PROJECT FORMULATION OF TERUWAI AQUARIUM

PROJECT FORMULATION STUDY OF THE KUWAIT AQUARIUM

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1. INTRODUCTION

1-1 Mission Purpose

In response to the request of the Ministry of Public Works of the State of Kuwait, a mission consisting of specialists in various fields and headed by Dr. Fujio Yasuda visited Kuwait in December of 1975 for the purpose of conducting studies pertinent to the construction of an aquarium in Kuwait. This was the third such mission, preceeding to missions being dispatched in February and December, 1974 respectively.

The first and second missions concentrated primarily upon basic studies of the concept of optimum aquarium and operation and various forms of training. The purpose of the third mission was mainly to conduct a programming study, i.e. a project formulation study, based upon the results of the earlier missions' studies. The project formulation study in turn is intended to assist in preparations for the actual design and engineering of the aquarium, the first step in implementation of this project.

Four tasks must be developed by the project formulation study:

(1) Procedure of Promoting Project

(2) Exact Project Planning and Design Requirements
- To make up "Terms of Reference" of Project

(3) Preliminary Cost Estimates for Budgeting
- Including Extention of Budgeting in Future Construction

(4) Training Program
- Number of Personnel
- Qualification
- Period

1-2 Make-up of Mission

In order to successfully complete the tasks assigned the mission, it was constituted as follows.

(1) Mission head : Dr. Fujio Yasuda

As in the previous two missions, Dr. Yasuda assumed overall leadership of both the mission and preparation of the report after returning to Japan.

(2) Specialist in aquarium operation technology : Yoshitaka Abe

As in the past two missions, Mr. Abe investigated the optimum aquarium for Kuwait from the viewpoints of keeping and caring for the fish and the methods of their exhibition, and he engaged in studies to determine the optimum facilities to be constructed along with the aquarium.

(3) Project coordinator : Katsuji Tainaka

Mr. Tanaka worked to assess the aquarium's cultural, political, and economic aspects so that the project would best reflect those "soft" or nontechnical considerations.

(4) Planning and design specialist : Takashi Kikkawa

Mr. Kikkawa analyzed various factors relating to actual construction of the aquarium and conducted comprehensive investigations of technological and spatial aspects.

(5) Interior design specialist : Koichi Ishikawa

Mr. Ishikawa conducted a comprehensive study of the types of displays to be included, a very important part of the aquarium, with special reference to the likes and dislikes of the people of Kuwait.

(6) Ocean Construction specialist : Mr. Tetsuichi Yanai

Because aquarium construction is hampered by difficulties in constructing seawater-intake facilities, Mr. Yanai engaged in field reconnaissance or the construction of such facilities

and investigated the natural sea conditions in the area.

1-3 Contents of this Report

This report contains the results of field reconnaissance and studies conducted and was prepared so that the above four tasks can be completely achieved. However, insofar as the report presents what the members of the mission feel is the most desirable form or approach at the present stage, it should be also construed as recommendations from the mission.

The Appendix-IV presents an outline of this report summarized for the "Terms of Reference" which the government of Kuwait prepared to use for employing consultants in the first stage of implementing the project. The attached drawings and sketch were prepared to promote the study, and present an example of what the recommendations of the report would look like in concrete form.

Finally, all of us who participated in the mission wish to thank Mr. Salem I. Mannai of Ministry of Public Works, Kuwait and his staff for their invaluable help and advice concerning our activities in Kuwait, as well as the many people who offered their cooperation to the mission both in Kuwait and in Japan.

2. GENERAL

This section features the more complete, detailed concept of the aquarium developed by the third mission building upon the concepts developed by the first and second missions.

2-1 Project Site

The project site is located about 6 km south-east of Kuwait Town, or about midway between Kuwait Town and Salimiyah. It lies between the newly constructed Arabian Gulf Street and the water-front and is a piece of land about 400 m long and 100 m wide. To the immediate south is a sea club called Paradise Cove. To the west, across Arabian Gulf Street, is located the site where a public garden is scheduled to be built (see Fig. 1-2).

2-2 Appreciation of the Reports Provided by the Former Missions

The third mission's studies were conducted employing the results of the study completed by the first mission and presented the government of Kuwait in September of 1974, and should be considered on extension thereof.

The basic concept of the aquarium have been established in the report presented by first mission. However, some of the outputs of the aforesaid report are revised and improved in accordance with the results of consultation between the first mission, after submission of its report, and the government of Kuwait, the results of studies and consultations conducted by the third mission when in Kuwait, and the results of further studies conducted after returning to Japan. For reference purposes, the report submitted by the first mission in September of 1974 is included in the Appendix. However, in the case of any discrepancies between the reports of the first and third missions, the later report is to be considered the more fully developed version.

The main items which have been further developed in the later report are as follow.

