by opening up walls at the stairway and hall. Coffee service could be provided on both floors or main floor only. Support staff will be spending the majority of their time in the hatchery and outside at the ponds. Support staff offices are located close to the major walks at the east and west end of the building. These walks will connect with the hatchery building and ponds.

The new hatchery building is sited on a north-south axis. Functions evolved linearly as the majority require outside access to the ponds. Also, this leaves adjoining space open for future expansion. One of the original ideas for a building block maximized the north facing wall, however, when the specifics of the site were studied, this did not prove feasible, as the administration building would severely reduce the north light and the northwest winds. If located south and west of the administration building, the hatchery can be a long north-south building, which takes advantage of the northwest winds for cooling, provides north light for the lab, and has full southern exposure for algal inocula tanks. Rooms which require natural ventilation, but not light could have louvered openings on east and west walls.

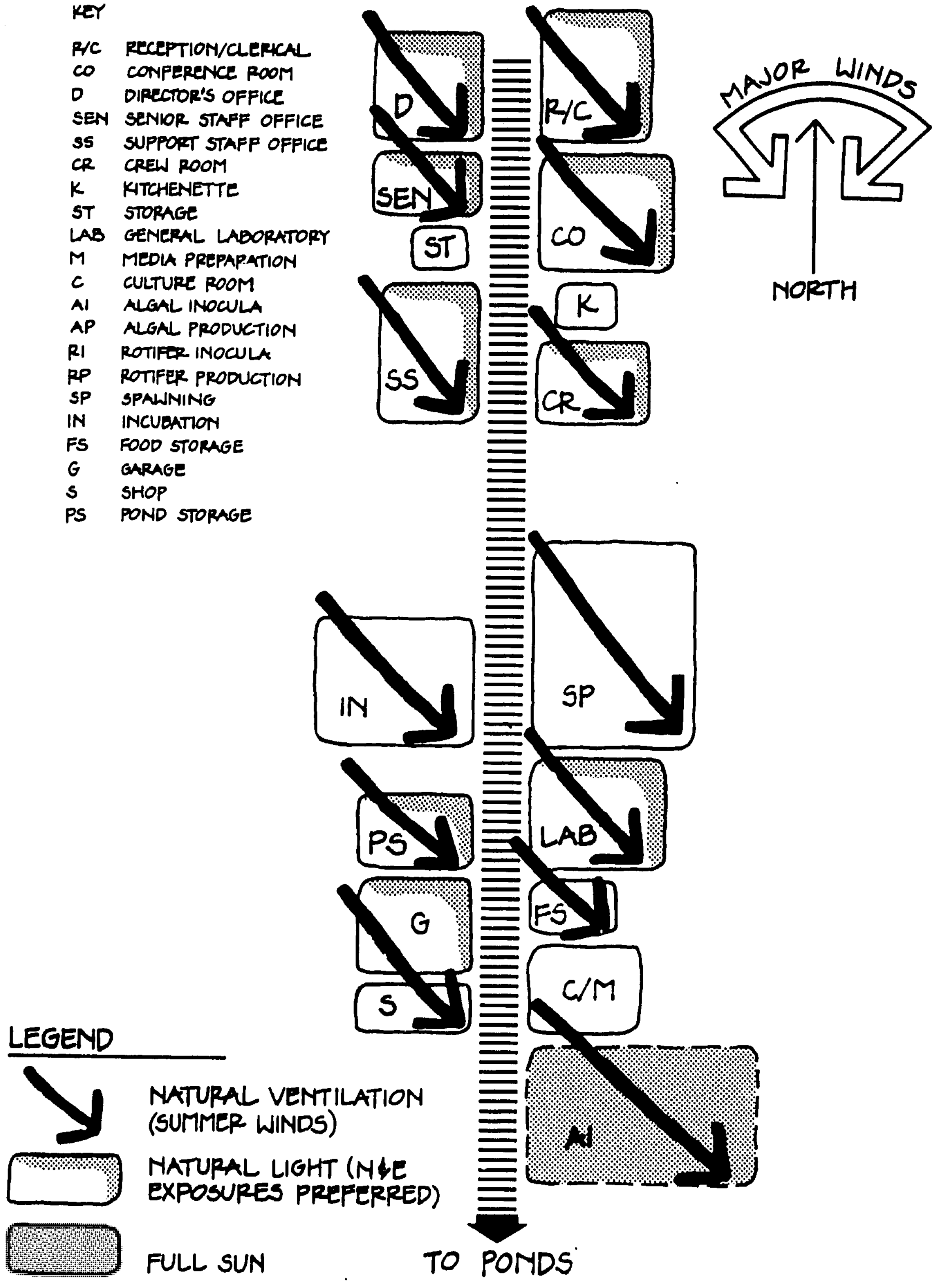
The east side of the building provides access for all rooms to a walk which connects to office and exterior ponds. Pond access is necessary for spawning, incubation, and lab work. The majority of this activity will be by foot but vehicle access is provided to the west for spawning and incubation.

4.4.2 Advantages

The use of the existing administration building will help to minimize construction costs. Although the building requires remodeling, it is assumed no major structural work will be required. The construction of the new building will not subtract from the natural lighting and cooling of the existing building. Existing vegetation is being preserved for the benefits to both buildings. The majority of desired relationships for function, sound, and natural systems have been achieved in this new complex.



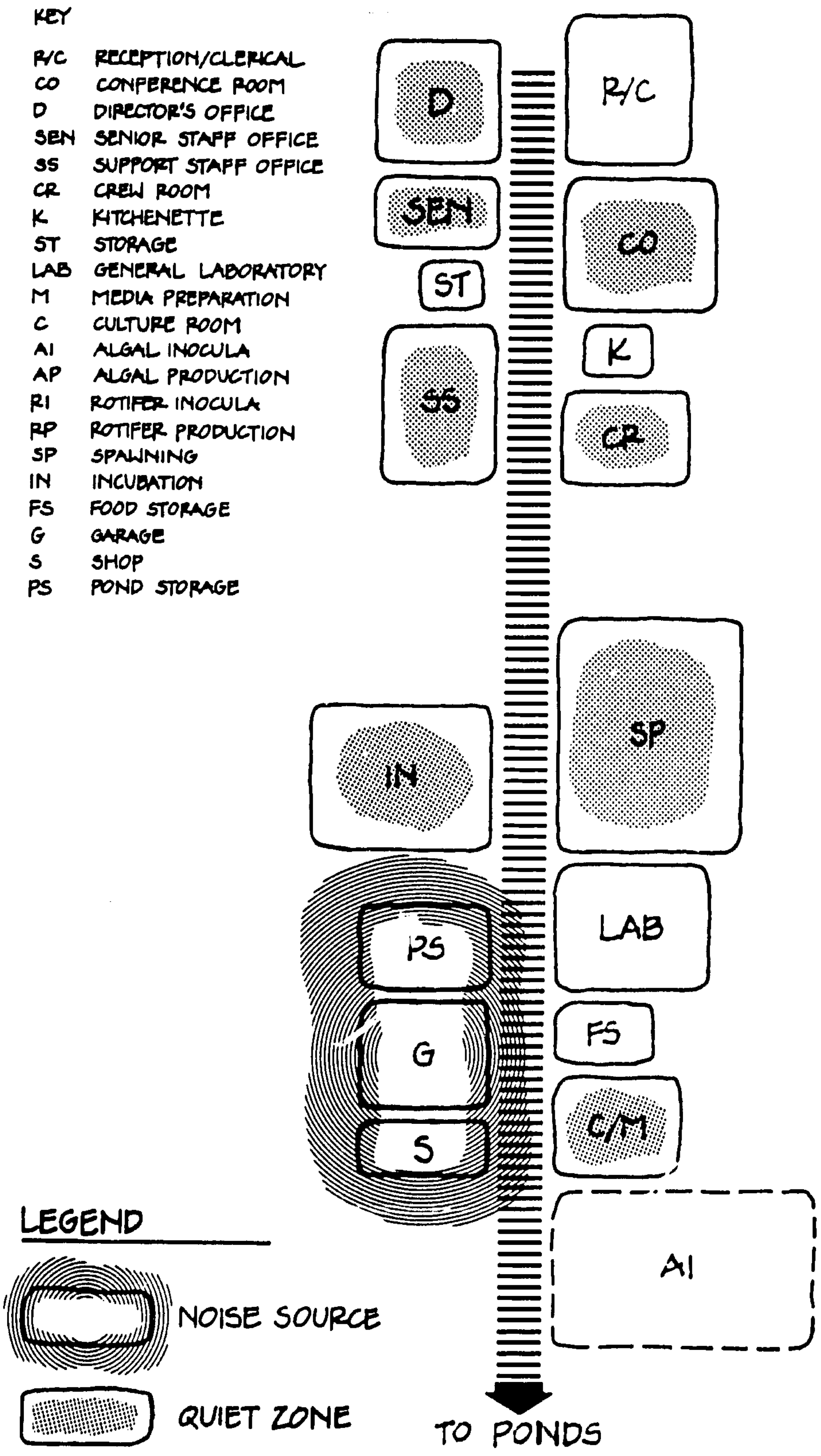
SFH Figure 4.1
Functional Relationships



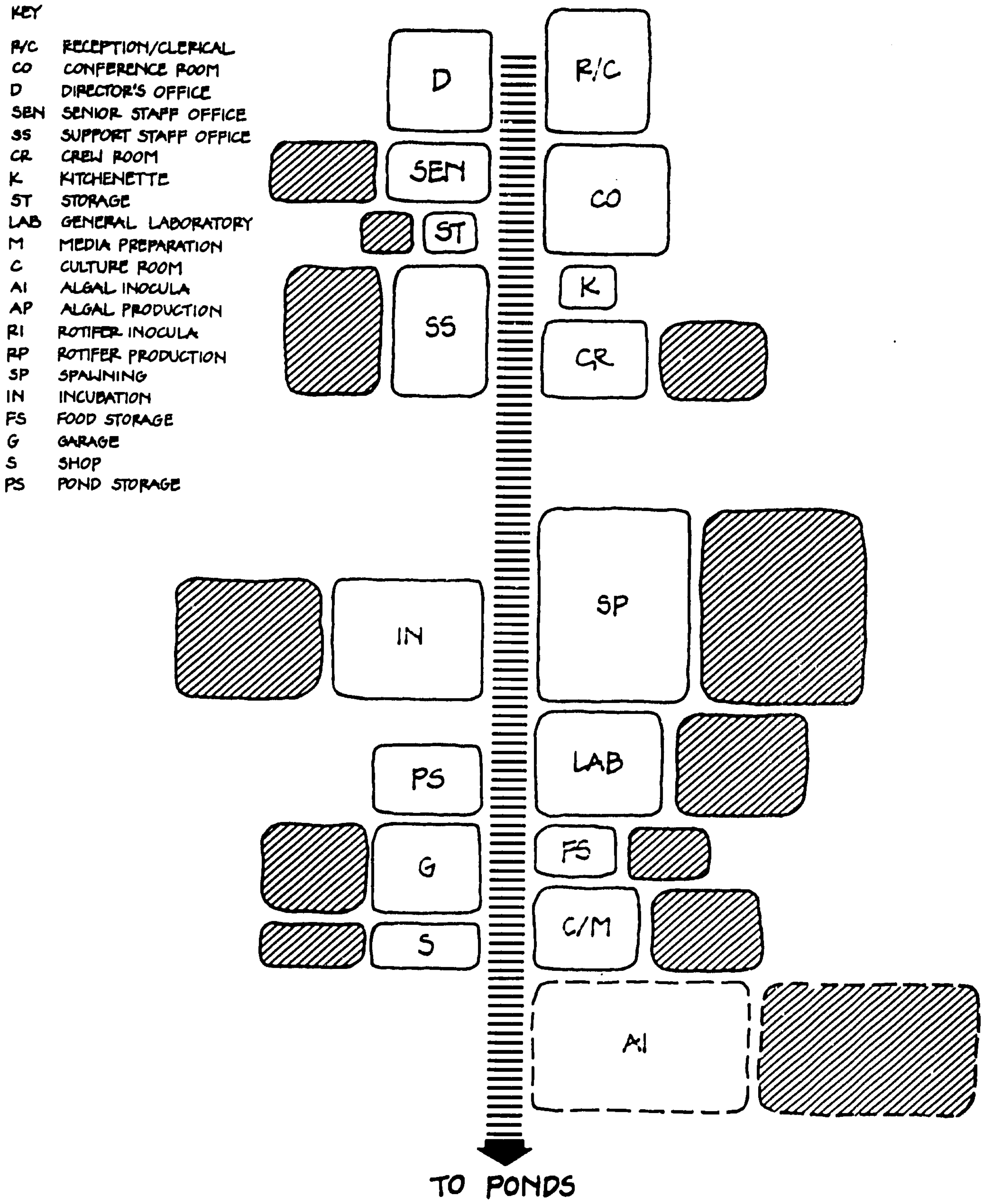
KEY

R/C	RECEPTION/CLERICAL
CO	CONFERENCE ROOM
D	DIRECTOR'S OFFICE
SEN	SENIOR STAFF OFFICE
SS	SUPPORT STAFF OFFICE
CR	CREW ROOM
K	KITCHENETTE
ST	STORAGE
LAB	GENERAL LABORATORY
M	MEDIA PREPARATION
C	CULTURE ROOM
AI	ALGAL INOCULA
AP	ALGAL PRODUCTION
RI	ROTIFER INOCULA
RP	ROTIFER PRODUCTION
SP	SPAWNING
IN	INCUBATION
FS	FOOD STORAGE
G	GARAGE
S	SHOP
PS	POND STORAGE

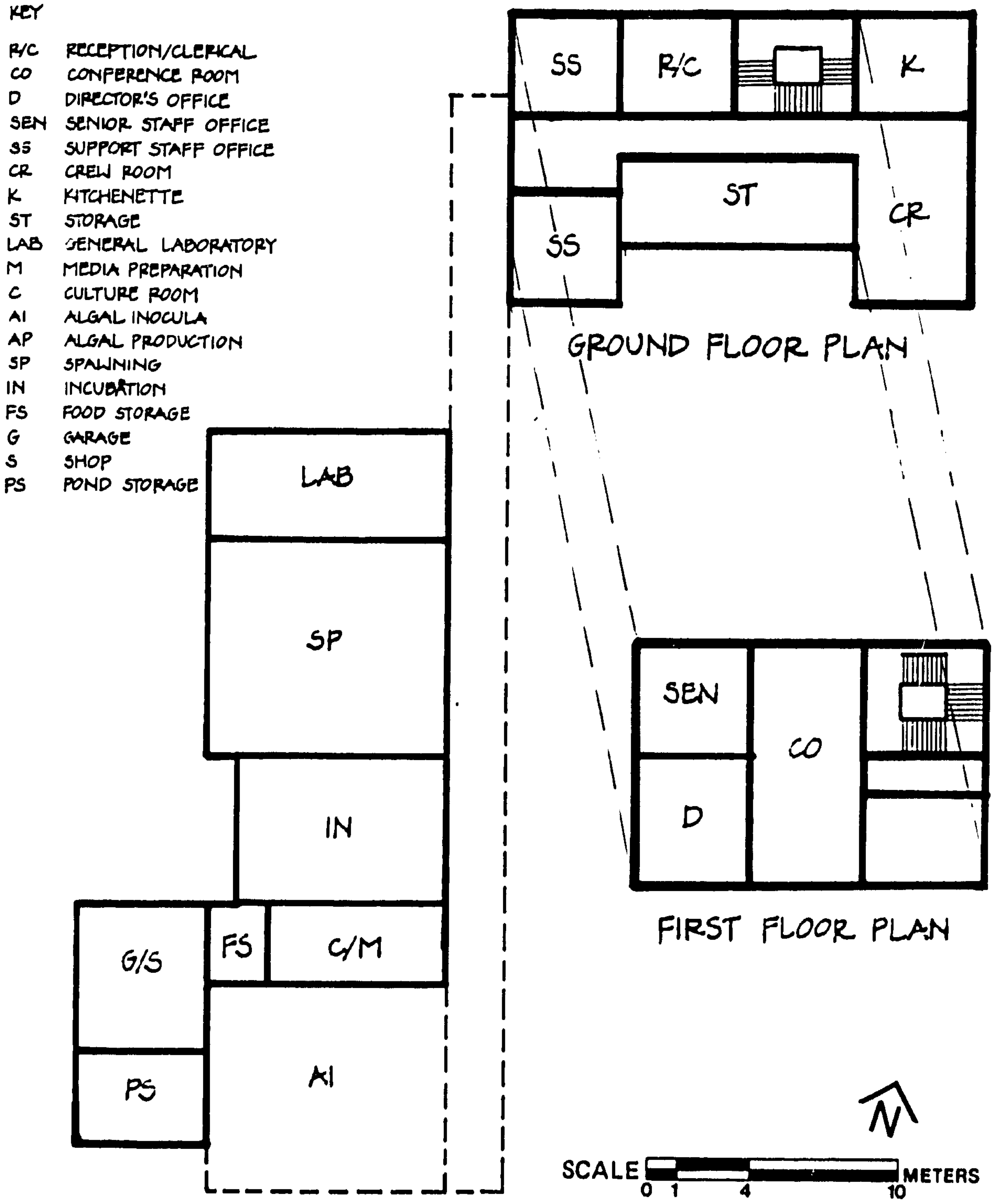
SFH Figure 4.2
Light/Ventilation



SFH Figure 4.3
Noise



SFH Figure 4.4
Expansion



SFH Figure 4.5
Conceptual Floor Plan

The new hatchery building will serve as a link between office spaces and rearing and production ponds. This new structure will house all hatchery production facilities and will generally increase the efficiency of the SFH.

4.4.3 Disadvantages

As mentioned in the site design concept, adapting an existing pattern to a somewhat different use can sometimes create difficulties. In the case of building function, the reuse of the administration building creates some problems in that the staff must be separated onto two levels. The proposed concept attempts to maintain the communication necessary for a working program. Access from a vehicle to the office building is somewhat indirect as vehicle access to the hatchery has taken precedence.

SEROW FISH HATCHERY
CHAPTER 5
ENGINEERING SYSTEMS

5.1 RECOMMENDED MECHANICAL SYSTEMS

The mechanical process systems are the main support for Serow Fish Hatchery (SFH). Their complexity reflects the need to meet the broad demands of various production programs. The concept of conserving energy has been incorporated into all the mechanical systems and concepts have been developed for solving the major engineering problems. It should be noted however that these are only engineering concepts and the actual systems may vary during schematic design. This concept program provides a basis for planning and a preliminary cost estimate.

5.1.1 Process Water Supply Systems

Only fresh water is needed to meet the requirements of the intended biological process at the SFH. The total water requirement for the SFH is estimated to be 14,000 l/min. Process water will be obtained from the navigation canal. Two water intakes at the navigation canal will be needed to provide different water quality to meet the biological needs.

One water intake will draw 1,725 l/min of water, which will be filtered and aerated prior to use. The treated canal water of 1,725 l/min will be distributed to the hatchery building, outdoor larval food tanks, quarantine ponds, spawning ponds and intensive rearing ponds. The distribution of treated canal water for the hatchery building and its related ponds is schematically shown in SFH Figure 5.1.

The other water intake at the canal will draw the remaining 12,240 l/min which will be distributed directly to the outdoor ponds without treatment.

The untreated canal water will provide water for recovery ponds, segregation ponds, donor ponds, brood holding ponds and extensive rearing ponds. The distribution of the untreated canal water is shown in SFH Figure 5.1.

5.1.2 Service Water Supply System

The sand-filtered canal water will be used through boost pumping, for service water supply, as shown in SFH Figure 5.2. Service water is primarily intended for cleaning purposes at the hatchery building.

5.1.3 Fire Water Supply System

The sand-filtered canal water will be pumped through boost pumps to provide water for fire protection, as shown in SFH Figure 5.2. The water flow needed for fire protection of the hatchery building will be determined using the recommendations established by the National Board of Fire Underwriters (USA).

5.1.4 Domestic Water Supply System

A water line is being planned to provide potable water to the project site. The domestic water supply system recommended here is an interim solution. The required potable water for the hatchery building is estimated at 2,000 l/day. This water will be delivered by truck and stored in a new elevated storage tank. The distribution of potable water is schematically shown in SFH Figure 5.1 and will be designed to be compatible with the planned water line.

5.1.5 Tempered Water Supply System

A need to provide the capability of heating water from November through February to 24°C has been established. About 150 l/min of process water needs to be tempered for the intensive spawning, incubation, and larval food rearing ponds. The water tempering system is presented schematically in SFH Figure 5.3. Solar energy will be the primary source for heating water to 24°C from November through February. It should be noted that cooling is not needed for the water tempering system. It is suggested that other alternative systems for water heating be included for further study.

5.1.6 Process and Service Wastewater Treatment System

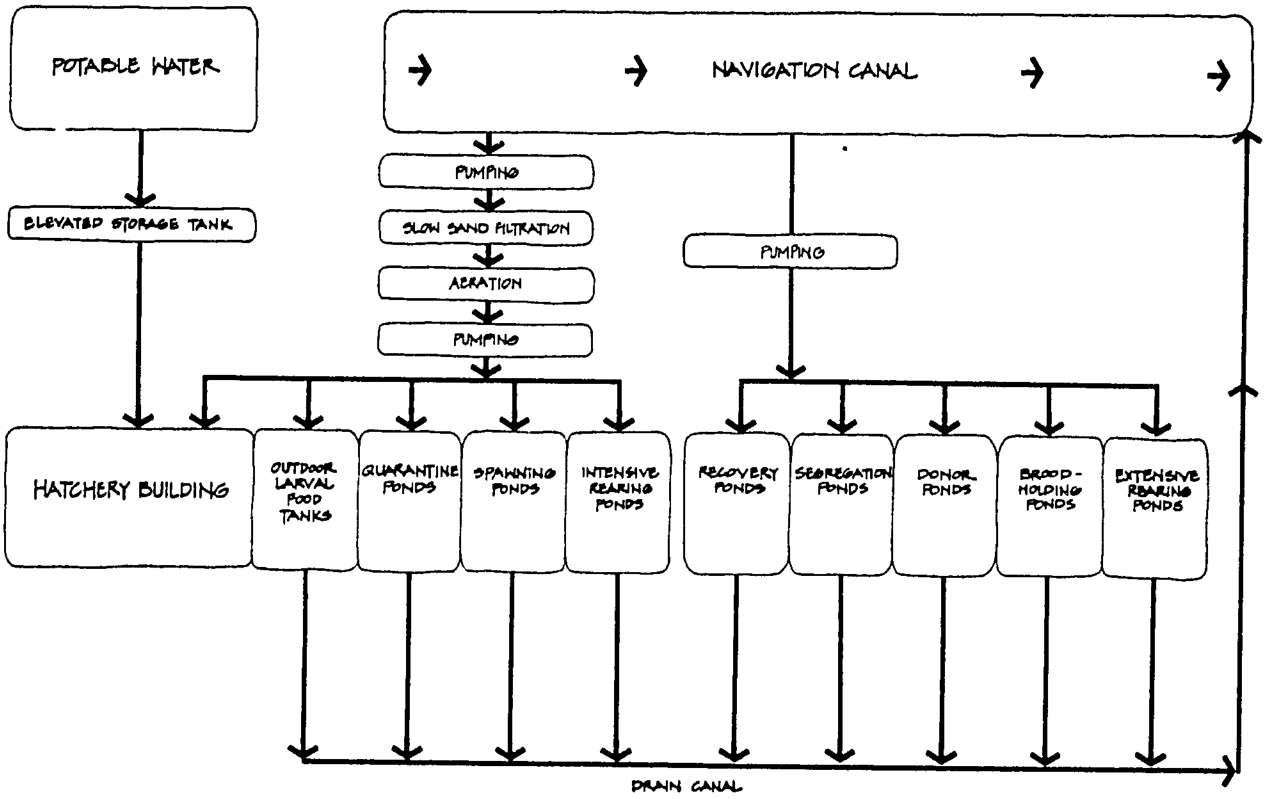
Process water, after outdoor pond use, will be discharged directly into the drain canal without treatment, as shown in SFH Figure 5.1. However, process and service wastewater generated from the hatchery building will be treated prior to discharge to the drain canal. The treatment system will include sedimentation and aeration, as shown in SFH Figure 5.4. The settled sludge out of the sedimentation tank will be hauled away for disposal. The aeration is to increase the dissolved oxygen content of the wastewater before it is discharged to the drain canal.

5.1.7 Domestic Wastewater Treatment System

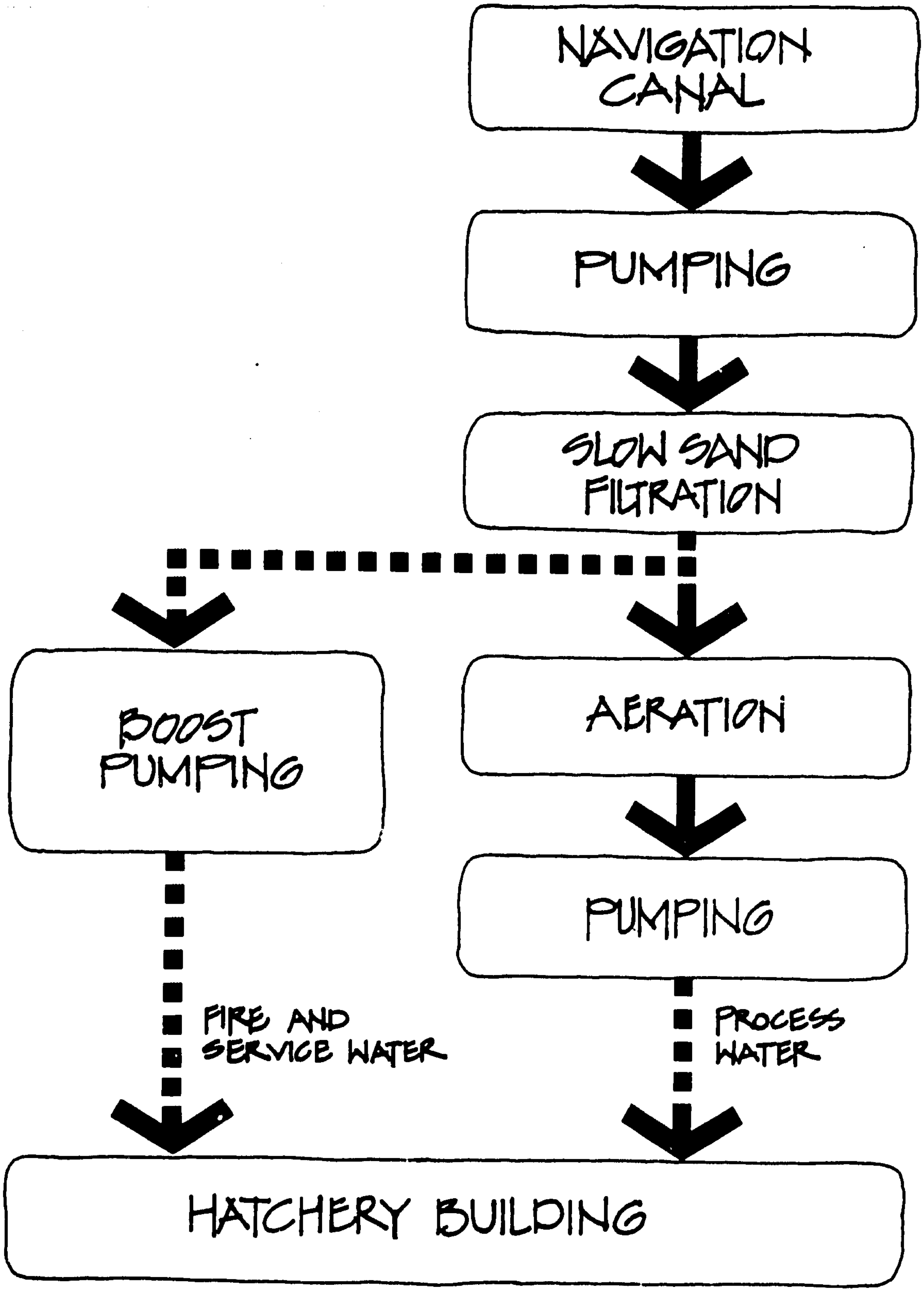
Domestic wastewater is generated from sanitary use and laboratory-related use at the hatchery building. The total sanitary wastewater is estimated to be 1,200 l/day. The sanitary wastewater will be aerated, stored and trucked away for disposal, as shown in SFH Figure 5.4. However, the existing domestic wastewater disposal system will be continuously in use if proved to be satisfactory. Septic tank and drainfield methods will also be considered depending on the soil conditions. The final decision on the domestic wastewater disposal will be made when the soils report becomes available.

5.1.8 Compressed Air System

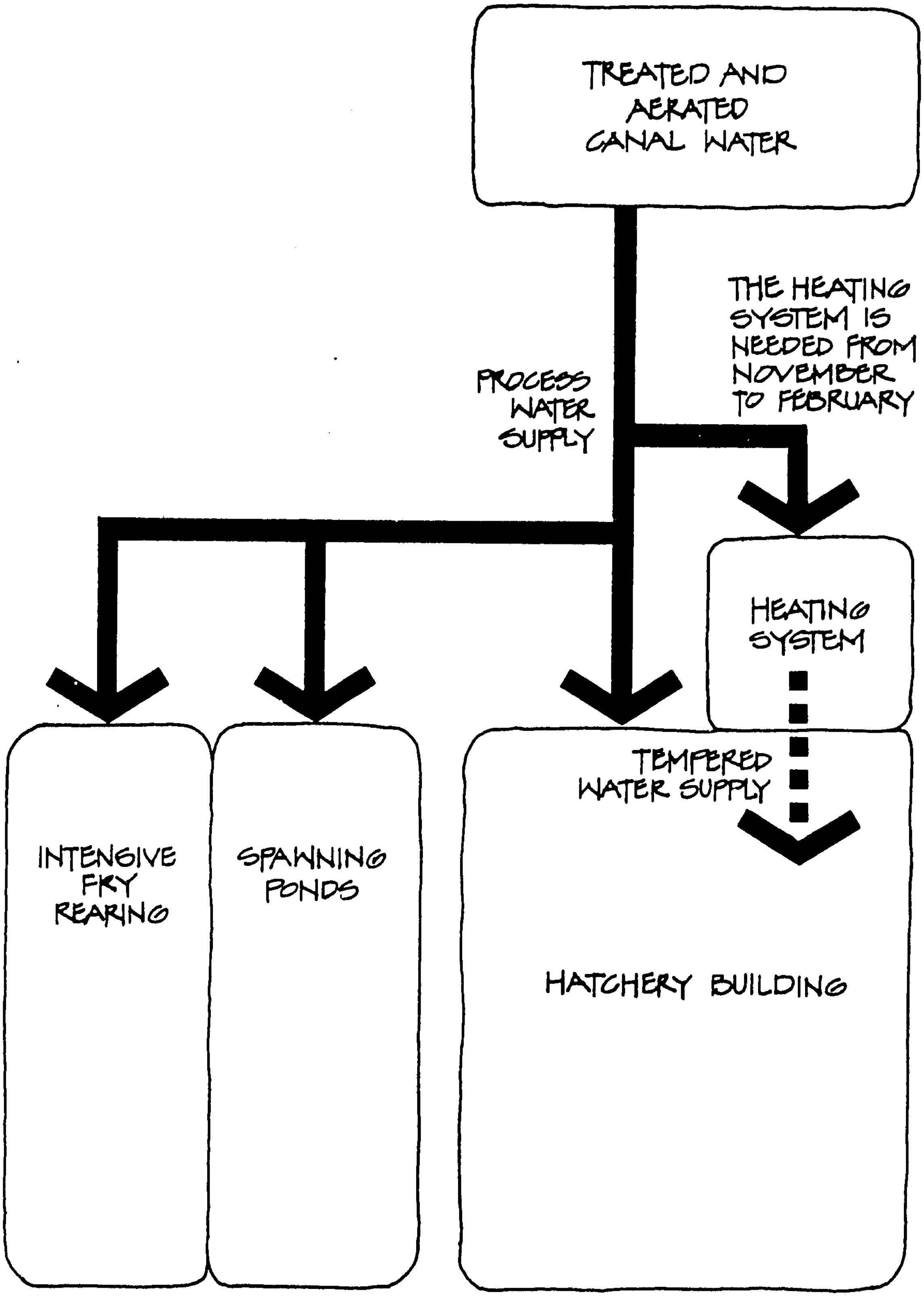
The compressed air system will be required in the laboratory larval food production and hatchery facilities. Two air blowers, one serving as a standby unit, will be located in the mechanical space of the hatchery building. Air will be piped to the laboratory and other areas that require this utility.



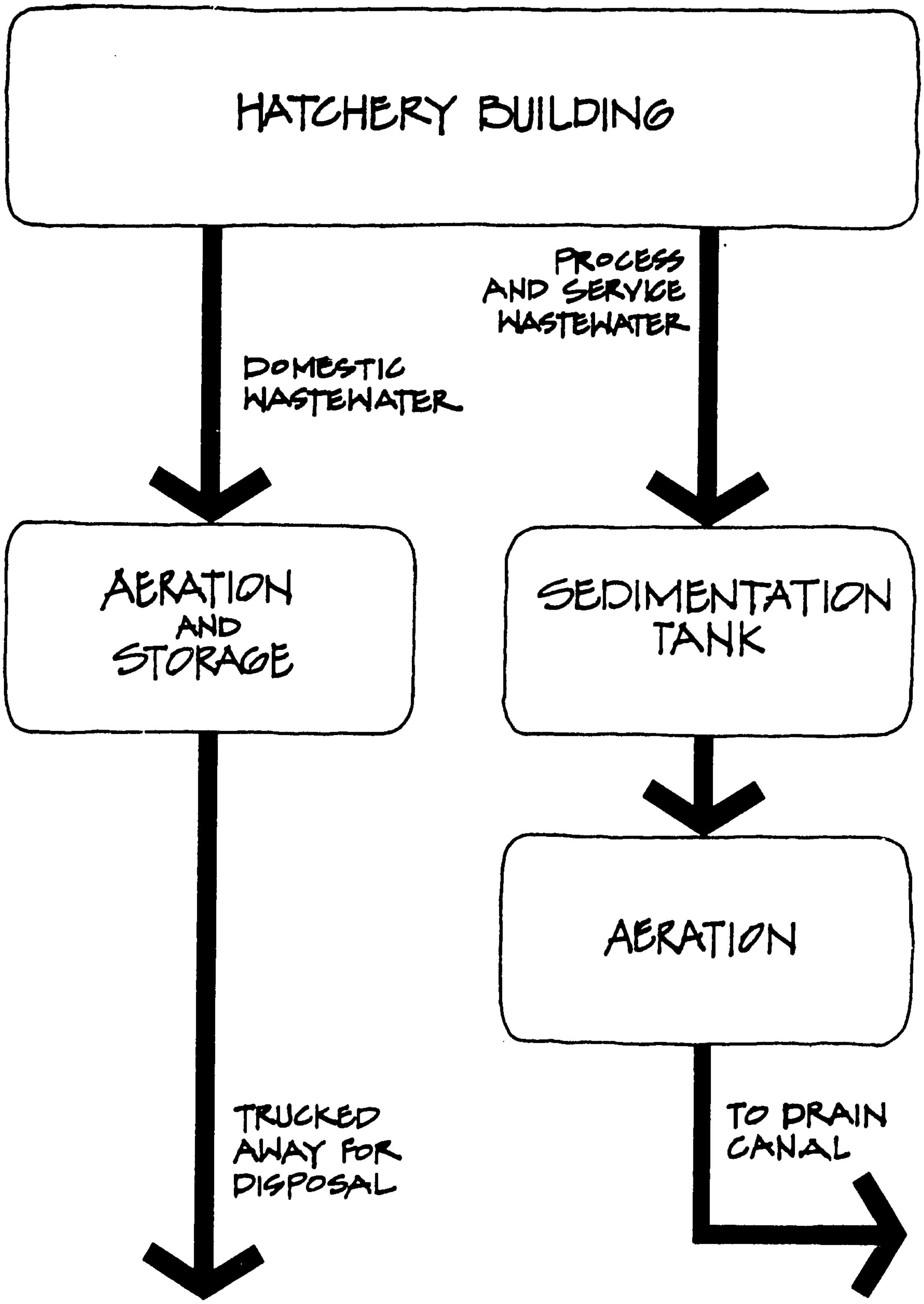
SFH Figure 5.1
Water Flow Diagram



SFH Figure 5.2
Service and Fire Water Supply System



SFH Figure 5.3
Tempered Water Supply System



SFH Figure 5.4
Process, Service, and Domestic Wastewater Treatment System

5.2 RECOMMENDED HVAC SYSTEMS

5.2.1 Ventilating System

Most areas of the SFH will have mechanical ventilation to aid in temperature and humidity control, removal of toxic fumes, and odor control. Mechanical ventilation will be accomplished with electrically powered fans of the following types: wall mounted propeller fans, centrifugal roof exhausters, and cabinet centrifugal fans. Selected fans will be provided with two-speed or variable-speed control.

Those areas not needing mechanical ventilation will be naturally ventilated with operable windows, openings, etc.

5.2.2 Air-Conditioning System

It is anticipated that two areas will be air-conditioned at the SFH to provide a temperature controlled experimental environment. These areas are as follows: culture room and the general laboratory.

Space cooling (air-conditioning) will be accomplished with electrically powered air-conditioners such as packaged through-the-wall units using air-cooled condensers, and/or roof-mounted single package units with air-cooled condensers.

In the interest of energy conservation and energy cost savings, independent "package" systems will be utilized so only those areas requiring cooling need be operated.

No ductwork will be used. Control will be provided by either integral or wall-mounted thermostats.

In those areas requiring dehumidifying, independent dehumidifiers of the dessicant or refrigeration type will be used. Wall-mounted independent humidifiers of the atomizing type and/or electrically generated steam type will be utilized where there is a need for humidification. Control will be automatic via humidistats.

5.2.3 Refrigeration Systems

No major refrigeration system per se will be provided at the SFH Refrigeration will be limited to appliance type refrigerator/freezers.

5.2.4 Design/Code Standards

Design and code standards will be the same as those established for the NAC Section 6.2.5

5.2.5 State of the Art

NAC Section 6.2.6 explains the state of the art for all the sites in general and therefore applies in this case for SFH.

5.3 RECOMMENDED ELECTRICAL SYSTEMS

5.3.1 Lighting System

Indoor, outdoor, and process lighting at this facility will be designed on the same basis and criteria as described in NAC Section 6.3.1, except that there will be no staff accommodations.

5.3.2 Power System

The power distribution system throughout this site will follow the parameters set forth in NAC Section 6.3.2 and in accordance with the regulations and practices of the regional electrical utility.

5.3.3 Communications System

A conventional telephone system, designed on the basis described in NAC Section 6.3.3, will be installed throughout this facility. In addition, there will be a refreshment signalling system and intercommunications between management level offices and the associated secretarial posts, as outlined for the NAC.

5.3.4 Hydraulic Monitor/Alarm System

Monitoring of the hydraulic systems at this site, and the alarms to be provided at wet well and storage locations, will be designed as described in NAC Section 6.3.4.

5.3.5 Fire Alarm System

The fire alarm system at this facility will be essentially as described in NAC Section 6.3.5 throughout the process and office areas except that no sprinkler or extinguishing systems will be utilized.