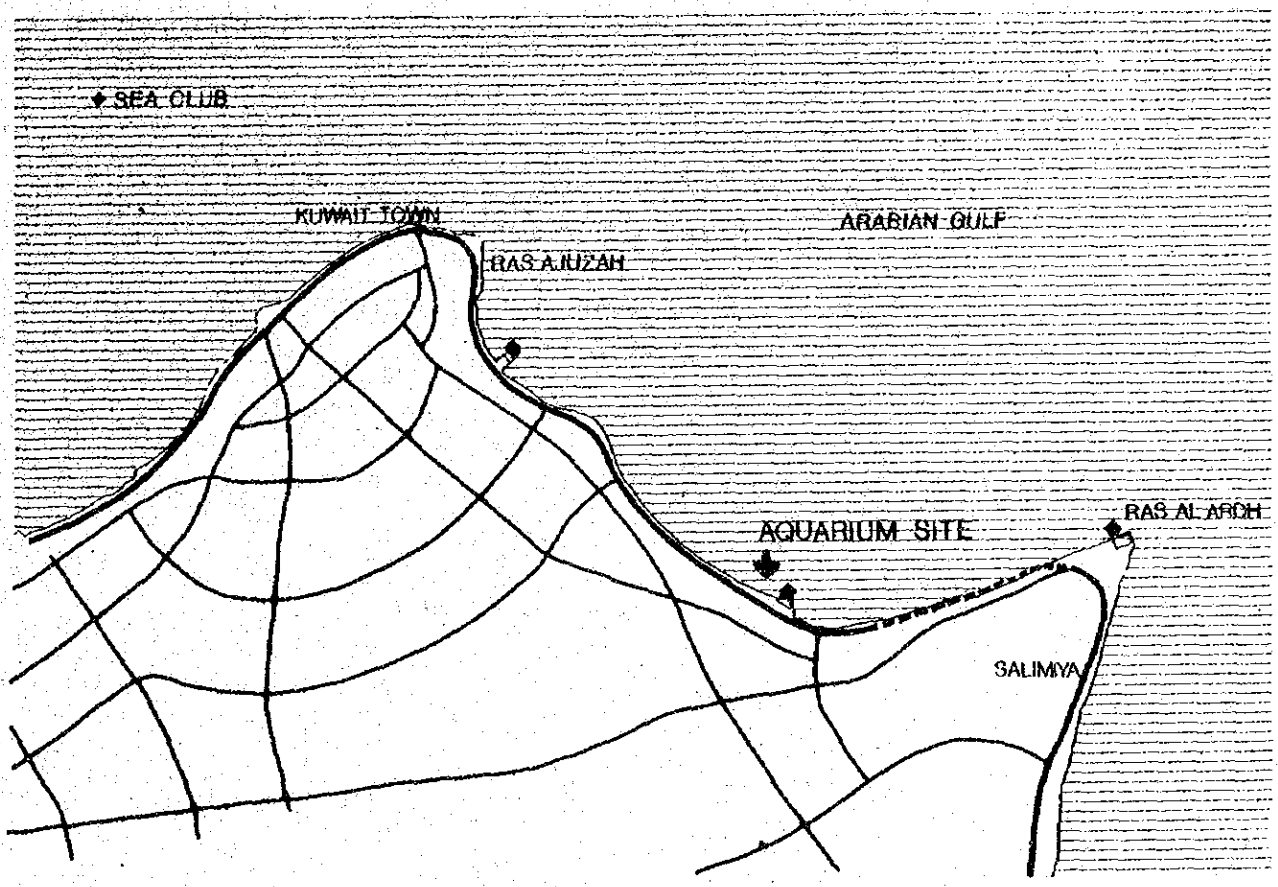


Fig.1 Location map of the site

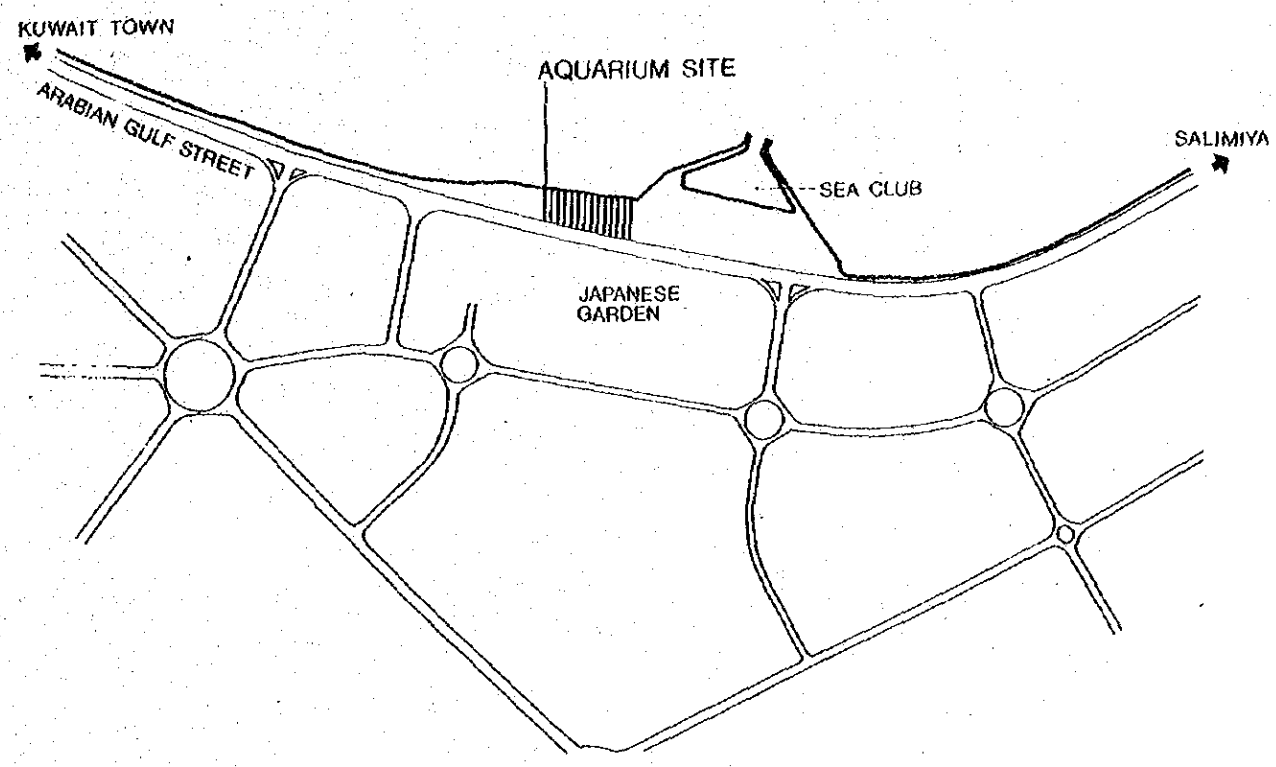


Fig.2 Site surroundings

(1) Construction of facilities in the sea has been provided to display large fish such as sharks and to keep dolphins in reserve. It is now planned that these facilities be built at the same time as the aquarium itself, but it would be possible to do it at a different phase.

(2) Construction of a show-pool for dolphins is planned simultaneously with the main aquarium, although this, too, could be done at a different phase.

(3) The aqua-terrarium will not be given the distinctive name "Tigris-Euphrates".

(4) The outline of the aquarium building has been modified.

2-3 The Mission

The personnel of the mission were desceribed in the introduction. On outline of the activities of the mission in Kuwait are as follows :

(1) Mission Schedule in Kuwait

Dec. 13, 1975: Mission arrives in Kuwait, met by officials of the Ministry of Public Works in charge of the project and staff of the Japanese Embassy in Kuwait.

Dec. 14, 1975: Discussion with embassy personnel.

Dec. 15, 1975: Discussion of the work of the mission in the presence of embassy personnel, and commencement of reconnaissance.

Dec. 16, 1975: Same as above, plus preliminary talks with officials at Agriculture Department, Ministry of Public Works.

Dec. 17, 1975: Discussion with officials at Fishery Section, Ministry of Public Works concerning gather-

ing of reference materials. Continuation of reconnaissance.

Dec. 18, 1975: Discussion regarding the work of the mission
Dec. 19, 1975: and continuation of studies.

Dec. 20, 1975: Discussion with responsible officials at the Agriculture Department, Ministry of Public Works and continuation of reconnaissance.

Dec. 21, 1975: Discussion regarding the work of the mission and continuation of reconnaissance.

Dec. 22, 1975: Final meeting with officials of Agriculture Department, Ministry of Public Works, and expression of appreciation to the officials for their cooperation in the reconnaissance.

Dec. 23, 1975: Mission departs Kuwait

(2) Outline of Discussion with Government of Kuwait

While in Kuwait, the mission held meetings with officials of the Agriculture Department, Ministry of Public Works. The items discussed are outlined below. As indicated above, a total of four meetings were held, and staff of the Japanese Embassy also attended these meetings. The items discussed were as follows:

i) Tasks of the Mission

After successful completion of the four tasks mentioned hereof, a consultant are to be employed to enter into the first stage in implementation of the project. The results of the field reconnaissance conducted by the mission during its stay in Kuwait have clarified necessities to conduct the engineering surveys for the implementation of the project.

ii) Project Implementation Procedure

After preparation by the consultants of a book of tender, the contractor who is to construct the aquarium is to be determined in accordance with Tender Low in Kuwait.

iii) The scope of consulting services for this project shall involve, in addition to the design and construction supervision, the preparation of various program i.e. program for staff training, program for operation and management and program for training of dolphines, and various technical assistance in practice training, operation and management of Kuwait Aquarium. Such comprehensive consulting services, including the such "soft" aspect related to operation and management of the aquarium as these are indispensable in view of the nature of this project.

iv) Planning and Design

- The aquarium must be in full harmony with facilities adjacent to the project site.
- The customs of the Kuwaiti people who will visit the aquarium must also be fully respected.

v) The need for providing the government of Kuwait with the advisory group composed of highly qualified personnel who will offer policy guidance on the implementation of the project was also discussed. This group is to center around reputable ichthyologists with sufficient knowledge and experience on the realization of such aquarium project.

vi) Future Director of the Aquarium

Also discussed was the idea that, in view of the nature of the project, the person who is expected to become

director of the aquarium should be selected as early as possible and should participate in the project as a member of the steering committee.

(3) Reconnaissance Surveys Conducted and Data Collected by the Mission

Herein appears a brief description of the data collected by the Mission in December while conducting reconnaissance surveys and studies in Kuwait. The salient points of an underwater field reconnaissance carried out for sea-water intake and off-shore structure are also introduced. This latter reconnaissance, while not part of the various reconnaissance undertaken last time, is considered to be of importance to the construction of an aquarium.

i) Reconnaissance Conducted

a) Land use and development status at the site and in its vicinity.

b) Inspection of all spots related to marine products and the sea, including the fishing port, fishing market, harbor, and dhow building yard.

c) General inspection of existing urban districts of Kuwait Town, Salimiyah, and Ahmadi.

d) General inspection of the existing museum, university, research institutes, etc. focusing on the structures, displays, and activities under way.

e) Inspection of the experimental firm and nursery of the Agriculture Department, Ministry of Public Works.

f) Inspection of other buildings and structures as well as construction sites.

g) General survey of the availability of construction materials.

h) Interviews to obtain reference information with competent officials of the Ministry of Public Works, Construction Department, Major Project Department, Fishery Section, and also the Port Authority,

Kuwait Institute for Scientific Research, and the museum.

i) Underwater field reconnaissance for seawater intake and off-shore structure construction (explanation follows),

ii) Data Collected

a) General information and data on construction costs.

b) Maps of the site and its environs,

c) Marine meteorological data for Shuwaikh Port.

d) Data on water pollution in Kuwait Bay,

e) Photographs and other materials for each spot visited by the Mission.

iii) Summary of the Underwater Field Reconnaissance

The object of the field reconnaissance was to obtain basic data for a decision on what future in-depth studies will be required for such matters as seawater intake and off-shore structure construction. The place of the Field Reconnaissance was the water area fronting the site proposed for the aquarium. The field reconnaissance consisted of three parts :

1) Investigation of the site shore: At ebb tide the shore area was investigated primarily to determine the soil quality, biota, and topography; photographs also being taken.