5.3.6 Design/Code Standards

Design codes and standards will be those described in NAC Section 6.3.6.

5.3.7 State of the Art

The state of the art envisaged for this facility will be the level described in NAC Section 6.3.7.

5.3.8 Other Considerations

The parameters discussed in NAC Section 6.3.8 will apply to this site as well, where applicable.

5.4 RECOMMENDED CIVIL SYSTEMS

This section of the report is devoted principally to the description of site earthwork and water supply/distribution and drainage for the outdoor pond areas. Earthwork for the SFH is limited to the consideration of new facilities' space and grading requirements, and to modifications to the existing open-channel water distribution and drainage systems. Water system considerations include:

- Peak transmission rates
- Quality
- Energy conservation
- Operation and maintenance requirements

Preliminary construction cost estimates for the systems and modifications described in this section are summarized in SFH Chapter 6 and detailed further in Appendix C.

It must be emphasized that the following descriptions are for conceptual schemes which will either be refined or modified and possibly changed during schematic design. The conceptual schemes, however, provide a basis for planning and for the preliminary cost estimate.

5.4.1 Earthwork

Besides foundation excavation for the new buildings and the pump station, earthwork will be necessary to construct the intensive rearing tanks, spawning ponds, chlorella production ponds, and the broodstock recovery pond. This will be accomplished by excavation and grading of existing pond embankment material or grade. A very limited amount of earthwork will also be necessary to construct the inlet to the pump station at the navigation channel and to install the underground piping to the wet wells and from the pump station to the distribution canal.

Side slopes of 3:1 or shallower will probably be required for all newly constructed earthen pond embankments. This is believed necessary because of the unstable soil conditions observed during a site visit. Actual design will be developed when the soils report becomes available.

5.4.2 Paving

The entry road as well as parking and turn-around areas at the site will be paved. The crushed rock base and paving thicknesses will be based on the largest weight class of vehicles expected to have access to the site. Foot paths atop the pond embankments will not be paved but are expected to require vegetative soil stabilization measures to reduce maintenance requirements.

5.4.3 Water Intake

The total water requirement for the SFH will be about 14,000 liters per minute and will be obtained from the adjoining navigation canal. Two pipe conduits will be installed from the intake structure at the canal to the pump station. One pipe will draw up to 1,725 liters per minute of water which will be filtered and aerated for distribution as described in Section 5.1.1. The second pipe will draw up to 12,240 liters per minute which will be distributed directly to the outdoor ponds without treatment. The intake structure at the canal will be constructed using reinforced concrete and will be shared by the two water intake pipes. A trash rack will be incorporated in the intake structure to prevent entry of large floating objects which could clog the intake pipes or inflict damage to the pumps. Each intake pipe will terminate in a separate wet well located at the pump station.

5.4.4 Hydraulic Profile

Pumping will be required for all water in order to provide the required filtration, or to provide sufficient hydraulic gradient through the revised open channel water distribution and drainage system to satisfy peak flow requirements. The hydraulic profile for the proposed system is shown on SFH Figure 5.5. The existing system is similar, but construction of a new system is recommended for water quality and quantity considerations.

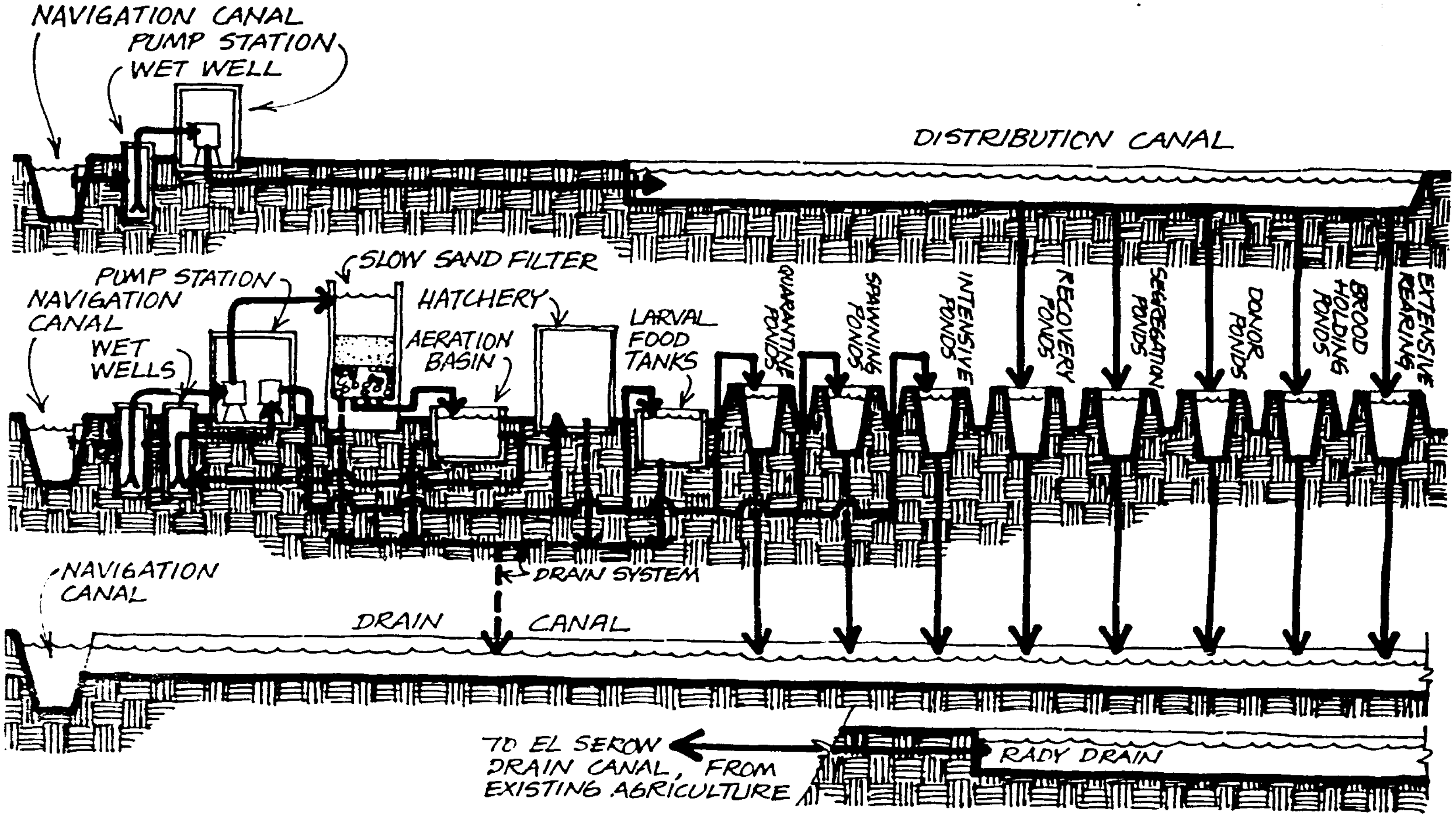
The system requiring filtration and aeration has been discussed earlier in this chapter and no further descriptions are believed necessary. The untreated canal water system, however, needs to be discussed further. The extensive changes to this system are recommended to prevent any recirculation of drain canal water through the water intake, thus preventing the possible spread of disease from one afflicted pond to the whole hatchery.

It is possible that recirculation of water occurs with the existing system. This is indicated because the Rady drain canal discharges into Serow primary drain upstream of the intake pump station for the navigation canal, the only source of water to the SFH. It is therefore proposed to reverse the flow direction through the ponds by utilizing the unfiltered pumped supply to feed the existing drain canal which is shown as the distribution canal in SFH Figures 5.5 and 5.6. The existing supply canal would then function as a drain without any further modifications because of hydraulic gradient. Removal of the existing inlet structure at the supply canal may or may not be necessary. This will be determined when its dimensions and design become available.

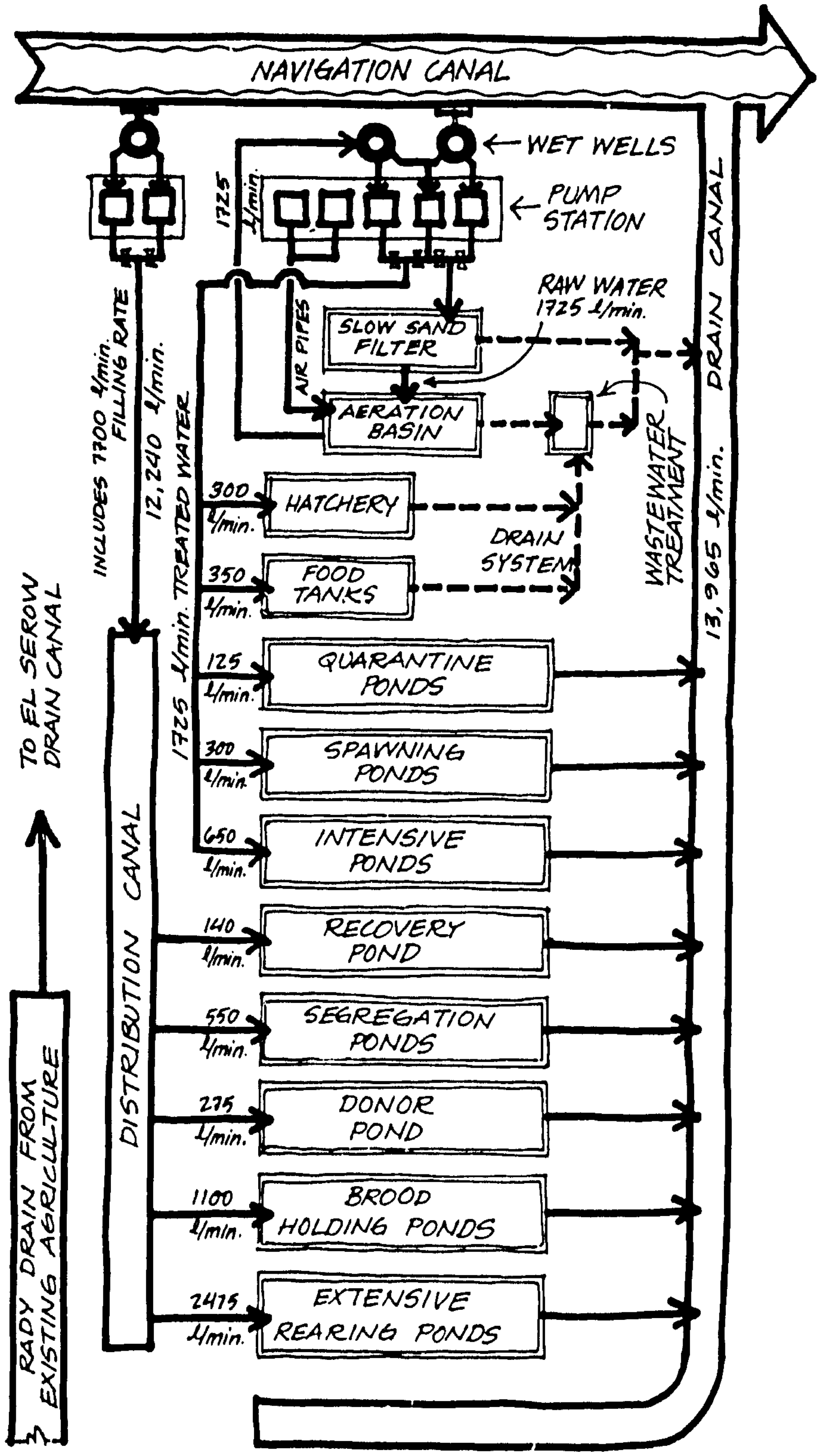
The conceptual water supply and drainage scheme for the SFH assumes that the flow rate in the navigation canal is significantly greater than the peak water needs of the site. If this assumption is not true, the proposed water system would result in greater recirculation potential than with the existing works and would be totally unsatisfactory. Even if the navigation canal flow rate is slightly higher than the water demands of the site, tidal fluctuations in Lake Manzala, and/or restrictions in the flow path of the canal (i.e., siltation and excessive aquatic vegetation) downstream of the site could result in some recirculation. Because this condition cannot be tolerated a hydraulic evaluation of the canal should be conducted, and historical flow and tidal information should be obtained to ascertain the feasibility of the proposed system.

5.4.5 Water Distribution and Drainage System

The water distribution and drainage system for the site is shown on SFH Figure 5.6. The treated canal water will be distributed by pipeline to the hatchery building, outdoor larval food tanks, quarantine ponds, spawning ponds,



SFH Figure 5.
Hydraulic Profil



SFH Figure 5.6
Water Distribution and Drainage System

and intensive rearing tanks. The untreated canal water will be piped to the distribution canal which will supply the broodstock recovery pond, segregation ponds, donor pond, broodstock holding ponds, and the extensive rearing ponds. Outflow from all the ponds and tanks will be conveyed by gravity to the drain canal by a system of pipes and open channels.

Screening will be provided at all outlet conduits and at the inlets of the ponds supplied by the distribution canal. Visual observation of the inlet and outlet gates of the existing rearing ponds indicated that most were inoperable due to lack of use and maintenance. It is assumed that this problem will be remedied by the ongoing restoration work. Inlet and outlet modification costs for the existing rearing ponds are not included in the cost estimate.

5.4.6 Design/Code Standards

The only portion of the recommended civil systems discussed in this section that will incorporate design standards will be the site road work. The APWA standards will be adopted for this work.

5.4.7 Other Considerations

To guarantee that the water supply system for the site will function properly, an adequate and reliable electrical power source must be provided. Continuous monitoring of pump performance and water surface elevations both upstream and downstream of the pump station must also be provided to prevent large fluctuations in water levels which could impair the effectiveness of the water distribution system.

5.5 STRUCTURAL SYSTEM

5.5.1 Loads

The SFH design loads are the same as those loads described in NAC Section 6.5.1.

5.5.2 Building Materials

Cast-in-place (CIP), reinforced concrete is the recommended building material for the structural members of the SFH. Red brick or hollow concrete block are the recommended materials for exterior wall construction. See NAC Section 6.5.2 for a discussion of these building materials.

5.5.3 Foundations

The foundation for the SFH may be either isolated spread footings or continuous footings as described in Section 6.5.3 of the NAC portion of this report. The final selection of foundation type will be made after the results of soil tests performed at this site are received.

5.5.4 Building Framing System

A CIP, reinforced concrete frame with masonry infill walls is the recommended structural system for the SFH. A description of this system can be found in NAC Section 6.5.4.

5.5.5 Design Criteria

See NAC Section 6.5.6 for a description of the design criteria which are applicable to the SFH design.

SEROW FISH HATCHERY
CHAPTER 6
ESTIMATED COST OF CONSTRUCTION - SUMMARY

6.1 BASIS OF COST ESTIMATE

The conceptual construction cost estimate for the Serow Fish Hatchery (SFH) is based on the concept design criteria researched and developed for this project as described herein as well as the currently understood project site conditions and limitations. All material, labor, and equipment costs are based on the joint professional knowledge and related construction experience for similar projects by the design team for both home and abroad.

Wherever possible, construction costs are based on native construction materials and current Egyptian construction practices. Construction is to be performed by local contractors. The cost of all American (U.S.A.) made material and equipment used in this cost estimate includes all expected handling and freight charges, F.O.B. Alexandria, Egypt, but does not include any United States export duties which may be levied against such goods.

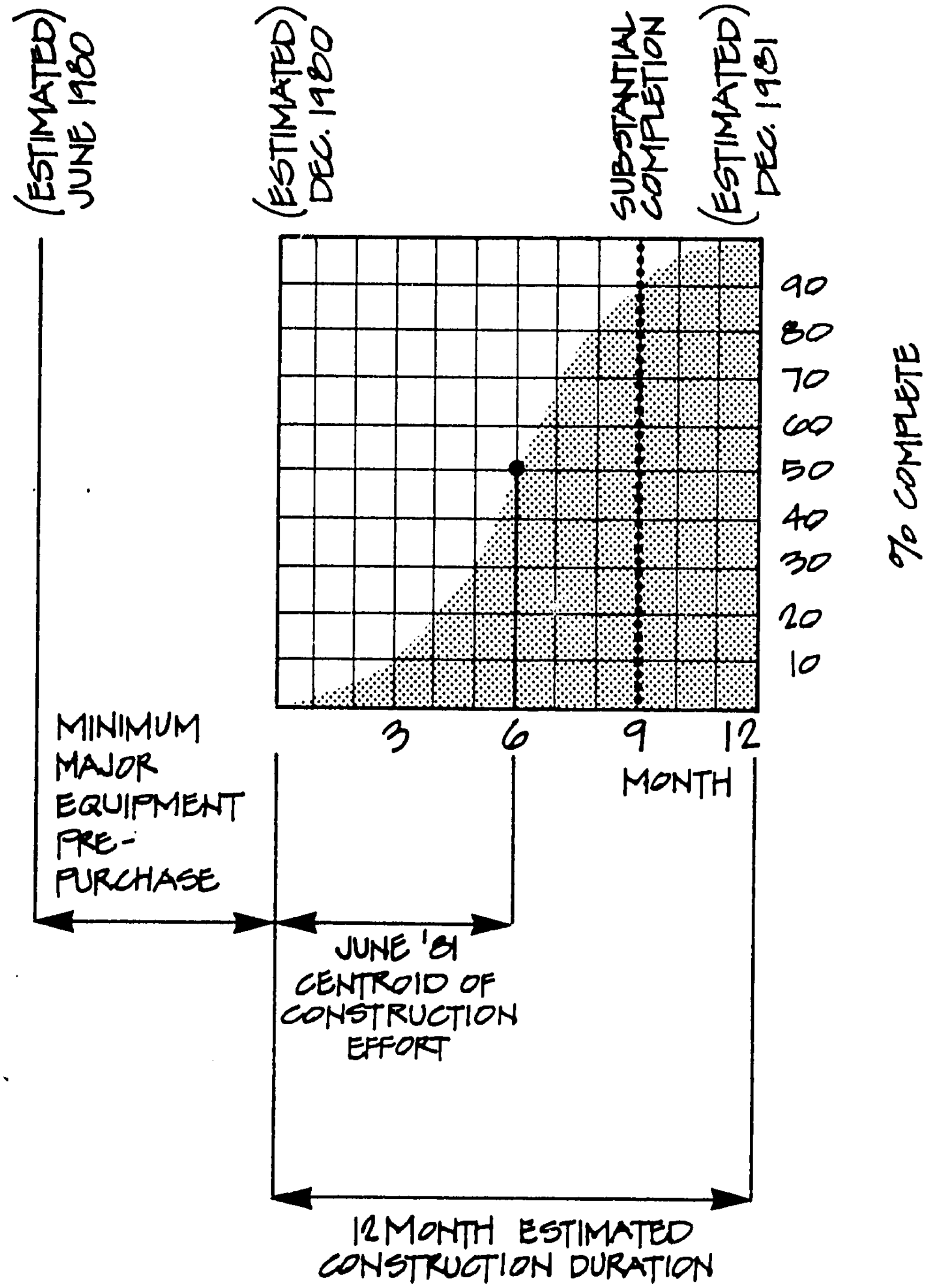
All construction costs are shown in U.S. dollars as of February 1980, escalated to the projected mid-point of project construction (see SFH Figure 6.1).

6.2 SCOPE

The proposed project budget covers all work necessary to construct the SFH including the production facility, fuel storage building, retrofit of the existing administration building, and all associated work including all site mechanical, electrical, and civil work as described herein within the limits of the proposed site boundaries. It is important to note that in no case does the cost estimate reflect an expenditure for any work on the public water systems.

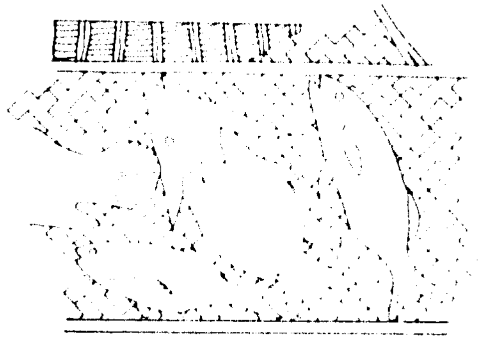
6.3 COST SUMMARY

6.3.1	Site Work	US $ 401,000
6.3.2	SFH Laboratory and Hatchery Building	292,000
6.3.3	SFH Existing Administration Building	38,000
6.3.4	SFH Feed Storage Building	7,000
6.3.5	Cost Factors and Assumptions @ 10%	73,800
6.3.6	Construction Cost - Subtotal	US $ 811,800
6.3.7	Overhead and Profit @ 20% of Line 6.3.6	162,360
6.3.8	Mobilization @ 5% of Line 6.3.6	40,590
6.3.9	Remoteness @ 15% of Line 6.3.6	121,770
6.3.10	Construction Cost - Total (February 1980)	US $ 1,136,520
6.3.11	Contingencies @ 15% of Line 6.3.10	170,478
6.3.12	SFH Project Subtotal (February 1980)	US $ 1,306,998
6.3.13	Escalation to September 1981 @ 38% of Line 6.3.12	496,659
6.3.14	SFH Project Total Projected Cost	US $ 1,803,657
6.3.15	SFH Project Total Projected Cost, Rounded	**US $ 1,804,000**



ALL COSTS ARE BASED ON A PROJECTED MID-POINT OF CONSTRUCTION, JUNE '81

SFH Figure 6.1
Construction Timetable Diagram



MULLET COLLECTING STATIONS

MULLET COLLECTING STATIONS
(MCS)

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MULLET COLLECTING STATIONS
CHAPTER 1
GENERAL PROJECT PROFILE

1.1 PURPOSE AND FUNCTION

The demand for mullet fry (Mugil cephalus and Mugil capito) for stocking Lake Qarun and private fish ponds in Egypt is at least 35 million each year. Demand for mullet fry during the next decade, based upon known government development plans, is estimated to be 155 million fry. A new lake to be developed in Wadi El Ruwayan, southwest of Lake Qarun, will require at least another 10 million mullet fry per year.

At present, the El Mex fry collecting station is the only station providing mullet fry to fish ponds. The El Mex station originally provided 20 million mullet fry but now produces only half that number due to chemical and organic pollution of the El Mex waters. Therefore, the long-term potential of the El Mex station is at best uncertain. Certainly it is inadequate to meet the demand for mullet fry.

Two better sites for collecting stations have been identified. One is at the El Gameel Channel which connects Lake Manzala to the Mediterranean about 6 km west of Port Said. The other is at the Gamassa Channel about 50 km west of the Domyat (Damietta) branch of the Nile. Both locations have access to good roads, and the distance to the southernmost point of fry distribution is about 200 km or well within practical fry transport range. Land and fresh water are also available, although dechlorination of fresh water will probably be necessary at both locations.

Each collecting site can probably yield about 30 million fry (M. cephalus and M. capito) per year. Collecting stations at both locations have been designed to accommodate this number of fry. The fry yield at each collecting station may increase by about 15 percent through refinement of management techniques, although major expansion cannot be expected from these sites for several reasons. Since the output is dependent upon the numbers of natural spawned fry in each locale, the natural productivity will determine fry availability. Also, the area that can supply a given collecting station is limited by the transportation time required to deliver the captured fry to the station. Each will require about 2.5 feddans of land area surrounded by security fencing in the vicinity of a floating pier which will receive fry delivery from local fry collecting boats. Collected fry will be checked for disease conditions, acclimated to fish pond salinities, and then transshipped to nursery and grow-out ponds. These fish ponds will be located at: (1) the National Aquaculture Center (NAC) at El Abbasa, where the fry will be held for 1 to 12 weeks before distribution to the farms of the Model Homestead Complex (MHC) nearby, (2) the existing private and government fish farms in the region, and (3) the fingerling ponds at the NAC.

1.2 ADMINISTRATIVE PROFILE

Each mullet collecting station and its activities will be the responsibility of an MCS station administrator. Activities at each station will be closely monitored by NAC personnel.

1.3 EXPERIMENTAL/RESEARCH PROFILE

Research efforts at the mullet collecting stations (MCS) will be limited during the collecting seasons. Most research during this period will be directed toward identification and control of pathogenic organisms affecting the fry. Handling and transport of fry, as well as crowded conditions at the collecting stations, will contribute to the stress on the fry, making them more susceptible to disease organisms. A continuous monitoring program is essential to maintain healthy and disease-free acclimation facilities at the collecting station.

During the off-season the MCS may conduct research experiments designed to improve acclimation procedures and develop information on fry nutritional requirements. Alternate feeds or feeding regimes might evolve from such experiments.

Research at the MCS may be done using the acclimation and isolation facilities or in the laboratory. The wet-lab portion of the laboratory is intended to support experimental fry populations and is capable of duplicating many of the conditions encountered during the normal acclimation cycle. Other laboratory components may be used for data gathering and analyses.

1.4 PRODUCTION PROFILE

Mullet fry will be acclimated to fresh water at the El Gameel and Gamassa MCS in 10-day cycles. M. capito will be collected for acclimation and subsequent transport to the fish farms from mid-February to mid-July of each year. From approximately mid-July through November of each year, the fry being collected will be M. cephalus. This results in fry collecting activity for about 9-1/2 months of each year (MCS Table 2.2).

Fry of both species will be treated according to the same schedule. Mullet fry will be delivered to the MCS by boat to the incoming pier at the station or by surface road. Fry will be examined for general health and transport injuries upon receipt by the station. Healthy fry will be counted into the acclimation raceways where they will be acclimated to freshwater conditions.

The salinity of the acclimation raceways will be adjusted to that of the collecting waters to minimize transport and handling shock for incoming fry. Water in the acclimation raceways will remain at this salinity for two days to allow the fry to become stabilized after collection and transport to the collecting station. Once the condition of the fry becomes stabilized, the salinity may be slowly adjusted to the target salinity, or fresh water for most farm ponds. This salinity change should require one to two days to complete to avoid further stress on the fry.

The remaining six days of the acclimation cycle are intended to accomplish several objectives. The fry are permitted to stabilize at the new salinity while being closely monitored for disease outbreaks or continued transport mortality. Mullet fry that exhibit excessive mortalities or disease symptoms should be immediately transferred to the isolation tanks for treat-

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ment. This portion of the 10-day acclimation cycle may be used to plan for disposition of the fry to nursery and grow-out ponds. Logistics of fry transport are very important since transport-induced stress is directly correlated to handling care and length of time in transit. Also, at least 24 hours is required to clean and sun-dry each acclimation raceway thoroughly in preparation for the next acclimation cycle. This part of the cycle is necessary to prevent pathogenic organisms from infecting consecutive fry lots. Therefore, all nets and equipment used in the tanks and raceways should be dipped in a disinfecting solution or completely sun-dried between each use.

Mullet fry that have been determined to be diseased or excessively stressed should be placed in the isolation tanks to prevent spread of infection to healthy fry and to permit treatment of the affected fry. Standard treatment procedures are to•be followed for the situation as determined by the collecting station's laboratory staff.

Upon completion of the acclimation period, the fry will be crowded to one end of the raceway where they may be netted and counted into transport containers. Transport containers will be moved to the shaded loading dock where they may be loaded onto trucks for distribution to grow-out ponds. Transport time, from crowding in the raceway to release at the fingerling or grow-out pond, should be kept to a minimum.

1.5 SUPPORT PROFILE

Periodic maintenance and light repairs of MCS facilities and equipment may be done at the station by the laborers and security staff as directed by the station administrator and support staff. This might include maintenance of vehicles, pumping systems, and the station building.

1.6 FEED PROFILE

Dry fish rations, such as rice bran, will be fed to the mullet fry at about five percent of body weight per day. This will require almost 13 kg of food per day when all tanks and raceways are stocked to capacity, which is 1.7 million fry. A one-month supply of feed would be about 375 kg.

1.7 STAFFING PROFILE

The station administrator will be assisted by four technically-qualified support staff members. The support staff will operate the laboratory and manage the day-to-day tasks at the collecting station. This will include the receipt and distribution of fry to fingerling and grow-out ponds as well as maintaining the acclimation schedules. When required, they will also transfer weak or stressed fry to the isolation tanks and see that treatment is carried out. Feeding schedules and equipment maintenance are also the responsibilities of the support staff.

The four support staff will supervise the work of five laborers and security guards, as well as two drivers for each station. Their schedules will include night shifts as required.

MULLET COLLECTING STATION
CHAPTER 2
BIOLOGICAL PROCESS DESIGN

2.1 MULLET PRODUCTION PROGRAM

2.1.1 Mullet Production Goal

The mullet collecting stations (MCS) will serve as a collecting point for natural-spawned mullet fry, Mugil cephalus and Mugil capito. Fry will be captured by local fishermen as well as in fish traps at the station. Upon delivery to the MCS, the fry will be acclimated to fresh water and transshipped to fingerling and grow-out ponds at the National Aquaculture Center (NAC), Model Homestead Complex (MHC), and private fish farms. Each MCS is designed to acclimate and transport at least 30 million fry per year, although total numbers of fry depend on the natural productivity within the fry collecting range. Facilities at each MCS are capable of holding 1.67 million fry at one time.

2.2 FACILITIES REQUIREMENTS

MCS facilities' requirements are summarized in MCS Table 2.1.

2.2.1 Pier Requirements

Captured mullet fry (M. cephalus and M. capito) will be brought to the pier for incoming fry at the El Gameel and Gamassa MCS. They should be delivered to the pier in aerated containers or fish baskets at a suggested density of not more than 1,500 fry (0.15 g each)/l. The water in the containers should be the same as the water where the fry were collected, and care should be taken to keep from exposing the fry containers to direct sunlight.

Piers at the MCS should have low freeboards to permit easy access for the small, local vessels that are presently used for harvest. Saltwater hoses should be provided to supply water for hosing out fish boxes, boats, and pier. The pier should provide access for four boats at a time.

One or two fyke-type fish traps (5-m-wide mouth by 3-m-long by 1-m-deep) of 3-mm mesh should be suspended under the pier to supplement fry catch. These traps should open to the prevailing currents. An additional trap will be located at the station's submerged water discharge point but oriented away from the water flow.

Boats delivering fry will be met at the incoming pier by one of the station's technical staff. This person will supervise the transfer of the fry to an appropriate acclimation raceway and verify the fry count. Acclimation of transport containers to ambient raceway water temperatures will require at least 15 minutes to avoid temperature shock-related mortalities.

2.2.2 Acclimation Requirements

Facilities at the MCS will permit segregation of different deliveries of fry so that fry condition and survival may be monitored for each group.

MCS TABLE 2.1
FACILITIES REQUIREMENTS

Space/Facility	Estimated Area (m^2)	Purpose	Capacities	Requirements	Relationships
Incoming pier	75	Receive fry deliveries Trap fry Boat access to station	Tie-up space for 4 boats 2 traps 30m x 2.5m	Floating in 1.2m water, road access to station, low freeboard with railing water hose	Close to isolation tanks and acclimation raceways (5 minutes)
Isolation tanks	112	Isolate and treat diseased fry Fry feeding trials during off season	(4) 5m x 2m x 1m tanks hold 3,000 fry	4m-wide truck access to each, 0.2% bottom slope, 20 l/min/ tank SW and/or FW minimum, multiple air-water outlets Complete and independent draining	Adjacent to acclimation raceway
Acclimation raceways	4,830	Acclimate fry to fresh water Fry feeding trials during off-season	(60) 21m x 3m x 1.5m raceways hold 1.67 mil. fry Segregated lots and hapa capability	4m-wide truck access to each, 0.2% bottom slope, 10 l/min/ raceway SW and/or FW minimum multiple air-water outlets, screen dividers, complete and independent draining	Close to pier Adjacent to isolation tanks
Loading dock	10	To provide shaded truck loading space and ramp access for fry and bulk shipments	1 truck space Cart ramp	Elevated, shaded loading ramp	Close to acclimation raceways, adjacent to equipment and storeroom
Storeroom	5	Storage for dry bulk feed storage General station supplies	375-kg feed bin Wall shelves and cabinets	Rodent and insect protected No water leakage	Adjacent to loading dock near crew room
Equipment room	14	House mechanical support systems (auxilliary generator, 2 air blowers, water pump, work space)	Total primary mechanical systems Support for station	Single and 3-phase electrical power, bench repair space, adequate ventilation, tools, and cabinet space	Adjacent to loading dock, near to crew room
Crew room	5	Temporary accommodations for overnight or off-hours personnel	Sleeping and eating facilities for 2 persons	2 banks, table, chair, sink/cooking facilities	Close to storeroom, equipment room
General lab	18.5	Experimental monitoring and pathology facilities for MCS-related functions	Aquaria wet-lab space, post-mortem examination table, general lab instrumentation	Wet space and wet counter space, bench-top space, wall cabinets and shelves, air at one l/sec, FW and SW at 20 l/min, water filtered to 5 microns	Close to common and senior office space
Senior office	12	Office space for station administrator	Office and conference space for 5	Desk, table, chairs, wall shelves, files	Adjacent to common office
Common office	18.5	Office space for 4 technical personnel	Office and filing space for 4	4 desks, chairs, file cabinets, shelves, 1 table	Adjacent to senior office and general lab

Acclimation of the fry to designated salinities will occur in 60 paired, raceway-type structures (21 m by 3 m by 1.5 m) which may be subdivided into three sections using mesh screens. Screens should be of rigid construction with a 3-mm metallic mesh to allow easy use and maintenance. The raceways may also be used as containers in which hapas or net bags (6 m by 2.5 m by 0.75 m) can be suspended from poles across the raceway to segregate fry stocks. This additional capacity will require no changes in raceway construction. The bottom of each raceway should have a slope (0.5 percent) towards the outflow for complete and independent drainage and drying. Sand-filtered seawater and fresh water is required at flow rates of 10 l/min/raceway. Each raceway will have multiple air outlets for aeration and multiple water nozzles to spray water on the water surface.

Raceways may be harvested using braided nylon seine nets of 3-mm mesh to crowd the fry to one end. They may then be removed with braided nylon dip nets of 3-mm mesh for counting and transport.

Net drying facilities should be provided. Poles, 2.2 m high, should be installed at 3-m intervals to allow nets to be hung for drying. Three rows of six poles will be sufficient. Freshwater hoses will be required at the drying racks for cleaning suspended nets.

2.2.3 Isolation Requirements

Mullet fry delivered to the MCS that exhibit disease symptoms or excessive mortalities will be transferred to the four 10,000-liter isolation tanks (5 m by 2 m by 1 m). Except for dimensions, the isolation tanks are to be designed similar to the acclimation raceways. The bottom of each tank should be sloped (0.5 percent) towards the drain and be supplied with multiple aeration and water (120 l/tank fresh water and sea water) nozzles for surface spraying. Truck access to each tank is necessary.

2.2.4 MCS Station Building Requirements

Each collecting station will have its station building adjacent to the acclimation raceways and isolation raceways and as close to the incoming pier as practical. This building will include office space for the station administrator as well as a common office for the support staff (four). A general laboratory will also be housed in this building. The laboratory will be equipped with a refrigerator-freezer, microscope, wet space for aquaria, post mortem examination counter, and basic water-quality analysis capabilities.

Also included in this building is an equipment room to house mechanical support systems (auxiliary generator, air blowers, tools, etc.). A crew room/kitchen will provide accommodations for staff members required to remain at the station for extended periods of time.

A storeroom will be used for general station supplies as well as bulk storage for dry fish rations such as rice bran. Approximately 13 kg of dry food will be required daily to feed fry stocked in the raceways. The monthly storage capacity would be about 375 kg of dry food. The storeroom should be screened to prevent insect and rodent infestation.

Fry will be loaded onto trucks from a shaded loading ramp for distribution to grow-out ponds elsewhere. This ramp may also be used for bulk handling of feed, equipment, and other stores.

2.3 PROGRAM OPERATION AND SCHEDULING

Operational periods for the MCS will correspond to the natural spawning seasons, beginning about six weeks after spawning commences. For M. capito this season will last from mid-February to mid-July, and from mid-July through November M. cephalus fry will be collected. Each station will thus be actively engaged in acclimation of fry to fresh water and transport of fry to fingerling and grow-out ponds for approximately 9-1/2 months per year. The remaining 2-1/2 months of each year may be used for maintenance and research efforts. (See MCS Table 2.2, Operating Schedule.)

The principal water source for each raceway will be at the common end and a swinging-arm discharge pipe emptying into a 1-m-wide drain channel next to the 4-m-wide access road. Slots for two 3-mm metallic mesh screens, as described above, will be located immediately in front of the discharge pipe to prevent fry from being carried out of the raceway. The double slots will permit changing the screens without loss of fry.

Both salt water and fresh water supplies must be aerated to saturation prior to delivery. Both supplies will be filtered through sand filters prior to entering the headboxes. If fresh water is supplied from a well or is potable water, filtration will not be required, however. Headboxes will be covered.

Emergency generators will provide both fresh and salt water during the event of a power failure. Low-level alarms are needed in both headboxes.

The saltwater intake should be located at a depth that sufficiently avoids contamination. It should be at least 0.5 m above bottom to reduce sediment intake. Duplicate underwater piping systems will eliminate downtime due to fouling and should be able to be backflushed. Impingement velocities at the intake should not exceed 0.15 m per second. All organisms and debris larger than 5 cm should be screened from the intake.

Water supplied to the laboratory should be filtered to 5 microns. Two cartridge filters in the laboratory are recommended for fresh water and for seawater.

The total flow requirements are 1,500 l/min for each water type. For filling rearing tanks, three tank volumes over an eight-hour period are required (567,000 l salt water over eight hours).

2.4 ENVIRONMENTAL REQUIREMENTS

All acclimation and isolation facilities at the MCS will be outdoors. The loading ramp and the working area adjacent to the incoming pier will be provided with a roof to prevent overheating of fry transport containers. Inside the station building, the general and wet laboratories will require adjustable photoperiod control.

MCS TABLE 2.2
OPERATING SCHEDULE

<table>
<tr><th>SPECIES \ MONTH</th><th>JAN</th><th>FEB</th><th>MAR</th><th>APR</th><th>MAY</th><th>JUN</th><th>JUL</th><th>AUG</th><th>SEP</th><th>OCT</th><th>NOV</th><th>DEC</th></tr>
<tr><td>Mugil capito</td><td></td><td colspan="4">collection, acclimation, transport (10-day cycles)</td><td colspan="2">feeding trials</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Mugil cephalus</td><td colspan="2">feeding trials</td><td></td><td></td><td></td><td></td><td colspan="5">collection, acclimation, transport (10-day cycles)</td><td>←</td></tr>
</table>

2.4.1 Water Quality

All seawater at the MCS should be sand-filtered to remove sediment and other particulate matter. Fresh water, unless it is potable, should also be sand-filtered. All water used in the fry tanks and raceways should be aerated to 80 percent of saturation before delivery to the holding facilities. Filtration of particulates to a nominal pore size of five microns is necessary for the sea water and fresh water in the laboratory. Water supplies should be covered to limit biofouling.

2.4.2 Water Temperature

Water temperature in the acclimation and isolation facilities will be allowed to adjust to ambient levels. The water in static containers, such as fry transport containers, should be shaded to prevent overheating and stress of the fry.

2.4.3 Water Exchange Rates

Both salt water and fresh water will be required at the collecting stations. Salinity adjustments will be made in individual tanks to acclimate fry to fresh water prior to shipment. Therefore, separate salt and freshwater lines must be provided to every rearing unit and holding tank. Adjustments will be made by opening two valves at each tank to achieve the desired salinity. To reduce fluctuations in salinity due to fluctuating water demands, pipes should be sized to minimize "starvation."