2) Investigation of the sea fronting the site: The quality of the bottom sediment, water (transparency), biota, and bottom topography were investigated to a distance of 6 km off-shore; photographs also being taken.

3) Collection of materials: Marine and land meteorological data, geological data, and other materials were collected.

a) Results

The following results were derived from the aforementioned

field reconnaissance and collected materials.

-1. Soil quality:

- Shore: Exposed coral rock and reef layer extending downward for 0,5 - 0,8 m.
- Sea bottom: Blueish silt (clay) layer extending downward for at least 2 m.

-2. Water quality: Suspended particulates are abundant and transparency is about 1,5 - 2,0 m. Concentration is greater than that of the seawater of open sea.

-3. Water temperature: Maximum temperature is 35°C.

-4. Tidal current (near Salimiyah): At flood tide the current flows from Ras Al Ard past Salimiyah toward Al Kuwait at a speed of about 1,0 m/s. At ebb tide the current flows in the reverse direction at about the same speed, Little change is to be noted in the flow in a perpendicular direction.

-5. Water near shore: Maximum wave height of 1,0 - 1,8 m is observed when there is a strong north or nothwest wind. Turbidity occurs at such times from the shore to about 500 m off-shore due to the disturbance of bottom sediment.

-6. Biota: Barnacles are found on the shore and sargassum live in the water.

-7. Meteorology:

- Climate: Tropical climate throughout the year.
- Rainfall: A small amount of rain falls for about 10 days per year.
- Wind force and direction: A virtually windless state continues throughout the summer, although gentle and quite strong north and northwest winds blow in the winter with a force of 4 - 18 meters per second.
- Temperature: Maximum temperature of 49°C will occur between July and September, a minimum

of -3°C is recorded in January, and the annual mean temperature is about 26°C.

b) Conclusion

-1. Engineering Survey

It was impossible to secure an adequate volume of basic data for the construction of underwater structures in the field reconnaissance and collection of existing reference materials. In order to commence designing, a full complement of information and materials must be collected investigating anew the study items listed below.

-2. Intake Facilities for the Area

Since shallow water extends for some distance offshore and the sea bottom is lined with a silt layer, full consideration must be paid to these factors in the installation of intake facilities. A basic design should be drafted using the results of the engineering survey.

-3. Engineering Survey Items

1) currents
2) water depth
3) water quality
4) water temperature
5) bottom foundation
6) marine biota
7) tide level and meteorology
8) land survey
9) equipment and materials for construction

Detailed reports of the above field reconnaissance and reference materials describing the methods for the field reconnaissance are to be found in the Appendix.

2-4 Concept of the Kuwait Aquarium

Originally, in the years prior to the discovery and exploitation of oil, Kuwait was an ocean-oriented nation. The trade carried our with India and Africa, the fishing industry, and the pearl industry all atest to the close affinity that existed between the people and the sea. Even today, in fact, Kuwait retains superior techniques for building of dhow, one of the central traditions of the former day. In this age of oil, however, the traditions of sea-going Kuwait have naturally become somewhat diluted. At such a time, probably nobody would deny that this aquarium project, on a deeper dimention than its basic function of entertatining and educating visitors with marine-world exhibits, will serve in cultural terms as a symbol of Kuwait's tradition.

The underwater creatures constitute a subject of knowledge as yet well understood by few lay people. Accurate information on such organisms may, however, be imparted by means of properly designed exhibits, and in this way a reawakening of the affinity with the sea may be fostered. Dhow Harbor, which opens out from sief Palace, already serves as symbols of the trade aspect of Kuwait's past; an aquarium, then, symbolic of other aspects of Kuwait's tradition as an ocean-oriented nation, would be a perfectly matching counterpart.

(1) Nature of the Aquarium

In overall perspective, it is necessary for a public aquarium such as the one envisioned to be both a place of entertainment and an arena for enlightenment, "enlightenment" in this context meant to signify learning which takes place in the course of pleasurable activity. If the proper degree of balance can be maintained between these two ends, the result will be none other than a "high quality" aquarium.

One more ingredient should be added, and that is a research capability supplementing the two foregoing attributes.

This research capability in itself will not necessarily directly affect the exhibits that the visitors view, but it is essential to sustain their high quality and to open the way to improvements. Prerequisite, accordingly, is that the aquarium officials be specialists in biological fields and that conditions be prepared so that they can further refine their own skills. This implies that in research matters the institutional capability of the aquarium must be sophisticated enough to uplift the morale of all employees.

If we examine the world's aquariums, we can identify two broad tendencies behind their display methodologies that pivot on the founding objectives. One tendency is to stress education, and the result is museum-like aquariums; the other is to stress the amusement effect, and oceanarium-type aquariums are the outcome. Both tendencies lead to separate, distinctive features. However, due in part to the progress made in display techniques in recent years, aquariums that are hard to classify under either type are becoming more numerous. In other words, it is now commonly agreed that a modern aquarium must skillfully blend the best features of the educational aquarium and the amusement aquarium.

i) Capacities for Entertainment, Education, and Research

Considering the particular conditions for the Kuwait aquarium, we might attempt one ordering of priorities--albeit highly subjective--among the capacities for entertainment, education, and research as follows:

Entertainment	40%
Education	40%
Research	20%

ii) Aquarium Quality

There is at least one compelling reason from an international perspective why it would be desirable for the

aquarium to be above average in terms of the size, quality of the collection, and excellence of the display techniques; The Kuwait aquarium would be the first full-fledged aquarium to come into existence in the overall Middle East region. The aquarium project of course would directly affect Kuwait itself in cultural terms, but more than that it might elevate Kuwait's status among neighboring states as an entity of refined culture. And from the global outlook, it would be distinguished as the first aquarium to be established under Kuwait's specific climatic conditions. Whatever the viewpoint, it is impossible to dismiss the potential advantages to be gained through elevated prestige.

iii) *Other Necessary Considerations*

We may say that most aquariums in the past have taken the display of their collections as their central function. The Government of Kuwait, however, is placing emphasis on development of sports and recreation activities, and some response to this might be included in the aquarium plans. Keeping the character of the Kuwait people also in mind, we should envision the aquarium not simply as a place of display but as a place of human interaction, a place where people have the opportunity to get together with other people. To emphasize this side of the aquarium's character, we might speak of it as a "recreational facility".

For entertainment purposes, plans are being laid for the introduction of pools for shows featuring dolphins as well as the instinctive behavior of other fishes as "perfomances" for the spectators. It needs to be emphasized, however, that such shows are not proposed solely to enhance the aquarium's entertainment value. They should also be designed with educational content, so that as a spectator watches a show he simultaneously learns that the dolphin has the ability to behave this

way, or a fish to behave that way, each acting according to its particular nature.

a) Animal Exhibits (See Table 1 and Note)

Generally speaking, first-class aquariums make their central exhibition the fish species found off their nations' shores, and displays of coral fish are frequently added. Furthermore, since fresh-water fish species that are of profound biological interest and are valuable as exhibits are to be found distributed throughout the world, those species from each continent adapted to breeding tend to be collected and displayed.

For the Kuwait aquarium, the fish section would ideally focus on the fish species found in the Arabian Gulf, the Gulf of Oman, and the Red Sea. To this, two beneficial basic additions would be an exhibit of colorful coral fish from tropical waters of the Pacific and an exhibit of the representative fresh-water fishes from each continent.