The total flow requirements for the MCS are 1,500 l/min each for fresh water and seawater. For filling the raceways, three raceway volumes per eight-hour period are required (600 l/min). Normal operating flows will be 10 l/min per raceway, 120 l/min per isolation tank, and 100 l/min in the general laboratory's wet-lab space.

2.4.4 Emergency Support

An emergency generator will be needed for water supply and air blowers of sufficient capacity to maintain minimum dissolved oxygen levels of 3.5 mg 0_2/l in all of the tanks and raceways in case of electrical power failure. Spare water pumps and air blowers are recommended since a mechanical failure will soon result in mass fry mortalities due to heavy fry stocking densities.

2.5 EXPANSION REQUIREMENTS

Since the production potential of each MCS is dependent upon the natural spawning productivity within the area that it serves, little expansion of the facilities at either site is envisaged. Significant expansion of productivity will necessitate the development of additional collecting stations.

2.6 TRANSPORTATION

2.6.1 Intrasite

The incoming pier must be connected by surface road to the isolation tanks and acclimation raceways for transport of fry shipping containers. Each acclimation raceway and isolation tank requires truck access at some point. A loading ramp will be used to assemble and load fry shipments leaving the MCS. Carts may also be utilized for small fry transfers within the MCS site.

2.6.2 Intersite

Mullet fry will be delivered to the MCS via boat and surface road. Fry shipments to other fingerling and grow-out ponds will be via surface road. Station resupply will also make use of surface roads. Two trucks are to be assigned to each MCS.

MULLET COLLECTING STATIONS
CHAPTER 3
PROJECT SITE

3.1 EXISTING ENVIRONMENTAL CONDITIONS

Two sites for the mullet collecting stations (MCS) have been tentatively selected by the Ministry of Agriculture (MOA). However, because ownership of these sites is not clearly defined, the selection has not been finalized and no site surveys were conducted by the design team. Therefore, the site analysis drawings of the two tentative sites, El Gameel and Gamassa, are drawn from photographs and are not intended to be accurate. (See MCS Figures 3.1 and 3.2.).

El Gameel is located between Lake Manzala and the Mediterranean Sea on a narrow canal which connects the two bodies of water. The site is just west of Port Said. Gamassa is a resort village located west of Damietta on the Mediterranean sea. The Gamassa site is located to the west of an agricultural drain canal near the Mediterranean Sea.

After design review of the project and these two sites, it appears that there will be no significant adverse environmental impact from either project. This conclusion is from a relatively cursory review as no detailed environmental impact assessment has been made for this project.

3.1.1 Climatic Conditions

El Gameel and Gamassa sites are located in relatively arid climates tempered by the water mass of the Mediterranean Sea and Lake Manzala at the El Gameel site. The El Gameel site has no vegetation other than water grasses to provide climate control. Gamassa does have dense groves of trees to the north and south of the site.

Rainfall at El Gameel is very light with a mean annual total of 71.7 mm over the last 30 years. The highest monthly mean rainfall is in December at 17.6 mm with the months of June, July, and August showing no rainfall or only a trace. The relative humidity is moderate on the site running from a mean low in March of 67 percent to a mean high in the months of January, July, and December of 72 percent.

At Gamassa the rainfall is also light with a mean annual total of 106.6 mm over the last 40 years. The highest monthly mean rainfall is in December at 24.9 mm with the months of July and August showing only a trace. The relative humidity is moderate on the site running from a mean low in the months of March, April, and May of 68 percent to a mean high in August of 76 percent.

The predominant winds year-round at El Gameel come off the Mediterranean Sea from northwest to northeast. These winds are generally mild except for occasional storms coming off of the Mediterranean.

At Gamassa the winter winds tend to come from the southwest, with the predominant summer winds from the northwest off of the Mediterranean. These winds are generally mild except for storms.

The temperatures at El Gameel are mild in the winter and quite warm during the summer months. The lowest mean day temperature of 14.3°C is in January with the maximum mean day temperature of 27.3°C in August. The minimum monthly mean temperatures occur in December, January, February, and March, which are respectively 13.3°C, 11.3°C, 12.0°C, and 13.4°C. The maximum monthly mean temperatures happen in June, July, August, and September and run from 28.6°C to 30.8°C. The highest temperature recorded for El Gameel was 45.0°C in May 1970.

At Gamassa the temperatures are also quite mild in winter and warm in the summer. The lowest mean day temperature of 12.9°C is in January with the maximum mean day temperature of 26.0°C in August. The minimum monthly mean temperatures happen in December, January, February, and March which are respectively 10.7°C, 8.4°C, 8.8°C, and 11.0°C. The maximum monthly mean temperatures happen in June, July, August, and September and run from 29.5°C to 31.2°C. The highest temperature recorded for Gamassa was 46.5°C in May 1941.

Day length, at both sites, throughout the year is not extreme because of Egypt's position in relation to the equator.

3.1.2 Topographic Features/Soil

The sites at El Gameel and Gamassa are both extremely flat. At El Gameel a road elevated on an embankment 1 m to 2 m high runs through the site.

Because these sites are not finalized, soils investigations have not been conducted, however, from site observation it is known that both sites have sandy soil.

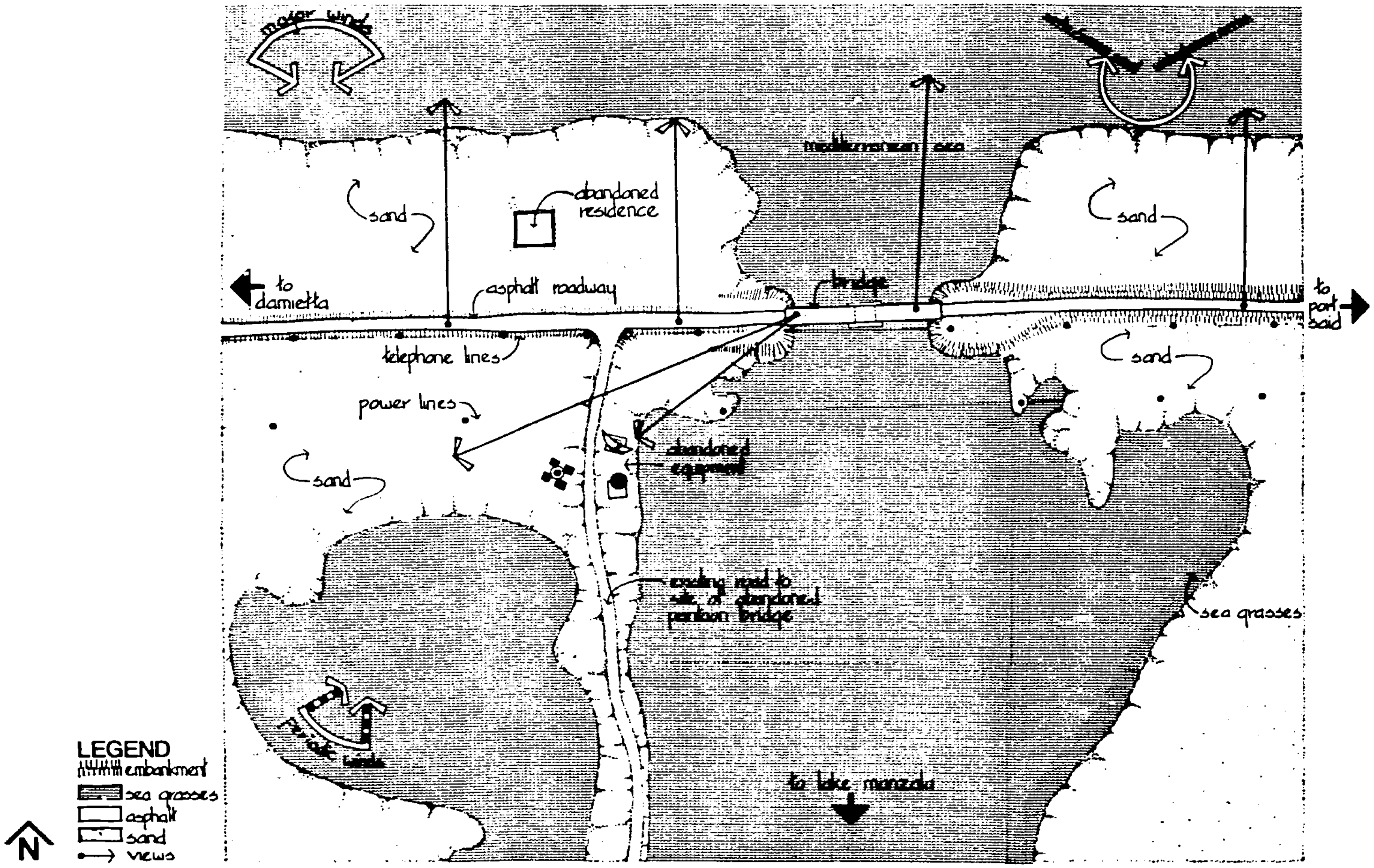
3.1.3 Flora/Fauna

El Gameel is bleak with virtually no vegetation except for marsh grasses growing in the shallows of the canal. At Gamassa the site is barren but enclosed on the north and south by citrus groves.

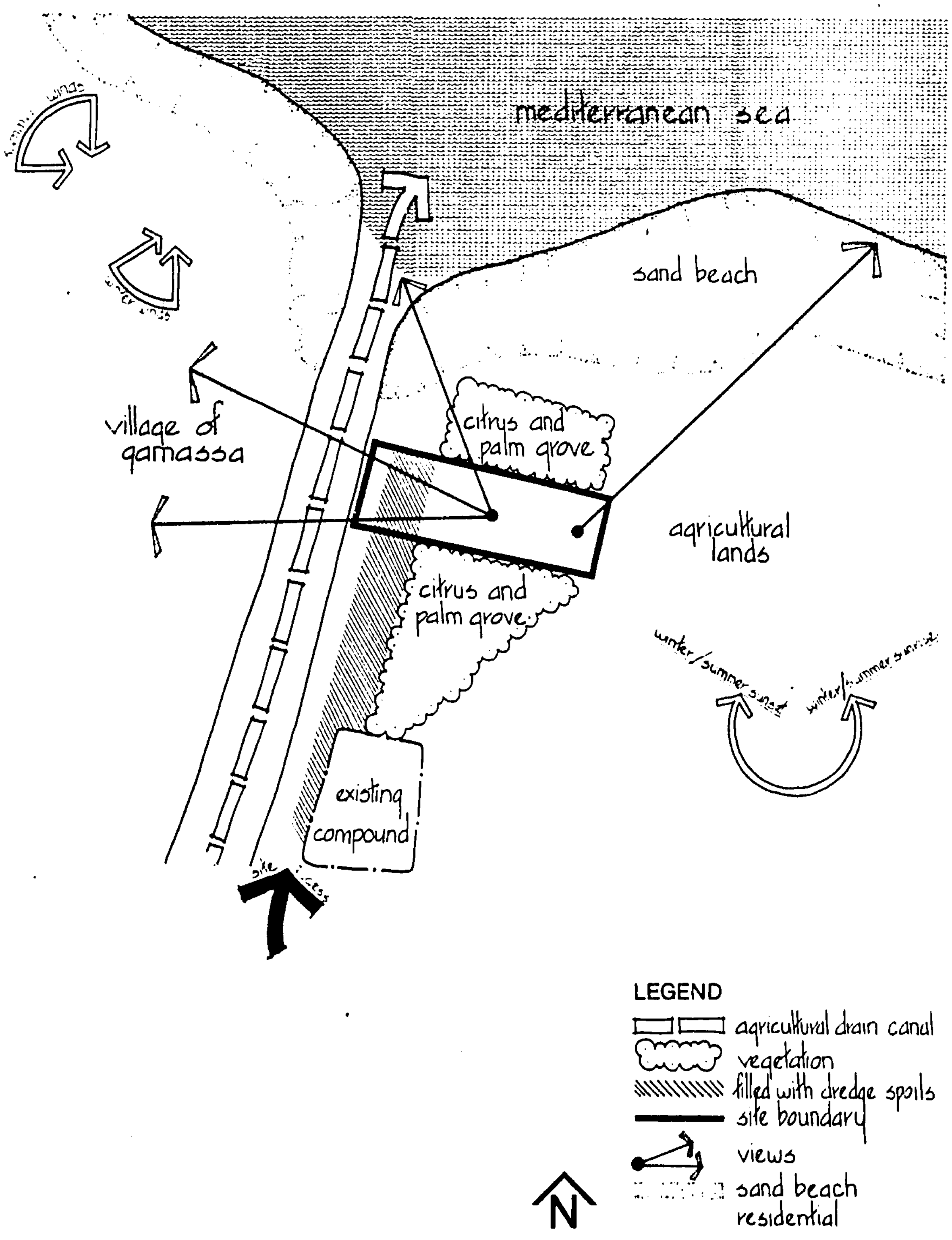
Neither site supports any wildlife other than rodents and songbirds. The waters of the sites are plentiful with mullet and other fish species.

3.1.4 Water Supply System

Because a site survey has not been conducted, there is no specific information about the existing water supply systems. At El Gameel a water supply line runs adjacent to the road from Damietta to Port Said. At Gamassa a potable water system is located in the adjacent village which is approximately 200 m from the site. No details on this system are as yet available.



MCS Figure 3.1
Composite Site Analysis El Gameel



MCS Figure 3.2
Composite Site Analysis Gamassa

3.1.5 Drainage and Collection System

No drainage or collection system exists on either site. Because of the sandy soil, the surface water percolates into the ground rapidly.

3.1.6 Utilities

Power and telephone lines exist at both sites. No wastewater collection or treatment is available at either site.

3.2 DESIGN PARAMETERS

3.2.1 Site Character

The site at El Gameel is located on a sand isthmus which separates Lake Manzala from the Mediterranean Sea. The site is bleak and human development has been abandoned. On the north side of the road is the Mediterranean, on the south side the shores of Lake Manzala.

The Gamassa site is located across a drainage canal from the resort village of Gamassa. The buildings are typical rectangular Egyptian structures which are often painted in pastel colors.

3.2.2 Future Expansion

There are no apparent physical limitations of the sites which limit growth. The major limitation to expansion of both facilities is the supply of mullet fry in the adjacent waters. It is likely future expansion will be limited to construction of other sites, rather than additions to the proposed ones.

3.2.3 Flexibility

The location and design of these stations limit them to the sole use of collection and acclimation of mullet fry. The acclimation raceways will be designed with intermediate screens dividing the length. This feature allows considerable flexibility in the management of the raceways.

3.2.4 Circulation

Vehicle access will be provided from the access road to the building and the loading dock as well as to the pier and to the ends of all raceways. Parking for three vehicles will be provided adjacent to the building for staff and visitors.

All vehicle access at the MCS will be paved in asphalt to accommodate the use of wheeled carts to move the fry without seriously shocking the fish.

The main access road will be 8 m wide; all other roads will be 4 m wide.

3.2.5 Existing Conditions

The existing conditions listed previously are criteria for development of the site and must be considered as parameters.

3.2.6 Design/Code Standards

Refer to NAC Section 3.2.6.

3.2.7 State of the Art

Refer to NAC Section 3.2.7.

3.3 SITE DEVELOPMENT PROGRAM AND GUIDELINES

3.3.1 Introduction of Components

In developing a master plan, the functional relationships of all the MCS components must be considered and related to the existing environment. (See MCS Figure 3.3.)

The projects are made up of several components which were discussed in the previous chapter. The building functions will be described in the next chapter and will only be discussed here as an operational unit which relates to the other components of the project.

The major components which make up the MCS are categorized as follows:

- Building
- Acclimation raceways
- Isolation raceways
- Pier
- Pump house
- Parking
- Circulation

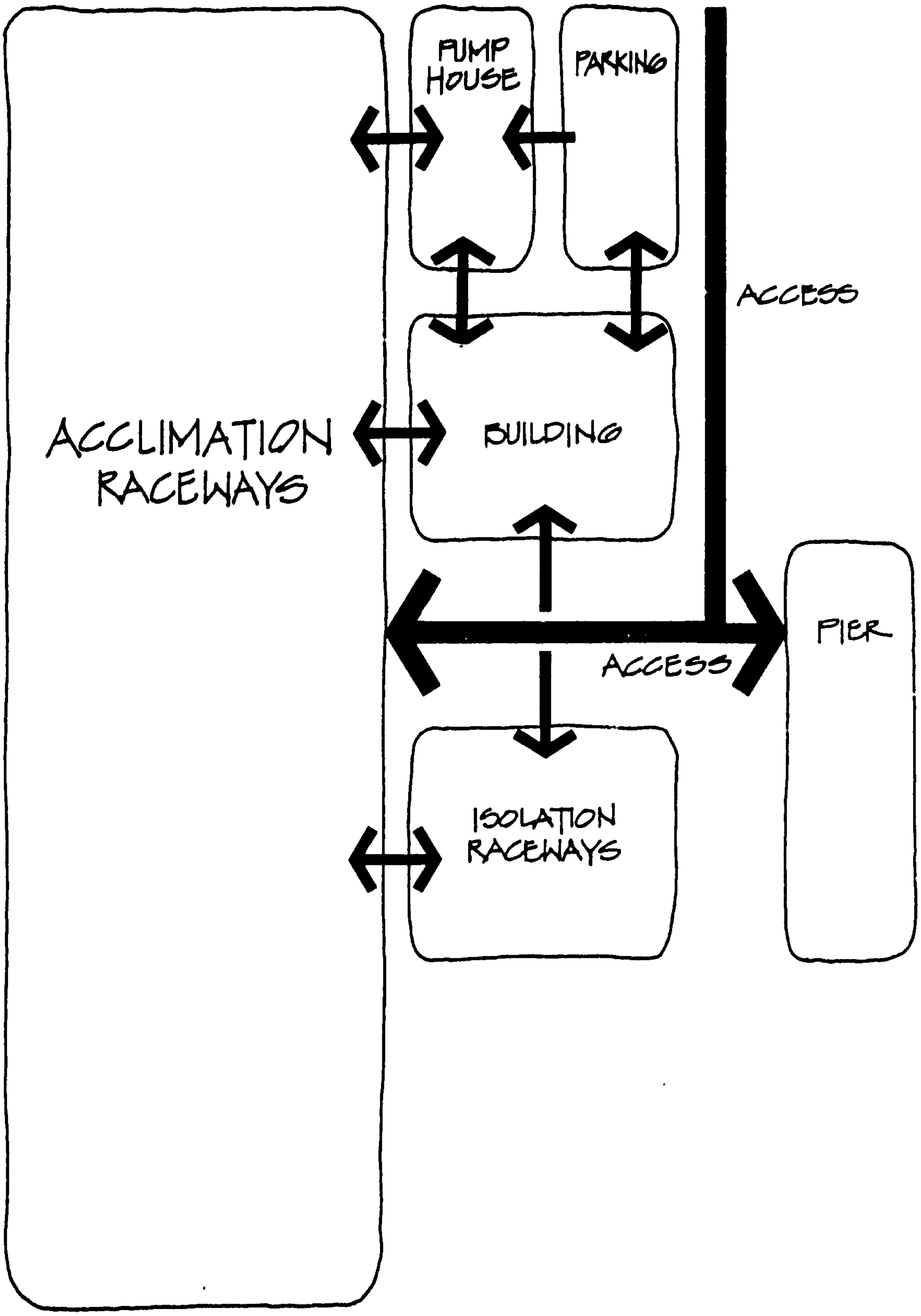
3.3.2 MCS Building Component

The MCS building is for administration and laboratory functions and relates closely to the acclimation and isolation raceways as well as to the pier. Circulation and parking also relate closely as all staff and visitors will arrive and park adjacent to the building. A loading dock is attached to the building and will be used to load fry onto trucks for transportation to El Abbasa and other facilities in the Nile Delta.

3.3.3 Ponds Component

3.3.3.1 FUNCTION

Acclimation raceways will allow mullet fry to adjust to fresh water and will make up the majority of the facility. Fry will be carried from the pier to the acclimation raceways on a paved road. After the acclimation process, the fry will be loaded onto trucks.



MCS Figure 3.3
Overall Functional Site Relationships

The second set of ponds at the MCS will be isolation raceways. Any fry in the acclimation ponds which exhibit abnormal or disease symptoms will be moved to the isolation raceways. These raceways relate directly to the acclimation raceways and to the laboratories in the MCS building.

3.3.3.2 AREA

The acclimation ponds are 21 m by 3 m by 1.5 m in depth. The isolation raceways are 5 m by 2 m by 1 m in depth.

3.3.4 Circulation Component

3.3.4.1 ACCESS

Access to the El Gameel site will be from the main road connecting Damietta with Port Said. This access will probably align with the existing road which runs south to the site of an abandoned pontoon bridge.

Access to the Gamassa site will be by the road which runs north and south along the east side of the canal. This road currently stops at the military facility which is just south of the site. The road will be extended along the beach to enter the southwest corner of the site.

3.3.4.2 CIRCULATION

Vehicle roads will lead up to the MCS building and will provide circulation to the pier and to the ends of all raceways. The entrance road will be 8 m; all other roads will be 4 m. All roads will be paved with asphalt.

3.3.4.3 PARKING

Parking for three vehicles will be available adjacent to the building and will be paved in asphalt.

3.3.4.4 PIER

The pier will provide access for fishing boats unloading mullet fry. The pier cannot be sized until the site details and depth of the water are known.

3.3.5 Landscaping

Because of the harsh environments of both sites little landscaping will be attempted except for a protected courtyard within the building.

3.4 RECOMMENDED SITE CONCEPT

Please note that this site concept is not site specific.

3.4.1 Introduction of Concept

The main entrance road will lead up to the MCS building and then split and circulate to the raceways and the pier. The building will be located between the pier and the acclimation raceways. The isolation raceways will be located adjacent to the building. (See MCS Figure 3.4, Recommended Site Concept.)

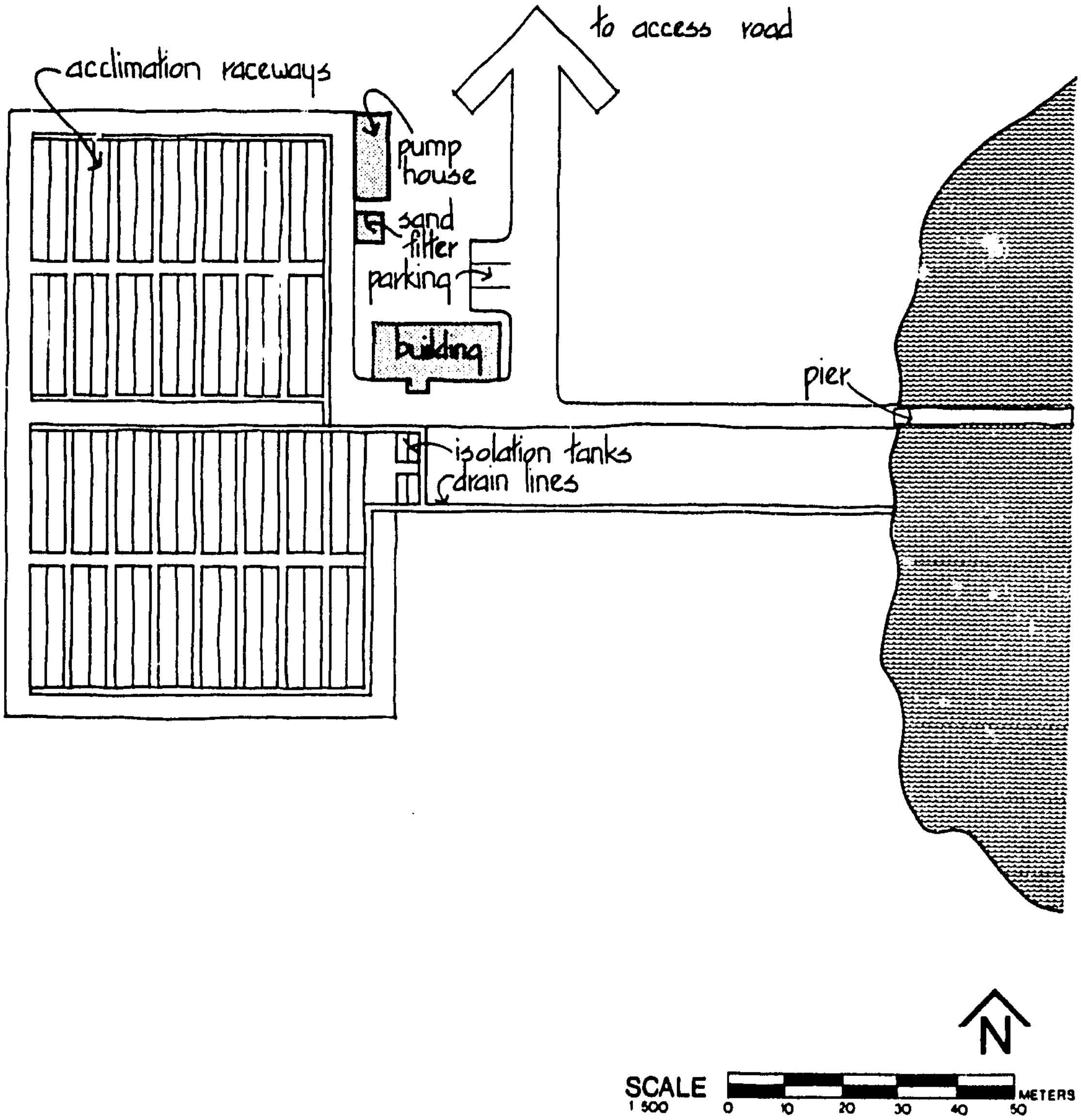
Water supply lines will run through the pump house, located between the raceways and the water source, and run between the center of each two rows of raceways. Water will exit the raceways into a drain canal at the opposite end which will drain back into the main channel downstream from the water intake.

3.4.2 Advantages

No comment can be made until the plan becomes site specific.

3.4.3 Disadvantages

No comment can be made until the plan is site specific.



MCS Figure 3.4
Recommended Site Concept

MULLET COLLECTING STATIONS
CHAPTER 4
MCS BUILDING

4.1 DESIGN PARAMETERS

4.1.1 Introduction

The design parameters that influence the development of a building program for the mullet collecting stations (MCS) are discussed in this section. Where appropriate, reference has been made to other sections of the report.

4.1.2 Function

The mullet collecting stations located at El Gameel and Gamassa will provide mullet fry for stocking private and government fish ponds. For more detailed explanation, see Chapter 1, General Project Profile, and MCS Chapter 2, Biological Process Design.

MCS Section 4.2, Building Program, is the result of a detailed analysis of space requirements for the functions of the MCS. MCS Section 4.3, Relationships, analyzes the various relationships between the spaces developed in the building program. Together these two sections form the basis for development of a functional design.

4.1.3 Flexibility and Expansion

As discussed in previous chapters, little expansion of the facilities at either site is envisaged because production potential is dependent on natural spawning.

4.1.4 Site

Buildings must respond to the topography, climate, vehicular access, soils, and native vegetation. In this case, a specific site has not been selected, and therefore most of these factors cannot be discussed at this time. The portions of NAC Section 4.1.4, Site, that deal with climatic response are applicable to the MCS because the climates are comparable.

4.1.5 Building Technology

Refer to NAC Section 4.1.5 for a discussion of building technology.

4.1.6 Character

The MCS administration laboratory building provides different types of spaces, such as offices and laboratories. In addition, a resting or accommodation room for the crew and laborers is provided. The interior of this room should be designed using simple and relaxing forms, colors, and textures. The office areas and the laboratory must be private and doors, stairs, and counters must be carefully arranged to be functional.

4.1.7 Cultural Imperative

Refer to NAC Section 4.1.7 for a discussion of cultural factors that influence design in Egypt.

4.1.8 Codes and Standards

Refer to NAC Section 4.1.8 for a discussion of applicable codes and standards.

4.2 BUILDING PROGRAM

4.2.1 Introduction

The building program for MCS provides basic information about all rooms or definable areas required as a result of function and is summarized in MCS Section 4.2.2. Each space is identified by name and number and the net area (actual floor area measured inside the walls) and its purpose or function described. Spaces are grouped based on an analysis of functional relationships (see MCS Section 4.3, Relationships Analysis).

In MCS Table 4.1 total estimated gross floor area is calculated from the net areas of the individual spaces.

In Appendix D.1, a standardized form is used to provide the complete basic information about each space. The form was designed to be comprehensive and yet flexible enough to work for the variety of spaces involved. The relationships analysis (MCS Section 4.3) and recommended building concept (MCS Section 4.4) are highly dependent on the information provided for each space in Appendix D.1.

4.2.2 Building Program Summary and Notes

Senior Office

Space No: SO Area: 15 m^2

Function: Office space for station administrator and conference space for 5.

Common Office

Space No: CO Area: 20 m^2

Function: Office space for 4 technical personnel and filing space.

General Laboratory

Space No: GL Area: 18.5 m^2

Function: Experimental monitoring and pathology facilities for MCS-related functions.

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MCS TABLE 4.1

CALCULATION OF ESTIMATED GROSS FLOOR AREA FOR MCS ADMINISTRATION/LABORATORY BUILDING

Spaces	Code	Net Area m^2
Senior office	SO	15
Common office	CO	20
General laboratory	GL	18.5
Crew room	CR	17.5
Equipment room	ER	14
Storeroom	SR	7.5
Laborers' room	LR	20
Buffet (coffee room)	BR	4
TOTAL NET AREA		118.5
40% added to net area to obtain gross area*		47.4
TOTAL GROSS AREA		65.9

*Percentage is added to account for walls, structural elements, restrooms, pipe spaces, corridors, stairways, etc.

Crew Room

Space No: CR Area: 17.5 m^2

Function: Temporary accommodations for overnight or off-hours such as sleeping, eating, and praying.

Equipment Room

Space No: ER Area: 14 m^2

Function: House mechanical support systems (auxiliary generator, 2 air blowers, water pump) and work space.

Storeroom

Space No: SR Area: 7.5 m^2

Function: Storage for dry bulk feed, storage for general station supplies.

Laborers Room

Space No: LR Area: 20 m^2

Function: Space for changing clothes, resting, eating, and praying.

Buffet (Coffee Room)

Space No: BR Area: 4 m^2

Function: Preparing soft drinks, space for messenger (office boy).

4.3 RELATIONSHIPS

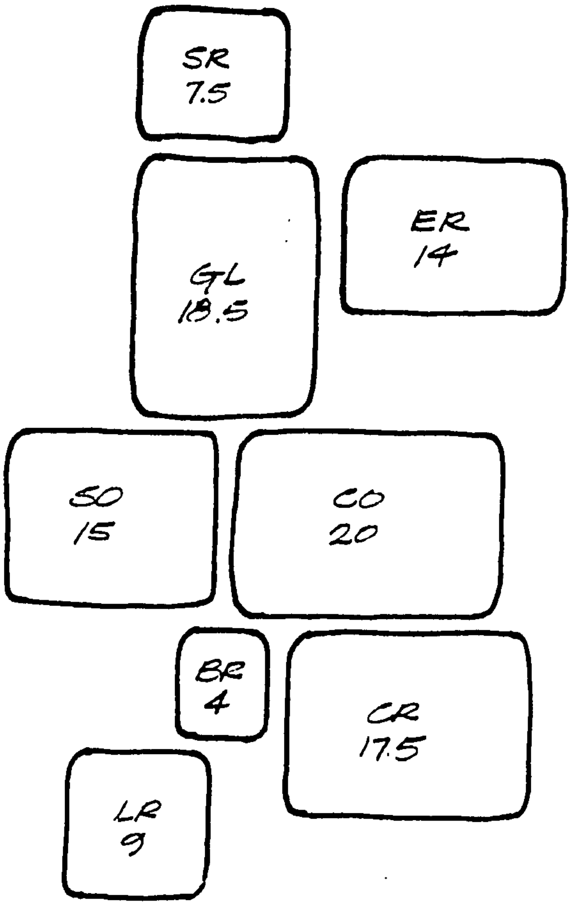
In this section relationships between the spaces programmed in MCS Section 4.2 are analyzed. As used here, relationships refer to similarities and differences between spaces. Types of relationships include function, light, ventilation, and outside access.

Functional relationships are shown in MCS Figure 4.1 and MCS Table 4.2. The diagram represents an idealized floor plan in which relationships between spaces for the efficiency, convenience, and privacy of the staff and visitors are the only consideration.

MCS Figure 4.2 is an idealized floor plan in which natural light, natural ventilation, and outside access are the only considerations.

KEY

SO	Senior office
CO	Common office
GL	General laboratory
CR	Crew room
ER	Equipment room
SR	Storeroom
LR	Laborer's room
BR	Buffet room

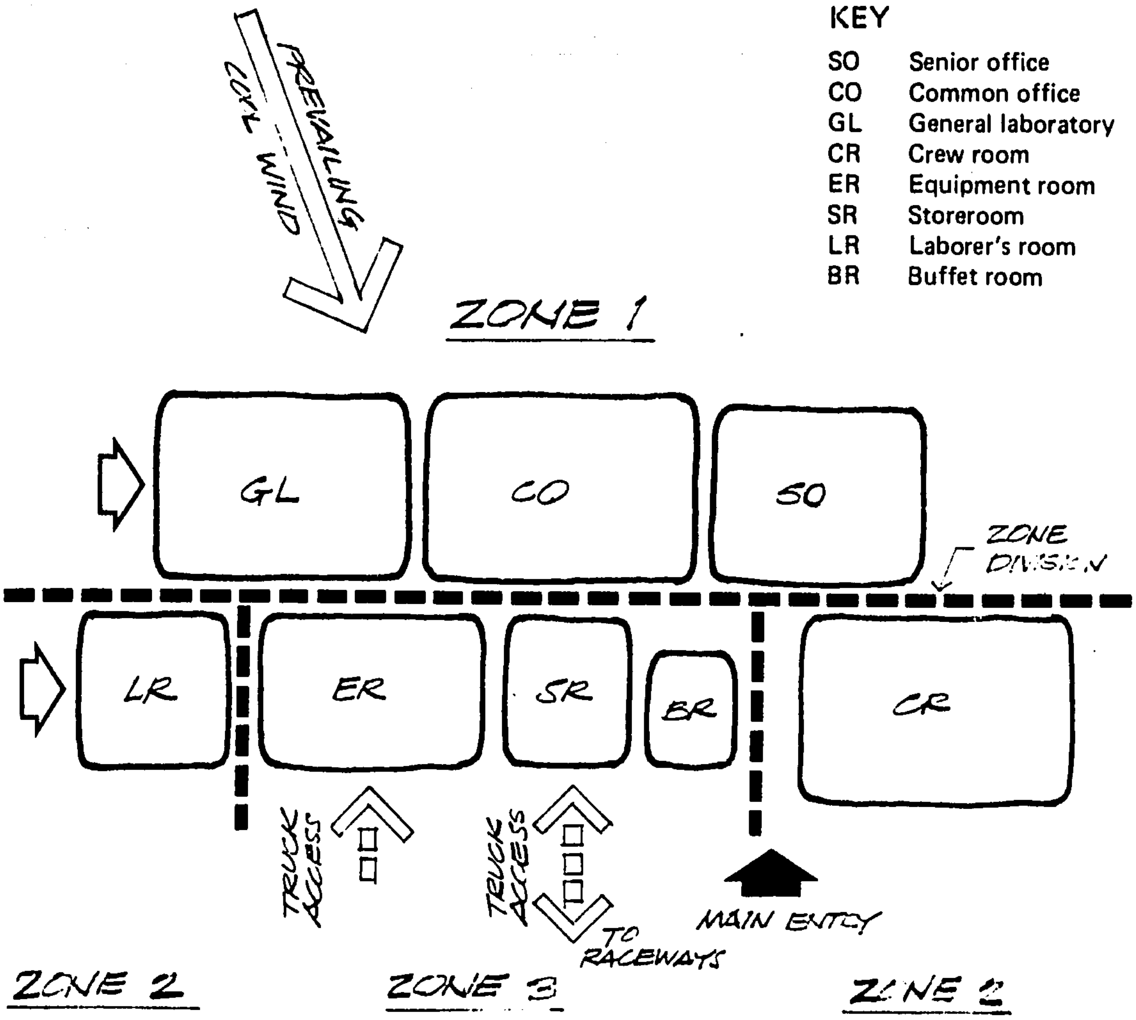


NOTE:

NUMBERS ARE GROSS SQUARE METERS

MCS Figure 4.1
Functional Relationships

KEY	
SO	Senior office
CO	Common office
GL	General laboratory
CR	Crew room
ER	Equipment room
SR	Storeroom
LR	Laborer's room
BR	Buffet room



LEGEND

ZONE 1 GOOD NATURAL LIGHT & VENTILATION

ZONE 2 INTERMEDIATE NATURAL LIGHT & GOOD VENTILATION

ZONE 3 MINOR NATURAL LIGHT & VENTILATION

N

MCS Figure 4.2
Light, Ventilation and Access Relationships

MCS TABLE 4.2
FUNCTIONAL RELATIONSHIP MATRIX

	SENIOR OFFICE	COMMON OFFICE	GENERAL LABORATORY	CREW ROOM	EQUIPMENT ROOM	STOREROOM	LABORERS' ROOM	BUFFET (COFFEE ROOM)
SENIOR OFFICE								
COMMON OFFICE	●							
GENERAL LABORATORY	●	●						
CREW ROOM		○						
EQUIPMENT ROOM			○					
STOREROOM			○					
LABORERS' ROOM								
BUFFET (COFFEE ROOM)	◉	◉		○			○	

LEGEND

●	VERY STRONG RELATIONSHIP
◉	INTERMEDIATE RELATIONSHIP
○	MINOR RELATIONSHIP
	NO PARTICULAR RELATIONSHIP
X	SOME DEGREE OF SEPARATION DESIRABLE

4.4 RECOMMENDED BUILDING CONCEPT

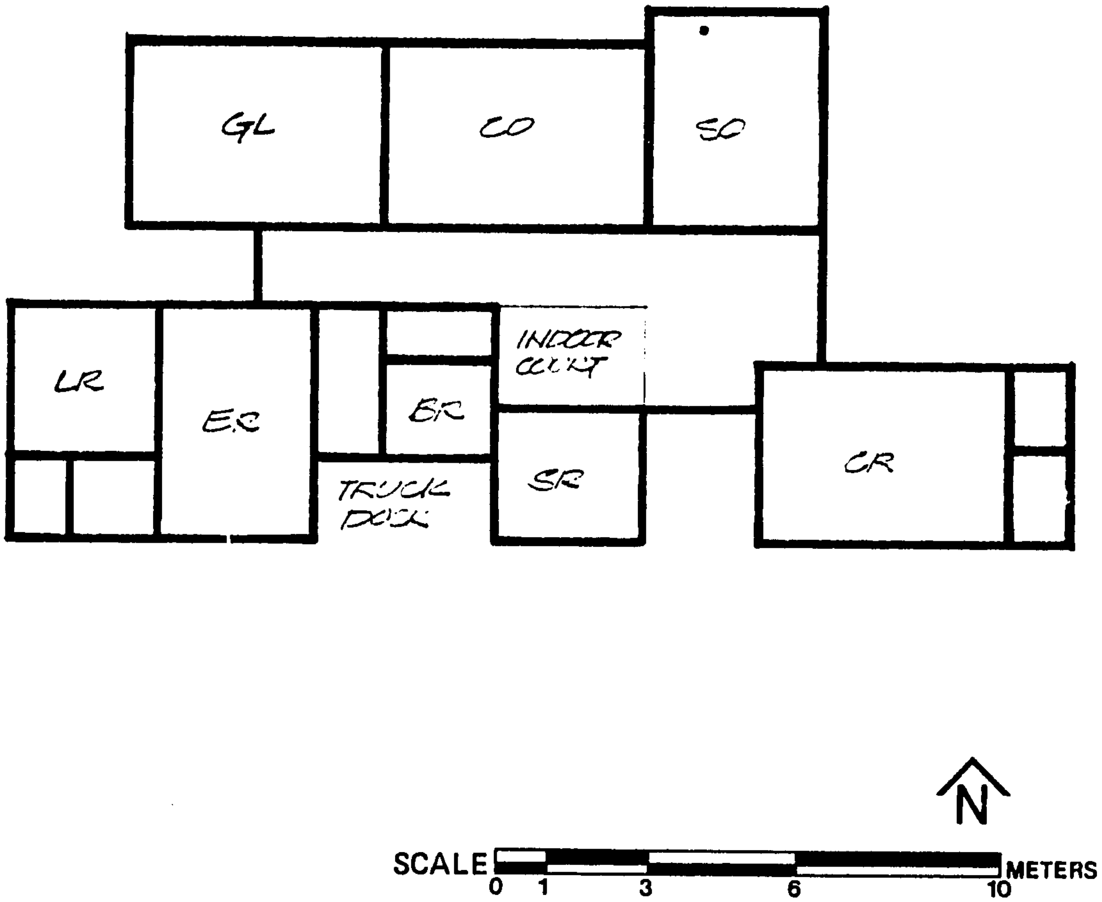
MCS Figure 4.3 shows the recommended building floor plan and section. The plan and section are the result of consideration of the design parameters, building development program, and relationships analysis. In this recommended plan, the three important elements (senior office, common office, and general laboratory) have good natural light and ventilation and are located in a quiet zone. The crew room has good ventilation. Less natural light and ventilation are found in the storeroom, equipment room, toilets, and coffee room. Truck access for the storeroom and the equipment room is provided.