The question of the initial supply of dolphins for the dolphin show apart, eventually the best plan will be to capture and train dolphins that live in the Arabian Gulf. Generally dolphin species that swim in shallow waters are well suited for shows, and this means that the chances are good that Arabian Gulf dolphins will also be a suitable species.

b) Arrangement of Exhibits

Many different ways can be conceived to arrange exhibits, but generally one or more of the following ordering systems are adopted.

-1. By systematic groups

-2. By geographical distribution

-3. By type of habitat

-4. By type of behavior

-5. By size, shape, and colour

It may be argued that the essence of a collection will be best exhibited by adhering as a rule to just one of these systems of arrangement, but in practice this ideal solution is difficult to implement due to limitations in the collection size or the number of tanks. A reasonable compromise is to establish a rough display policy of dividing the fresh-water species by continent and the marine species by type of habitat. Systems -2, -4 and -5 can then be put to use for more minute classification. Then, if educational displays are set up together with the exhibits, the interest of the viewers can be most effectively aroused.

c) Exhibit Methods

Two emerging trends are to be observed in the exhibit techniques being employed around the world. One is to enlarge the tank size for more dynamic exhibits and the other is to arrange "ecosystem exhibits." Larger tanks became possible with the development of acrylic panels to replace glass. Oceanic bonito, tuna, and even sharks, all of which posed breeding problems in the conventional showcase, can now be put on display. Ecosystem exhibits can be set up in a variety of ways, but recent experiments have featured a type of exhibit called the "habitat group." A model of a certain land-and-water habitat is created, and in it are raised and displayed not only the fish species found in the habitat but also amphibians, reptiles, birds, and vegetation. Both

these new exhibit methods are to preferably be put to use in the Kuwait aquarium.

d) The Need for a Marine Facility

One problem in the raising of such powerful swimmers as sharks and tuna is that of transporting and successfully introducing them to the aquarium. In order to achieve much higher survival rate, a marine pool is constructed in the sea by the aquarium, which ensures quick delivery of captured spieces from fishing boat before being transfered to the aquarium. Such large fishes would be left for a time in the pool until they had acclimatized. Their eventual introduction to the aquarium tanks might even be accomplished without removing them from the water if a slit is so designed in the pool as to connect it with the aquarium and the fishes are driven through it. Training of dolphin also could be undertaken in the pool, and another option would be to open it up to the public.

e) Other Exhibits

So far we have concentrated on the animal exhibits, but here we shall consider other kinds of exhibits that can enhance the value of the aquarium. Two of the foremost items are video displays and panel displays.

-1. Video displays

Two common means of video display are movies and television, and movies at least may be said to be an indispensable component of the aquarium project. The very scale of the aquarium will limit the size and scope of live exhibits that can be accommodated, but by use of movies this limit is effectively removed. The movies stored in a film library, in terms of quantity, will

extend and diversify the aquarium's "collection," and in terms of quality they will make possible the display of other than "live" exhibits. For example, film that document the sea itself can be shown. Accordingly, for an aquarium which will function as a symbolic institution in an ocean-oriented nation as discussed above, it is vital that it accommodate a theatre where films can be screened.

Television units are to be set at several spots in the spectator's gallery. They can be intertwined with live exhibits to produce such an effect on the viewer as to enviched the contents of the live exhibits by showing, for instance, reproductive behavior, feeding behavior and other interesting behaviors under natural environment. A prearranged program may be first recorded with a video recorder and then fed into the television set so that it can be replayed whenever desired.

-2. Panel displays

Panel displays should be considered in terms of those that are on continual display and those that are only used temporarily. In the case of the latter, display panels will of course be designed and prepared on the particular occasion. Permanent display panels that are indispensible to an aquarium fall under a number of categories. First are the graphic illustrations of useful knowledge, such as easy-to-understand outlines of the branches of the family of animals. Second are the guidepost panels that explain the aquarium's system and help visitors find their way around by diagrams. Third are the tank panels for each tank that explain the contents and the objects on display.

iv) Aquarium Mechanical Facilities

Because the building is an aquarium, it should naturally have those distinctive facilities which distinguish an aquarium from the ordinary building, these needed to ensure appropriate water quality and temperature for the animals housed there. As the aquarium brings together for exhibition animals from a variety of diverse marine environments, each tank must maintain an internal environment appropriate to the species therein. With the inherent limitations in the display tanks available, importance that these different environments must be artificially created and maintained. The water in the tanks is indeed the very life environment for the fish and other animals on exhibit, and it will be impossible to achieve quality exhibitions unless sub-systems are instituted for the fine control of this tank water.

The aquarium mechanical facility system should be decided based upon such characteristics of the aquarium as are determined by its location, such as the difficulty of obtaining quality waters, climatic conditions, exhibition methods, and species collected; such personnel conditions as the grade of caretaker staff and facility maintenance staff; and such other conditions pertinent to the aquarium.

a) Circulation System

At the present stage, it is considered that a closed system would be appropriate and that an open system ill-suited for the tank water circulation system.

b) Filtering

For the filtering system, possibilities include an open sand filtering system utilizing the gravity and a closed sand filtering system utilizing pressure pumps. In this project, the open sand filtering system is considered better, even though it

does require more space than the closed system, for its ease of maintenance and quality of performance.

c) Water Temperature Control

This is to be controlled with thermostats through heat exchangers in the filtering circuit for each tank. In order that this water temperature control may be finely done, it is imperative that the filtering circuits also be delineated and kept separate. Accordingly, it would be best if a filter tank could be provided alongside each display tank, which means that water circulates through a balance-type filter mechanism.

d) Seawater Intake and Reservoir

While further studies will be needed to determine exactly how many days a year water may be obtained from the sea, this will be a major factor in evaluating the needed reservoir capacity. Nevertheless, current expectations are that a considerable reservoir capacity will be needed.

By the same token, intake facilities should be determined based upon consideration of seabed studies, intake capacities, and other factors, such that this must also await the results of future studies.

Whatever decisions are made on intake and reservoir capacity, however, it is clear that the fact that seawater taken in will include plankton, silt, and other substances mandates that it be filtered before being put in the reservoir for storage.

e) Water for Dolphins

Because the water for dolphins does not require the same delicate quality and temperature control as

does water for other species, this can be used if treated by aluminum sulphate and chlorinated.

(2) Planning and Design

This section takes up the ideas expressed in Nature of the Aquarium as they apply from the perspective of actual aquarium planning and design.

At the risk of repetition, this aquarium project is to function not simply as a display of marine and coastal life for the enjoyment and education of the people but also as a place of recreation for the people of Kuwait's capital city and a symbol of the ocean oriented tradition of the people of Kuwait. This is the greatest factor in determining the nature of this project, and all of the below planning and design has been done in consideration of the project's distinctive characters.

i) On the relationship with the landuse in the vicinity and the landscape/townscape (See Fig. 1 - 2), the shape of this project aquarium is conceived in consideration of the vicinity's landuse as assessed in the Master Plan provided by Government, the current state of development of the area, the landuse since formulation of that Master Plan, and the interaction of all of these factors with this project.

a) Factors and Items to be Considered

-1. The site fronts upon Arabian Gulf Street, a major road soon to link Kuwait Town and Salmiyah.

-2. The site is located to the north of the Paradise Cove sea club (under construction), a major recreation facility.

-3. On the other side of Arabian Gulf Street is

the public garden land reserved as the site for the Japanese Garden, another major recreational facility.

-4. An important secondary school is also nearby.

-5. Also in the immediate vicinity is the palace of Shaikh Abdallah, the former ruler.

-6. The beach assessment in the Master Plan calls for its use as a recreational area.

-7. As a recreational area, this beach is located approximately midway between the symbolic Kuwait Towers and Salimiyah Beach.

-8. In view of the spectacular development of Kuwait, the tendency is for this area fronting on Arabian Gulf Street to be utilized for prestigious development.

-9. The Municipality is currently formulating a waterfront development plan for this coastline in view of the coastline's urban value and its importance as a recreational area.

Taking the above factors into overall consideration, the shape this project should take may be described as follows:

- The aquarium's nature is such that it can be formed as a part of a recreation complex along with the sea club and public garden, giving these three an inter-access relation. If possible, it would be well for auxiliary facilities to be laid out for convenient joint use. At the same time, some consideration should be incorporated to allow easy access to and from the public garden area even though this is across Arabian Gulf Street from the aquarium.

In shape and for urban landscaping considerations, it would be well for the aquarium to facilitate with the sea club activities, and this is especially important on the seaward side. At the same time, it is also important that the shape be symbolic of Kuwait's tradition as a sea-going nation.

- In consideration of the lushly verdant background of the public garden, secondary school, and Shaikh Abdalah Salem Palace, Both the shape of the aquarium structures and the landscaping within the site must be suited to the environment.

- Full coordination is needed with the waterfront development plan now being advanced by the Municipality.

- Because this project is to be implemented along the coastline, the buildings of the project should have a scenic low profile, and it may generally be said that, the floors in such buildings as this tending to be high, three stories is a desirable limit. This conclusion is also supported by the undesirability of placing too great a load on the bearing capacity of the soil, since part of this site is landfill.

- It would be desirable if this were developed as a recreational facility including an aquarium but also possessing such social interaction areas as a cafeteria, lounge, and halls.

In view of the considerable area required to satisfy these diverse needs and the space limitations of the site inherent in the distance between the coast and Arabian Gulf Street, it will be necessary to execute some landfill reclamation in keeping with the project plan.

ii) Architectural Planning Policy

Generally speaking, the aquarium is composed of the following kinds of areas.

* Administration area
* Mechanical and electrical area
* Animal keeping area
* Research area
* Exhibition area

The main functions and sub-divisions within these areas are as noted below.

a) Administration Area

This includes ticket sales booths, information booths, management and administration rooms, Director's office, Director's meeting room, temporary living quarters, rest locker room, conference rooms, and the like. Of these, the temporary living quarters should be conveniently located for water circulation management in case of emergency and must be equipped with emergency information facilities.

b) Mechanical Area

This includes the mechanical room, electrical room, power generation room, and workshop. The workshop especially must include storage of spare parts and must be able to fashion immediate repairs to aquarium mechanical installations and equipments in case of an emergency or malfunction. Direct access to the animal keeping area is also essential.

c) Animal Keeping Area

Because keeping includes such widely diverse work as transporting and replenishing sea water, collecting and transporting animals for the aquarium, managing the tanks (especially maintaining water temperature

and purity), caring for sick fish, and overseeing propagation, it is absolutely imperative that ample space be set aside for the care and management staff. This must be located with direct access to the exhibition tanks.

d) Research Area

Included here are a library, specimen room, laboratories, research rooms, and darkroom. While this research area does not necessarily have to be in the same building as the exhibition area, all due consideration should be given to its close connection with the animal keeping functions. Because the library contains highly specialized materials, the fact that it is not an ordinary library lending to the general public for education and enjoyment should be reflected in its operation. In addition to the standard experimental equipment, materials, and chemicals, it is to be expected that the laboratories will also include experimental tanks.

e) Exhibition Area

More than a room, the exhibition area is rather a series of halls and corners along a flowline, and it is around this flow that the library, specimen room, meeting rooms, film screening rooms, lounges, scales booths, and washrooms are appropriately located.

iii) Composition of the Project

As already noted, this project should be 40% entertainment, 40% education, and 20% research. In view of this, how should this project be composed?

For many years, there have been basically two kinds of aquariums: the primarily educational museum-like aquarium

and the primarily recreational oceanarium or marine land. At first, the vast volume of water required for an oceanarium-type aquarium meant that it could only be located where there was ready access to abundant water of satisfactory quality. However, as aquarium facilities have developed in recent years, this problem of location has been solved and it is now common for the outstanding aquariums to combine the best features of both types. At the same time, such combinations heighten the quality of the aquarium and the entertainment value keeping the proposed ratio of capacity.

In this project, the total is divided into three sectors with each sector complementing the others for quality target achievement. These three sectors are:

- Main aquarium : This includes display tanks of various size as well as single giant tank of oceanarium type. They altogether form a single sector as main aquarium.

- Dolphin show pool : This is separate sector from main aquarium because the means and contents of display are categorically different from those of the fishes.

- Marine facilities : In order to make best use of the above two sectors, facilities to acclimate sharks and other large migratory fishes and to provide preliminary dolphin training are needed. As it is functionally convenient to build these facilities in the sea, this is considered another sector.

a) Component of the three sectors

Each of the three sectors has its own exhibition mode, and these may be characterized by the spectators' spaces as follows.

-1. Main Aquarium

- Entrance hall
- Display tanks and spectators' corridors
- Experimental show tanks and spectators' space
- Cafeteria
- Movie theater
- Lounge
- Lavatories

The display tanks are explained in further detail below.

-2. Dolphine Show Pool

- Entrance hall
- Spectators' seats
- Show pool
- Reserve pool (for training)
- Lavatories

In addition, there is also a hospital pool for dolphins which spectators cannot see. The show pool is arranged so that spectators can also see dolphins through underwater windows.

-3. Marine Facilities

- Pool
- Observation space

vii) Aquarium Facilities

a) Aquarium Water

Although this was already touched upon generally, it would be preferable to detail the filtering system.

the most intimately related part to tank water quality, in the total circulation system.

As has been noted, an open sand filtering system is most suitable for this project. The following factors have been considered in making this decision.

The closed sand filtering system has the advantages that the filter unit is in a closed tank so it does not take much room and can still forcibly cleanse large volumes of water, yet it also has the disadvantage that there is the danger that air getting into the system might asphyxiate large numbers of fish. At the same time, the closed sand filtering system is more difficult to maintain than is the open sand filtering system. Accordingly, in view of the special conditions prevailing in Kuwait, it may be said that the open sand filtering system is more suitable for fish tanks.

Nevertheless, the closed sand filtering system is suitable for the sea-water intake facilities before the reservoir and for the water circulation of the dolphin pools, since the pools are so big and there is no danger of asphyxiating the dolphins.

For the ordinary display tanks, it would be well to adopt "balanced" filters to be set in parallel with display tanks and the water circulates with air-lift. For the larger display tanks, it may prove impossible to set the filters in parallel with larger display tanks, in which case it will be necessary to accommodate filters in another place and to circulate the water with pumps.

With the balanced system, one display tank and one filter together constitute a circuit. This

system also has the advantage of allowing close control of water temperature with heat exchangers and thermostats within each circuit.

While perhaps only marginally relevant to filtering, it should also be noted here that the dolphin pools must have their own reservoir since the quality of water is different from that for other fish. This reservoir can probably best be divided into segments.

b) Offshore Facilities' Water

Offshore facilities must also have their own closed circulation system. This is especially important in controlling water temperature since these are outdoor facilities and thus highly susceptible to the effects of direct sunlight or climatic changes.

It would be well for each of the three sectors' circulation systems to be independant, since this would be in keeping with the different natures of water quality control for each sector, would make construction in phases possible, and would be convenient for partial opening as work on the sectors is completed at different times. This idea of partial opening is dealt with at greater length below.

c) Fresh Water Tanks

With fresh water as scarce as it is in Kuwait, it is imperative that its use be economized. Yet because the total volume of water is less for fresh-water species than for sea-water species and because fresh-water species do not by nature require such difficult water quality control, it should be relatively easy to economize on fresh water. However, a special reservoir will be needed exclusively for fresh water.

viii) The Human Flow

a) Flow of Spectator in Display Areas

-1. All flow is to be one-way traffic and circulation is to be such that routes do not double back past the same tanks.

-2. Crossing of flow lines is to be avoided, not only to avoid confusion at crowded times but also to make the aquarium a more psychologically enjoyable experience for visitors.

-3. Corridor width should be adequate to accommodate peak crowds.

-4. Putting display tanks on both sides of the flow line should be avoided as it is inconsistant with the principle of one-way traffic and is a cause of congestion.