The laborers room has a private access and toilet and is located away from the offices. A small desk for reception near the entrance and also a small patio are provided. The patio provides good ventilation and serves to separate the office area from the service area.

As shown in the recommended building section, there are two levels: the zero level where service rooms (store, equipment) are located, and another level for the laboratories and the offices.

KEY

SO	Senior office
CO	Common office
GL	General laboratory
CR	Crew room
ER	Equipment room
SR	Storeroom
LR	Laborer's room
BR	Buffet room



MCS Figure 4.3
Conceptual Floor Plan

MULLET COLLECTING STATIONS
CHAPTER 5
ENGINEERING SYSTEMS

5.1 RECOMMENDED MECHANICAL SYSTEMS

The mechanical process systems are the main support for each mullet collecting station (MCS). Mullet fry delivered to each MCS will be acclimated to fresh water prior to shipment. Both fresh water and salt water will be needed at each MCS. The basic concepts have been developed for solving major engineering problems, but it should be noted that the actual systems may vary during schematic design. This preliminary definition, however, provides a basis for planning and preliminary cost estimates.

5.1.1 Process Water Supply System

Both salt water and fresh water will be required at each MCS. Salinity adjustments will be made in individual tanks to acclimate fry to fresh water prior to shipment.

5.1.1.1 SALT WATER SUPPLY

Salt water will be obtained from nearby existing seawater. Salt water will be pumped and treated before distribution to acclimation raceways and isolation raceways. The treatment for salt water includes slow sand filtration and aeration, as depicted in MCS Figure 5.1. The aeration is to maintain the required dissolved oxygen level. The salt water needed for laboratory use will have to be further filtered to provide the desirable water quality. The total flow requirement for salt water is estimated to be around 1,500 l/min.

5.1.1.2 FRESH WATER SUPPLY SYSTEM

Fresh water will be obtained from the existing potable water line which is assumed to be 500 m away from the MCS. Potable water will be dechlorinated and aerated before being used as a freshwater supply. The treatment method for potable water is schematically shown in MCS Figure 5.1. The total flow requirement for fresh water is estimated to be 1,500 l/min.

5.1.2 Service Water Supply System

Potable water will be directly used for service water supply, as shown in MCS Figure 5.2. Service water is intended for cleaning purposes for the administration building and raceways.

5.1.3 Fire Water Supply System

Potable water will be directly used for fire protection water for the administration building, as shown in MCS Figure 5.2. The required flow rate of fire protection water will be determined using the recommended rate established by the National Board of Fire Underwriters (USA).

5.1.4 Domestic Water Supply System

Potable water will be directly used for human consumption, sanitary use, and laboratory-related use. The domestic water supply system is shown in MCS Figure 5.1. Potable water will be distributed throughout the entire administration building.

5.1.5 Tempered Water Supply System

Water temperature in the acclimation and isolation facilities will be allowed to adjust to ambient levels. Thus, a tempered water supply system is not needed for the MCS.

5.1.6 Service Wastewater Treatment System

Process wastewater from raceways will be directly discharged to the main drain without treatment. Service wastewater generated from the administration building and raceways will be treated prior to discharge to the main drain. The treatment includes sedimentation and aeration, as shown in MCS Figure 5.2.

5.1.7 Domestic Wastewater Treatment System

Domestic wastewater generated from sanitary facilities and laboratories will be aerated and stored for trucking away, as shown in MCS Figure 5.3. However, septic tanks and drainfields may be used if soil permeability is sufficient. The final decision on the disposal of domestic wastewater will be made when the soils report becomes available.

5.2 RECOMMENDED HVAC SYSTEMS

5.2.1 Ventilating System

The ventilation system at the MCS will consist solely of operable windows. Mechanical ventilation through the use of fans such as roof exhausters, wall propeller fans, centrifugal utility fans, etc. will not be utilized at these sites.

5.2.2 Air-Conditioning System

No air-conditioning will be provided at the MCS. The occupancy anticipated for the MCS is such that air-conditioning will not provide enough benefit to justify the power and maintenance requirements.

5.2.3 Design/Code Standards

The design/code standards will be the same as those stipulated for the NAC. Since there is no mechanical ventilation, heating, or air-conditioning, only those design/code standards which pertain to natural ventilation will apply.

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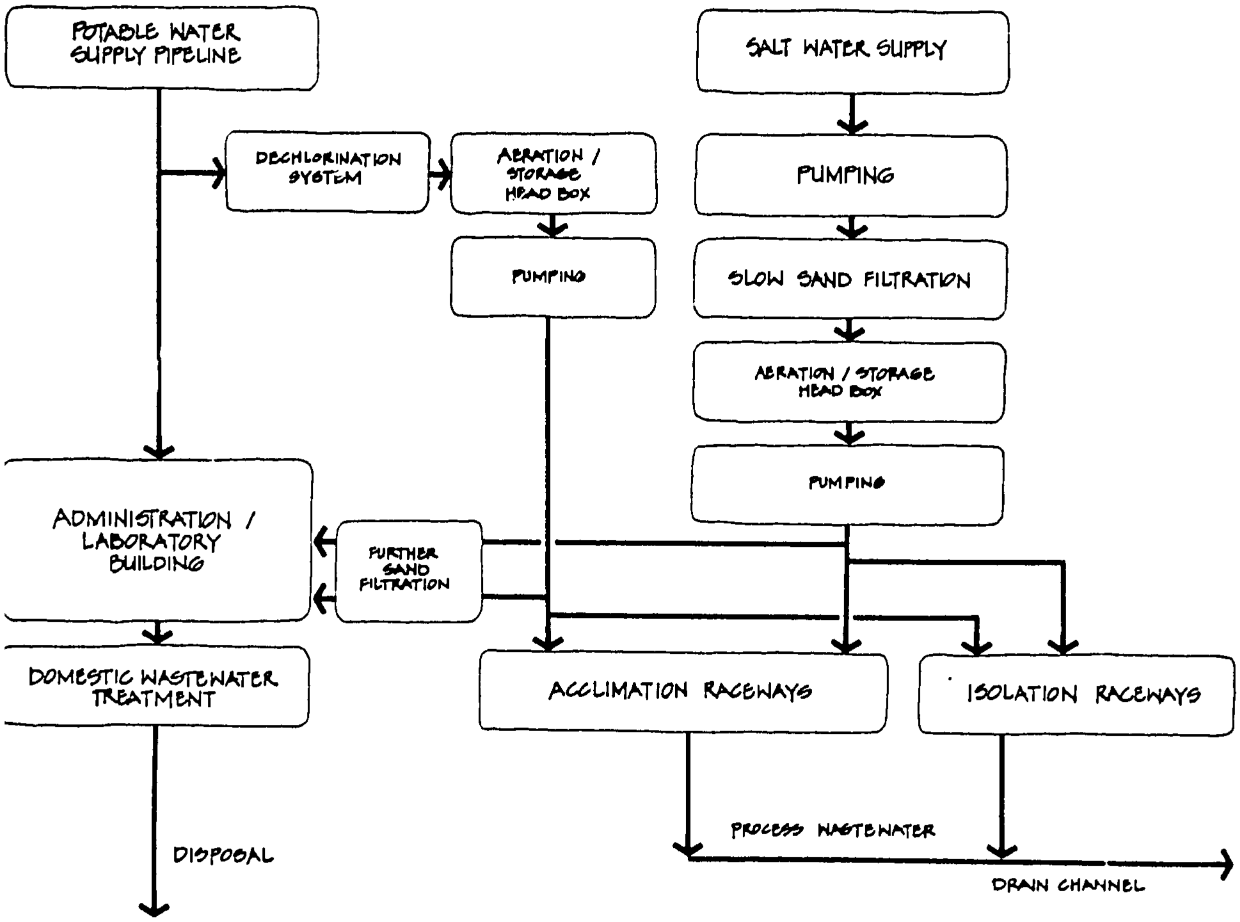
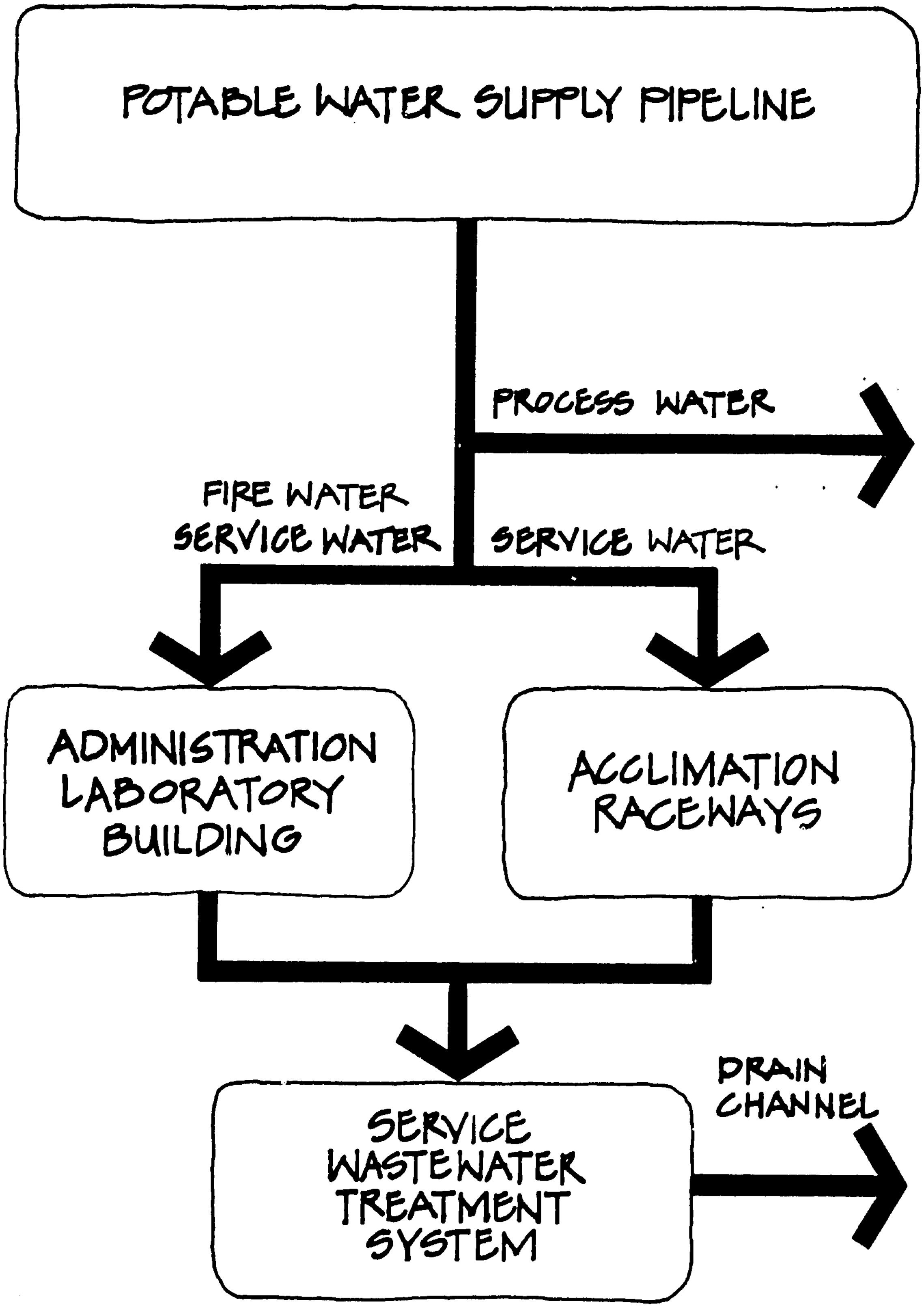
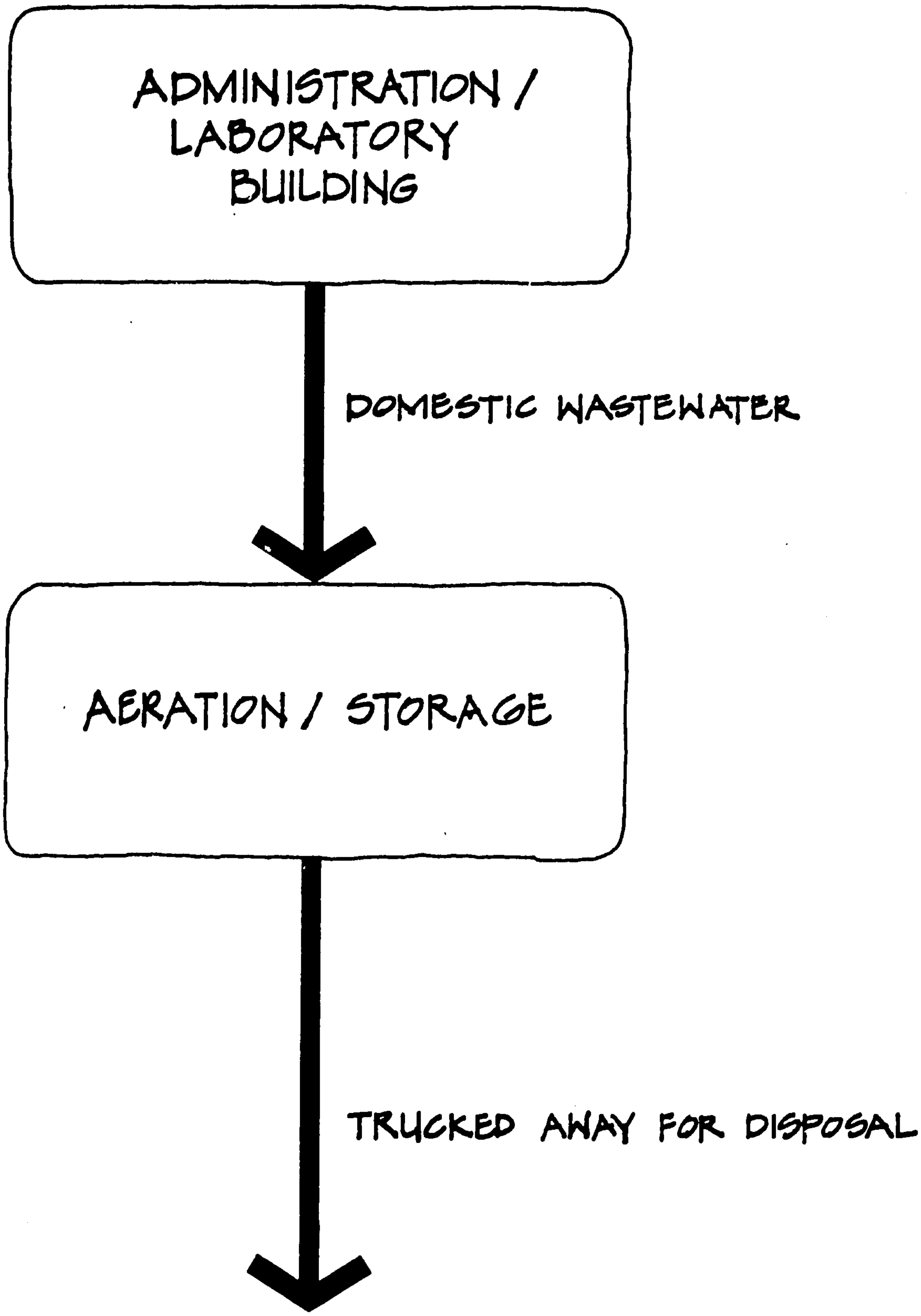


MCS Figure 5.1
Water Flow Diagram



MCS Figure 5.2
Fire and Service Water Supply System



MCS Figure 5.3
Domestic Wastewater Treatment System

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5.2.4 State of the Art

Generally speaking, mechanical ventilation and air-conditioning are only utilized in buildings such as banks, hotels, etc. The state of the art discussion for the NAC provides explanation in greater detail.

5.3 RECOMMENDED ELECTRICAL SYSTEMS

5.3.1 Lighting System

Lighting for the MCS buildings and grounds will be essentially as described for the NAC, except that lighting fixtures and hardware located on or near docks or piers must be selected with corrosion-resistant materials and finishes.

5.3.2 Power System

The power distribution system throughout these sites will follow the parameters set forth for the NAC and in accordance with the regulations and practices of the regional electrical utility.

5.3.3 Communications Systems

A conventional telephone system, designed on the basis described for the NAC, will be installed throughout the facilities.

5.3.4 Hydraulic Monitor/Alarm System

Monitoring of the hydraulic systems at these sites and the alarms to be provided at well and storage locations will be designed as described for the NAC.

5.3.5 Design/Code Standards

Design and code standards will be those described for the NAC.

5.3.6 State of the Art

The state of the art envisaged for these facilities will be the level described for the NAC.

5.3.7 Other Considerations

The parameters discussed for the NAC will apply to these sites as well. In addition, consideration should be given to the corrosion-resistant properties of the materials and finishes utilized for exposed or outdoor equipment.

5.4 RECOMMENDED CIVIL SYSTEMS

This section of the report is devoted principally to the description of site grading and water distribution and drainage systems for the outdoor raceways. Grading will consider energy conservation, economy of construction, and protection from flooding. Water system considerations include:

- Peak transmission rates
- Quality
- Energy conservation
- Operation and maintenance requirements

Preliminary construction cost estimates for the systems described in this section are summarized in Chapter 6 and detailed further in Appendix D.

It must be emphasized that the following descriptions are for conceptual schemes which will either be refined or modified and possibly changed during design development. The conceptual schemes, however, provide a basis for planning and for the preliminary cost estimates.

5.4.1 Site Grading

Cut and fill requirements can only be grossly estimated at this time because of lack of topographic data for each specific site.