-5. Although feasibility depends upon the line length, cafeteria, lounge, sales shops, and lavatories are in principle, to be at the route ends,

-6. Because the movie theater, dolphin pools, and like facilities may have people coming especially to see them, they are to be considered separate from the display tanks and are to be directly accessible from the entrance hall.

-7. There should be no steps on the spectators' route; and when level differences are inevitable they should be mitigated with ramps.

b) Operation and Management Staff Areas

-1. The staff entrance should be separate from the general admission for spectators entrance to avoid crossing of staff and spectator flow

lines.

-2. Although there is no need for the administration, and keeper, and mechanical areas to be adjacent, they should be mutually accessible without crossing visitor lines.

-3. The keeper area should have direct access to the mechanical area because of their intimate involvement with controlling water quality and water temperature.

-4. The keeper area and research area should have direct access to each other to promote mixing among their staffs.

-5. The keeper area should be directly accessible from the outside to receive deliveries of fish and fish foods. Hoists, lifts, or other equipments should also be available to handle deliveries of big fish, etc.

-6. Because the keepers are busy all day every day feeding their charges, checking water quality and temperature, and otherwise taking care of the fish, and because most of their work covers the basic route to and from the tanks, this route should be made as short and efficient as possible.

-7. In view of maintenance needs, the mechanical area should be directly accessible from the outside and should be such as to allow bringing in and taking out large equipment.

c) Points to Consider in Architectual Planning

Display Area

- A montage effect of changing shapes and colors should be created along the visitors' route to alleviate feelings of fatigue and enclosure.

- Special attention must be paid to acoustics and ventilation along the spectators' route.

- It is standard for display tanks to be bright and spectators' routes darker for better viewing under artificial lighting. As a result, it is imperative that spectators be cautioned to watch their step and that floor materials, foot-lights, and other safety factors be given adequate attention.

- It is normal for each tank to have its own title and explanation panels. Special care should be taken to make these easily legible since, as noted above, the spectators' route is dark. At the same time, routing directions should be kept as harmonious with the whole as possible.

ix) Points to Consider in Operation and Management

a) The aquarium displays are not complete once the building is opened to the public. Rather, they are complemented by staff efforts to maintain and improve them in keeping with the established display policy. For example, there are some fish which are very difficult to transport as adults and must be transported as fries, with the result that they would look lost in the tank designed for adults and the tank must be used for other species until the fries grow up.

Because the new aquarium cannot open with empty tanks, the opening of the aquarium is a busy time made busier by the inexperience of the staff and the newness of facilities. However, as with all institutions, the work quickly becomes routine once basic patterns are established. Making the mechanical facilities easy to handle and maintain also can serve to hasten this "routinization."

b) Even in nations with long histories of aquarium work, it is normal for experienced staff core to manage a new aquarium. The new Kuwait aquarium, such high-quality aquarium caring for and display diverse species, quantitative and qualitative in the work are to be still more natural.

c) Just as the aquarium itself is a distinctive institution, each aquarium has its own character depending upon location, display policy, and other factors. Experienced staff are indispensable to overcoming quirks and building the new aquarium's charactor.

d) For all to the above reasons, the training of key staff at established aquariums, aquariums inherently different from the Kuwait aquarium, shall be limited to basics. Although it has been noted that there can be only the most basic training, one of the most important things which the trainee should learn during this period is the need and ability for team-work between keepers and researchers, keepers and equipment maintenance personnel, and among keepers themselves.

e) There will inevitablly be a number of accidents, large and small, for some time after the opening of the new aquarium. Although it will be possible to affix responsibility and solve some of these problems, accidents carry the risk of death for animals on display. Valuable though the animals' lives are, there is, unfortunately, considerable learning through trial and error. With this in mind, there should be an ample contengency allocation in the budget for the purchase of animals. At the same time, the collection system should also be established.

f) Management and operation of the dolphin show pool requires special knowledges unlike that needed for fish tanks. Depending upon the species, some dolphins adapt to captivity more quickly than others, and some are easier to train for show than others. There are also individual differences in ability among dolphins. Over the years, considerable experience has been had with the shipping of dolphins, such that it should be possible to ship them to Kuwait. However, as noted above, maintaining the show requires access to an easy supply of dolphins. It would therefore be a good idea if new techniques were developed to capture and train dolphins from the Arabian Gulf. When the dolphin show pool opens depends upon whether shows are begun with imported dolphins or whether it is better to wait until new techniques are developed.

g) Although fish shows are currently held in some established aquarium utilizing fish training and conditioned reflex principles, it would be well for Kuwait aquarium to develop variation, albeit based upon the same principles. Accordingly, the participation of experienced specialists are considered desirable.

h) On engineer and maintenance staff training, for mechanical system, most of the actural training will depend upon the installations and equipments decided after the consulting services. At the consulting stage, the system will be decided upon and it will therefore be necessary to have people, although not many, study the broad dundamentals of aquarium management and operation. As for operation after the aquarium be completed, this must be considered in view of the contractor maintenance period and other factors. The aquarium will actually be in operation before it is opened to the public, this can also be profitably utilized as a training period.

3. PROJECT IMPLEMENTATION PROCEDURE

While this is also dealt with in Chapter 2, the important thing to do in implementing this project is to decide upon the construction contractor in accordance with the tender low of Kuwait after the consultant has prepared the book of tender. By the same token, it has also been noted regarding the scope of consulting services that, in view of the nature of the project these must include not only the planning, design, and construction supervision generally offered within consulting services but also such formulation of training programs for experts responsible for the operation of the aquarium, formulation of an operation and management programs, assistance with the training, and operation and management, assistance with the procurement and display of the many kinds of fish, and other assistance as these in the "soft" aspects of aquarium operation for a comprehensive consulting service. The need for an advisory group and steering committee is also dealt with in Chapter 2.

Based upon the above-established premises, this chapter takes up matters necessary to project implementation. (See Fig. 4 and Note)

3-1 Steering Committee

The need for a steering committee has already been discussed between the mission and competent officials of the Government of Kuwait, and this section deals with the policies, functions, and structure of that steering committee.

(1) Statement of Policy

Because the aquarium is to display living ecosystems, the implementation will include a variety of multi-strata problems. If the project is to be satisfactorily accomplished without undue delay, there must be a steering committee established on the Government side to give unified and coordinated direction to solving these problems.

(2) Statement of Function

The steering committee is to act in all stages of project implementation from consulting service on to check the reports, programs, and other documents submitted by personnel and firms concerned and to give direction to subsequent studies and sections. The committee is also to provide supervision from the Government side of construction and training.

(3) Structure

The steering committee should include the following members.

i) Ichthyologist:
In aquarium projects in capacity of producer.

ii) Aquarium Expert.
Practically experienced in operation and management of aquariums.

iii) Specialists from the Government of Kuwait:
For example, someone concerned with urban planning in the Municipality.
Electrical and water engineers from the Ministry of Electricity Water and Gas.
Sewarage specialist from the Ministry of Public Works.

Moreover, these specialists must be brought together as befits the material they are supposed to check.

In addition, in view of the nature of this aquarium project, the person to be Director of the aquarium should participate from the very beginning on the steering committee. At the same time, it goes without saying that it will be virtually impossible, since this project is the first of its kind in Kuwait, to find the requisite marine biologist and aquarium operations specialist in Kuwait.

The steering committee should be chaired by a competent official of the Agriculture and Fisheries Department, the Ministry of Public Works, since the aquarium project falls under said Ministry's jurisdiction. The first task of the steering committee will be to establish prequalifications for consultants.

3-2 Consultants

Because the consultant to this project are to provide the comprehensive service as noted above, the consultant will obviously have to have had previous experience with aquariums. By the same token, it is essential that such consultant shall have enough capacity to render such services as to cooperate with training, operation and management.

Because of the very special nature of the consulting services for this project, selection must be done with full consideration to technical performance after the prequalifying consultants have submitted proposals based upon the "Terms of Reference".

3-3 Staff Training

(1) Keepers

Very broadly categorized, keeper training is to be done in two stages.

Stage 1: This is basic training for keeper to be done at established aquariums under the supervision of the consultant for a period of three months.

Stage 2: This is training at the project site before the aquarium is open. Of course, this will also continue for a while after the aquarium begins public operation. It is imperative that this training be supervised by someone who has had adequate keeper experience at an established aquarium (in this case someone from the consultant's staff). This will be done after the pre-operation period (See Figure-4).

(2) Mechanical Facility Engineers

This training is to take place in three stages.

Stage 1: This is general training in mechanical facility maintenance to be given at established aquariums under

the supervision of the consultants for a period of three months.

Stage 2: This is individual training by the project contractor once the contractor is selected and the equipments and installation to be used in the project be decided. It is to run for a period of two months.

Stage 3: This is training at the project site before the aquarium is opened to the public, although this will naturally continue for a while even after the aquarium opens. It is imperative that this training be given by someone fully experienced in mechanical facilities at established aquariums (in this case, someone from the consultant staff). This will also continue after the pre-operation period (See Figure-4).

It would be well for stage 1 keeper training and stage 1 mechanical facilities maintenance engineer training to be conducted simultaneously. By the same token, there will obviously be parallel training programs for operation and management personnel.

3-4 Animal Procurement

The various fish on display may be (1) purchased, (2) captured, or (3) obtained in exchange.

As noted above, it would be good for all species to be in place by the time the aquarium opens, but there are a number of reasons which make this very difficult. It is imperative that preparations be begun with adequate leeway in the purchase and exchange of fish so that these may be ready for the opening. By the same token, because the sources for purchase and exchange procurement are diverse and not all deliveries will be made at the same time, it is a good idea to take advantage of that leeway period between completion and opening so that species can be in place by opening time. This period can also be used as a training period for staff.

Those fish to be procured through capturing, obviously, are species indigenous to the waters near Kuwait. These fish can be put in a giant tank, yet because they come in all sizes and because there are so many of the many different species, it will be impossible to capture them all at once. Accordingly, it will be necessary to set aside a period of time for their capturing. At the same time, provision will have to be made for stocking them, since they cannot be put into the tank before opening. Consequently, it would be well to aim for completion of the offshore pools before completion of the main aquarium and to use these pools for stock purposes.

Even after the aquarium opens, capturing will be necessary to replenish displays, and it is imperative that the system for capture replenishment be well established before the aquarium opens. For more information on fish species, please see the Appendix-3.

As already noted, it would be possible idea to import trained dolphins and to use them, but it will be more practical to capture and train dolphins available in local waters since there are very few trained dolphins available and the sources are very restricted. In this case it is required to invite to Kuwait specialists of dolphin-capture as well as dolphin trainers from outside because they are not expected to be recruited in locally. Should locally captured dolphins prove untrainable, another possibility might be to import untrained dolphin and to trained locally.

3-5 Video Displays

These video displays include both movie films using the theater and taped television programs using television sets in the spectators' gallery.

(1) Films

These may be generally obtained in three way: those produced especially for the Kuwait aquarium, those purchased from outside sources, and those borrowed from film libraries. If possible, it would be well to have at least the following six specially produced films.

i) Documentary on Kuwait's fisheries, maritime transport, and other marine industries (30 minutes)

ii) History and customs of the people, especially as they relate to the sea (30 minutes)
This is to deal with the traditions and range of activity of the sea-going Kuwaitis. It is well known that the Arabs went west, but there is a tendency to forget that they also advanced forcefully east, not only along the Silk Road but also by sea. This film is to deal with the tradition of not only the Kuwaitis but all the Arab people.

iii) Marine life in Asia (including the Near and Middle East) (40 minutes)

iv) Underwater review (20 minutes)
This is a fantasy film combining fine music with syncronized swimming or abstract art in a interesting glimpse of underwater.

v) The drama of the sea, the desert, and the people of Kuwait (45 minutes)
This is to be a relaxing and recreational film like iv) (even though it will have a story line to hold it together).

vi) Documentary of the aquarium's establishment (30 minutes)
This is a documentary of the birth of the aquarium, including surveys, plans, construction, fish procurement, and other work that went into creating this aquarium.

In addition to the 30-minute version noted above, there is also to be a full-length record of the aquarium's founding. All film are to be 16mm.

The following film projection facilities will be needed.

3 No. of 16mm projectors with cinemascope capability.

1 No. of stereo sound system.

1 No. of 800 x 584cm screen.

It is estimated that it will take at least 10 months to produce the above six films. A film library will also be needed to keep these and their films safe.

(2) Television

These programs are to show unusual species which aquarium does not have or which are difficult to display. Each program is to be 5 - 10 minutes. They will be shown on five television sets using video-recordings.

4. OPERATION PLAN

4-1 Staff for Running the Aquarium

The search for and appointment of the aquarium's working staff depend fundamentally upon the jurisdiction under which the aquarium is placed and the objectives of the aquarium. The following is a suggested scheme of organization for the Kuwait aquarium staff with reference to their specified duties and numbers.

	No. of Local Staff		No. of Expatriate Staff
Director			
Keeping of animals			
* Head of the section(curator : biologist)	1		
* Keeping of fish			
Chief keeper (biologist)	1		
Keepers; Sea fishes	4)	(2)	3
Freshwater fishes	3)		
* Keeping of dolphin			
Chief keeper (biologist)	1		
Keepers	6	(2)	3
Maintenance of mechanical facilities			
* Head of the section (chief engineer)	1		
* Mechanical engineers	2)	(2)	
Assistants	6)		
* Electrical engineer	1)	(1)	1
Assistants	2)		
Public relations and general affairs			
* Head of the section (administrator)	1		
* Public relations (commentator)	2		
* General affairs (administrative staff)	2		
Helpers	3		
* Projector specialist	2		1
* T.V. operator	1		
* Others; Janitors, Sweepers, Cafeteria operators, Gardeners, Clerks, etc.	As required		

N.B. Including night shift staff of which number is mentioned within ( ).

TABLE 1. THE ARRANGEMENT OF DISPLAY AND KIND OF ANIMALS ALONG THE GALLERY OF THE KUWAIT AQUARIUM. THE ALPHABET AND FIGURES IN THE TABLE CORRESPOND TO THOSE IN THE REFERENCE DRAWING

	NAME OF DISPLAY GROUP	TANK NUMBER AND NAME OF DISPLAY		a*	b*	c*	d*	e*	f*	g*	h* (Cub. M)	i*
A	Phylogenetic Tree			-	-	-	-	-	-	-	-	-
B	Giant Marine Tank	B-1	Large Fishes Found in the Arabian Gulf	S.W.	O.F.	25°C	15.0	8.0	6.0	6.0	720.0	A
C	Marine Invertebrates	C-1	Octopus, Sea Squid	S.W.	O.F.	15°C-25°C	1.0	1.0	0.8	0.8	0.8	G
		2	Shrimp, Crab	"	"	"	"	"	0.5	0.5	0.5	"
		3	Spider Crab	"	"	"	3.0	3.0	1.5	1.5	13.5	"
		4	Sea Snail	"	"	"	1.0	1.0	0.5	0.5	0.5	"
		5	Sea Urchin, Starfish	"	"	"	"	"	"	"	"	"
		6	Coral, Jellyfish, Sea Anemone	"	"	"	"	"	"	"	"	"
D	Sea Fishes of the Arabian Gulf	D-1	Fishes from Temperate Pacific	S.W.	B.F.	15°C-25°C	2.0	2.0	1.5	1.5	6.0	G
		2	Migratory Fishes	"	O.F.	25°C	5.0	2.5	"	"	18.75	G
		3	Fishes of Rocky Shore	"	"	"	5.0	2.5	"	1.5	18.75	G
		4	Symbiotic Behaviour of Grouper and Wrasses	"	B.F.	"	2.0	2.0	"	"	6.0	G
		Space for Explanation Panel		-	-	-	-	-	-	-	-	-
		5	Protective Color Change	S.W.	B.F.	25°C	2.0	2.0	1.5	1.5	6.0	G
		6	Coral Fishes in South of Kuwait	"	O.F.	"	5.0	2.5	"	"	18.75	G
		7	Fishes of Estuary	"	B.F.	"	2.0	2.0	"	0.2-1.0	4.0	G
		8	Color Change	"	"	"	"	"	"	1.5	6.0	G
		9	Fishes of Sandy Shore	"	O.F.	"	5.0	2.5	"	"	18.75	G
		10	Sound by Fish	"	B.F.	"	2.0	2.0	"	"	6.0	G
E	Fishes of Coral Reef	E-1	Symbiotic Behaviour of Anemonefish	S.W.	B.F.	25°C	2.0	2.0	1.5	1.5	6.0	G
		2	Shrimpfish and Seahorse	"	"	"	"	"	"	"	"	"
		3	Varieties of Typical Coral Fishes	"	O.F.	"	8.0	3.0	"	"	36.0	A
		Space for Explanation Panel		-	-	-	-	-	-	-	-	-
F	Five Sets of T.V. Receiver "Life of Fish"			-	-	-	-	-	-	-	-	-