Grading of the sites will be such that the open-channel drainage system will operate by gravity and both building structures at each site will be above the maximum expected water surface elevations. The acclimation raceways will be constructed of concrete and will require only minimal grading. Passageways among the raceways will be partly elevated to facilitate operation and maintenance. The fill for the passageways will be native sandy soil. The concrete-lined open channel drainage system will preferably be excavated in order to preclude having to fill the much larger raceway areas. The feasibility of this proposed site grading scheme can only be evaluated once topographic site data becomes available.

5.4.2 Paving

The access road, raceways service roads, and road to the pier will be paved, as will parking/turn-around areas. This will be required because of the sandy nature of the existing soil. Soil reports for the proposed sites are not available at this time. The crushed-rock base and paving thicknesses will vary based on the largest weight class of vehicles expected to travel on the surfaces. Footpaths among the elevated raceways will not be paved but may require soil stabilization measures such as crushed rock. No sidewalks are anticipated for the sites.

5.4.3 Pier

A floating pier 2.5 m wide and over 30 m long will be required at each site to facilitate unloading of incoming mullet fry.

Piers at El Gameel and Gamassa MCS will have low freeboards to permit easy access for the small, local vessels that are presently used for harvest. Rubber tires filled with expanded styrofoam are recommended because they provide excellent flotation, low maintenance, ease of repair, and eliminate the need for fenders to protect moored boats.

A low rail should be constructed the entire length of the pier to allow for tying boats and to serve as a curb. Saltwater hoses should be provided to supply water for hosing out fish boxes, boats, and pier.

The pier should provide access for four boats at a time. Therefore, approximately 30 m are needed with a minimum water depth of 1.2 m. The actual configuration of the pier will depend upon local conditions. A paved roadway extending from the pier to the raceways will facilitate transfer of the fry which will be by means of aerated containers or fish baskets carried via wheeled hand carts.

5.4.4 Hydraulic Profile

A tentative hydraulic profile for the sites is shown on MCS Figure 5.4. Salt water will be drawn from a screened concrete inlet structure submerged at least 3 m below mean low tide elevation. The specified depth will greatly reduce the possibility of recirculating raceway discharge water. Salt water will be drawn at a peak rate of 1,500 l/min from the inlet structure to a wet well near the pump station by means of two 250-cm (10-inch) diameter pipes. One such pipe would suffice, but two are proposed for reliability and maintenance reasons. The salt water will then be pumped to a sand filter and flow by gravity through an aeration headbox and into a separate wet well for pumping and distribution to the raceways. A small quantity of the salt water will also receive secondary filtration and be transmitted to the administration building for aquaria needs.

Freshwater supply of 1,500 l/min will hopefully be available from existing local potable water systems. This water will be transmitted to the site by a 15-cm or larger diameter pipeline and then be distributed to the administration building and to the pump station. The water going to the pump station will be dechlorinated and aerated. It will then be pumped to a piped distribution system which will parallel the saltwater distribution system to the raceways. Filtration of this water will not be necessary, but a small quantity to be piped to the administration building for aquaria needs will receive rapid sand filtration.

5.4.5 Distribution and Drainage Systems

Salt water and fresh water will be distributed by separate pipelines to the isolation and acclimation raceways as depicted on MCS Figure 5.5. Salinity and flow rate will be controlled by valving at each raceway. For the acclimation raceways, perforated pipelines will extend 7 m along the side of each raceway and will deliver water by spray from above the water surface.

Water level control and outflow from the raceways will be by means of screened swing pipes protruding from the narrow side of each raceway. The concrete-lined raceway bottom will be sloped slightly toward a sunken outlet for the outflow pipe to permit full draining. The overflow through the swing pipes will discharge into open channel drains which will carry the flow to the nearest large body of water. The drains will be concrete lined and sunken to provide gravity flow toward a common outfall. The outfall will be designed for minimum mixing if it is located in the vicinity of the saltwater intake. This will reduce the chance of recirculation through the submerged saltwater intake structure.

5.4.6 Design/Code Standards

The only portion of the recommended civil systems discussed in this section that will incorporate design standards will be the road work. American Public Works Association (APWA) standards will be adopted for this work.

5.4.7 Other Considerations

To guarantee that the water supply system for the raceways will function properly, an adequate and reliable electrical power source must be provided. Continuous monitoring of pump performance and water surface elevations in the wet wells upstream of the pumps must also be provided.

5.5 STRUCTURAL SYSTEM

5.5.1 Loads

The MCS located at Gamassa and El Gameel will be designed to the loads described in NAC Section 6.5.1.

5.5.2 Building Materials

Cast-in-place (CIP), reinforced concrete is the recommended building material for construction of structural members of the MCS. Red brick or hollow concrete block is the recommended material for exterior wall construction. See NAC Section 6.5.2 for a discussion of these building materials.

5.5.3 Foundations

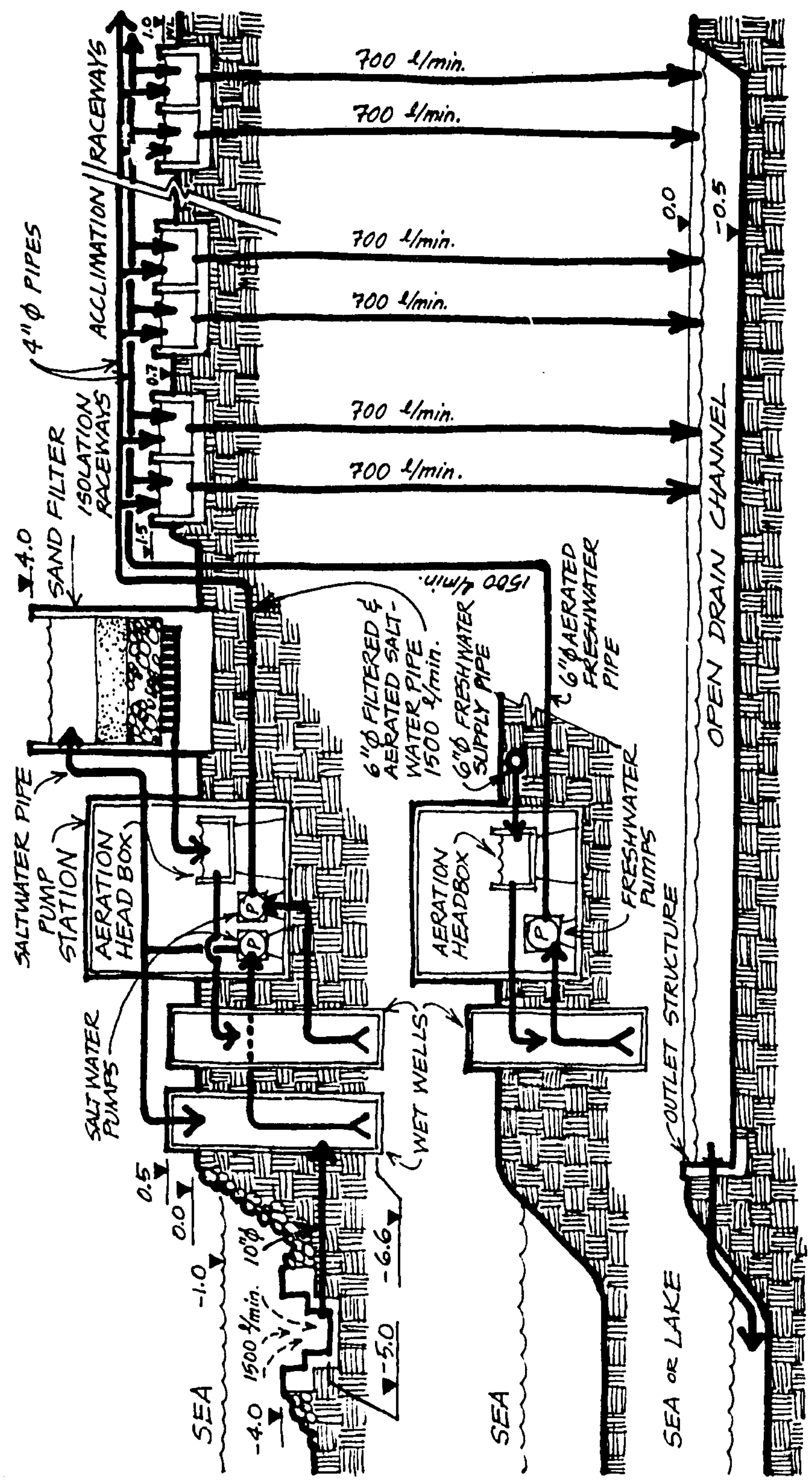
Soils conditions at the sites of the MCS appear to favor the continuous footing described in NAC Section 6.5.3. Final selection of foundation type will be made after receipt of soil tests made at these sites.

5.5.4 Building Framing System

Each of the MCS sites will have one medium-sized building and several smaller structures. A CIP, reinforced concrete frame is proposed for all of these buildings and structures. Red brick or hollow concrete block will be used as exterior walls for the buildings and structures which require wall closures. A discussion of this building system can be found in NAC Section 6.5.4.

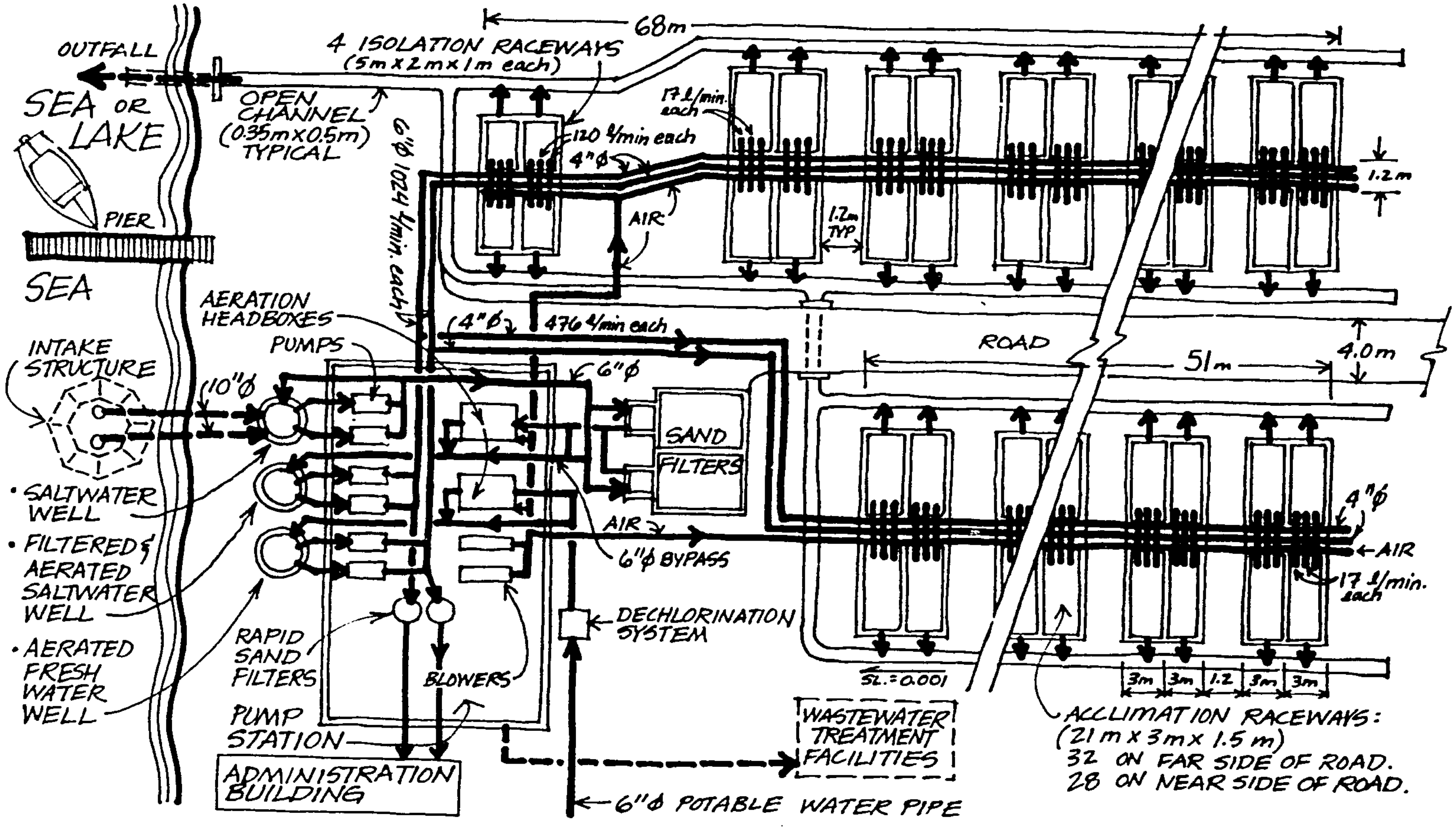
5.5.5 Design Criteria

The design criteria identified in NAC Section 6.5.5 of this report are also applicable to the MCS.



MCS Figure 5.4
Hydraulic Profile

MCS Figure 5.5
Distribution and Drainage System



5.6 RECOMMENDED SUPPORT SYSTEMS

5.6.1 Fueling Facilities

Fueling stations will be provided at each MCS. The fueling stations will be equipped with underground storage tanks, gasoline pumps, and compressed air and water distribution bibbs.

The fueling stations will provide gasoline for the fish transport vehicles as well as air for tires and water for cooling systems.

All safety design standards/codes will be complied with for gasoline handling facilities.

MULLET COLLECTING STATIONS
CHAPTER 6
ESTIMATED COST OF CONSTRUCTION - SUMMARY

6.1 BASIS OF COST ESTIMATE

The conceptual construction cost estimate for the MCS is based on the concept design criteria researched and developed for this project as described herein as well as the currently understood project site conditions and limitations. All material, labor and equipment costs are based on the joint professional knowledge and related construction experience for similar projects by the design team for both home and abroad.

Wherever possible, construction costs are based on native construction materials and current Egyptian construction practices. Construction is to be performed by local contractors. The cost of all American (USA) made material and equipment used in this cost estimate includes all expected handling and freight charges, F.O.B. Alexandria, Egypt, but does not include any United States export duties which may be levied against such goods.

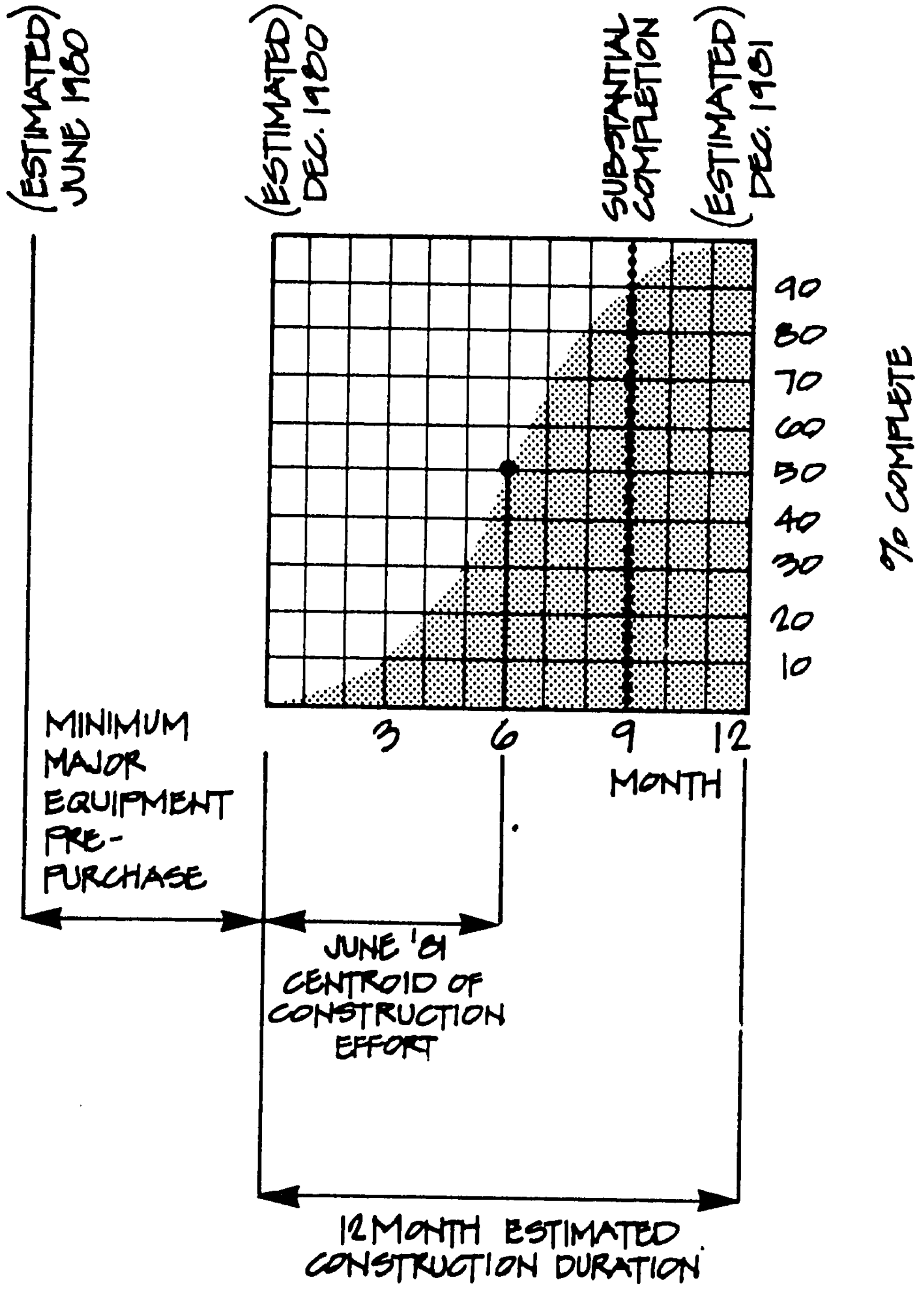
All construction costs are shown in U.S. dollars as of February 1980, escalated to the projected mid-point of project construction (see MCS Figure 6.1).

6.2 SCOPE OF WORK

The proposed project budget covers all work necessary to construct the MCS Station Building - Gamassa/El Gameel, including all site mechanical, electrical, and civil work as described herein within the limits of both site boundaries. It is important to note that in no case does the cost estimate reflect an expenditure for any work on the public water systems.

6.3 COST SUMMARY

6.3.1	MCS Site Work (One site)	US $	793,000
6.3.2	MCS Building (One building)		32,000
6.3.3	Cost Factors and Assumptions @ 10%		82,500
6.3.4	Construction Cost—Subtotal	US $	907,500
6.3.5	Overhead and Profit @ 20% of Line 6.3.4		181,500
6.3.6	Mobilization @ 5% of Line 6.3.4		45,375
6.3.7	Remoteness @ 15% of Line 6.3.4		136,125
6.3.8	Construction Cost—Total (February 1980)	US $	1,270,500
6.3.9	Contingencies @ 15% of Line 6.3.8		190,575
6.3.10	MCS Project Subtotal (February 1980)	US $	1,461,075
6.3.11	Escalation to September 1981 @ 38% of Line 6.3.10		555,208
6.3.12	MCS One Project Total Projected Cost	US $	2,016,283
6.3.13	MCS One Project Total Projected Cost Rounded	**US $**	**2,016,000**
6.3.14	MCS Mullet Collecting Station at Gamassa from Line 6.3.13		2,016,000
6.3.15	MCS Mullet Collecting Station at El Gameel from Line 6.3.13		2,016,000
6.3.16	MCS Two Projects Total Projected Cost Summation of Lines 6.3.14 and 6.3.15	**US $**	**4,032,000**



ALL COSTS ARE BASED ON A PROJECTED MID-POINT OF CONSTRUCTION, JUNE '81

MCS Figure 6.1
Construction Timetable Diagram