G	Fresh Water Fishes of the World	Africa	G-1	Living Fossils	F.W.	B.F.	25°C	2.0	2.0	1.2	0.6	2.4	G
			2	"	"	"	"	"	"	"	"	"	"
			3	Varieties of Endemic Species	"	"	"	"	"	"	"	"	"
			4-1	Spawning Behaviour	"	"	"	0.9	0.9	0.5	0.5	0.4	"
			4-2	"	"	"	"	"	"	"	"	"	"
			4-3	"	"	"	"	"	"	"	"	"	"
			4-4	"	"	"	"	"	"	"	"	"	"
				Space for Explanation Panel	-	-	-	-	-	-	-	-	-
		Tropical Asia	G-5	Anabantids Fishes	F.W.	B.F.	25°C	2.0	2.0	1.2	0.6	2.4	G
			6	Beautiful Varieties of Cyprinids Fishes	"	"	"	"	"	"	"	"	"
			7	Representative Species	"	"	"	"	"	"	1.2	4.8	"
			8	Feeding Behaviour of Archer Fish	"	"	"	1.5	"	"	0.6	1.8	"
		Ecological Display	G-9	Habitat Group	F.W.	O.F.	15°C-25°C	6.0	6.0	2.5	0.6	21.6	G
		Europe	G-10	Cyprinids of Europe	F.W.	B.F.	15°C-25°C	1.5	2.0	1.2	1.2	3.6	G
			11	Fishes in Cold Water	"	O.F.	"	4.0	3.0	1.2	1.2	14.4	G
		Temperate Asia	G-12	Salmonids Fishes	F.W.	B.F.	15°C-25°C	2.0	2.0	1.2	1.2	4.8	G
			13	Giant Salamander	"	"	"	"	"	"	"	"	"
		North America	G-14	Living Fossils	F.W.	B.F.	25°C	2.5	2.0	1.2	1.2	6.0	G
			15	Native Fishes	"	"	"	1.5	"	"	"	3.6	"
			16	Blind Cave Fish	"	"	"	"	"	"	"	"	"
		Central America	G-17	Livebearers	F.W.	B.F.	25°C	1.5	2.0	1.2	1.2	3.6	G
		South America	G-18	Carnivorous Charachin	F.W.	B.F.	25°C	1.5	2.0	1.2	1.2	3.6	G
			19	Giant Fish in Amazon	"	O.F.	"	5.0	5.0	"	"	30.0	"
			20	Beautiful Tropical Fishes	"	B.F.	"	1.5	2.0	"	0.6	1.8	"
			21	"	"	"	"	"	"	"	"	"	"
			22	Electric Discharge of Electric Eel	"	"	"	"	"	"	1.2	3.6	"
		Australia	G-23	Australian Lungfish	F.W.	B.F.	25°C	2.0	2.0	1.2	1.2	4.8	G

H	Experimental Show	H-1	Discrimination of Color	S.W.	B.F.	25°C	2.0	1.5	1.5	1.5	4.5	G
		2	Discrimination of Sound	"	"	"	"	"	"	"	"	"
		3	Mathematic Display	"	"	"	"	"	"	"	"	"
		4	Shape Discrimination	"	"	"	"	"	"	"	"	"
		5	Flag Hoisting	"	"	"	"	"	"	"	"	"
I	Goldfishes	I-1	Wakin	F.W.	O.F.	25°C	0.9	0.6	0.45	0.45	0.25	G
		2	Fringe Tail	"	"	"	"	"	"	"	"	"
		3	Lionhead	"	"	"	"	"	"	"	"	"
		4	Oranda	"	"	"	"	"	"	"	"	"
		5	Shubun-kin	"	"	"	"	"	"	"	"	"
		6	Calico-Oranda	"	"	"	"	"	"	"	"	"
		7	Pearl Scale	"	"	"	"	"	"	"	"	"
		8	Bubble Eye	"	"	"	"	"	"	"	"	"
			Space for Lineal Descent Chart and Explanation Panel	-	-	-	-	-	-	-	-	-
J	Photo Taking Tank	J-1	Beautiful Varieties of Sea Fish	S.W.	O.F.	25°C	2.0	0.8	2.0	2.0	3.2	G
K	Movies "Marine Biology and Fisheries Science"			-	-	-	-	-	-	-	-	-
L	Colored Carp's Pond	L-1	Many Varieties of Colored Carps	F.W.	O.F.	25°C			-		12.0	-
			Space for Explanation Panel	-	-	-	-	-	-	-	-	-
M	TOTAL VOLUME OF WATER OF DISPLAY TANKS								FRESH WATER SEA WATER		146.3 919.0	
M	Explanation Pannel on Water Circulation System			-	-	-	-	-	-	-	-	-
N	Dolfin Show	N-1	Show Pool	S.W.	C.F.	25°C	20.0	15.0	-	4.0	1,200.0	
		2	Training Pool	"	"	"	12.0	9.0	-	3.0	324.0	
		3	"	"	"	"	"	"	-	"	"	
		4	Hospital Pool	"	"	"	14.0	6.0	-	"	264.0	
	TOTAL VOLUME OF SEAWATER OF DOLFIN POOL										2,112.0	

O	Marine Facilities	Acclimatization and Training of Dolfin	O-1	Dolfin	S.W.	C.F.	ϕ15.0	-	3.0	500.0
			2	"	"	"	"	-	"	"
		Acclimatization of Sharks and Very Large Fishes	O-3	Sharks and others	S.W.	C.F.	ϕ10.0	-	2.0	220.0
			4		"	"	"	-	"	"
		TOTAL VOLUME OF SEA WATER OF OUT DOOR POOLS								1,440.0

Note 1 The width and height of the glass or acrylate will be approximately 10 - 15 percent smaller than the size of tank shown in this graph, in order to accommodate tank edging.

Note 2 S.W. .... Sea Water F.W. .... Fresh Water

Note 3 O.F. .... Open Filter B.F. .... Balanced Filteration
C.F. .... Closed Filter

* a - Sea Water of Fresh Water b - Filtering System c - Temperature of Water
d - Width of Tank e - Depth of Tank f - Height of Opening
g - Height of Water h - Volume of Water i - Glass or Acrylate

Unit of Size : Meter

NOTE: PRELIMINARY STUDY OF ARCHITECTURAL DESIGN FOR THE INTERIOR DECORATION OF TANKS FOR THE KUWAIT AQUARIUM.

B-1 A dynamic display by a giant marine tank will hold schools of migratory fishes and very large fishes found in the Arabian Gulf. The interior will be sparsely decorated with graduating sized rock, covering the bottom and growing smaller toward the back wall and top, but not breaking the water. Some parts of the rock will offer flat ledge.

C-1 - C-6 (except C-3)
These tanks will hold invertebrates mainly found in the coastal waters of Kuwait. The walls on all three sides will be plain and gently curved, as well the bottom of these tanks. All will be plain, painted cement.

C-3 This tank will display spider crab, a largest crabs in the world. On the side walls simple rocks will be arranged. The rear wall will be painted to give a vey cold effect, and the bottom will be rolling and sandy. Nothing else will be placed in the bottom of the tank.

D-1 Decoration: side walls will show low rock. The back wall will be painted and smoothly curved. Nothing will be placed on the bottom, which will be flat, painted concrete.

D-2 Migratory fishes. The side walls on this tank are curved, with a smooth and even surface. On the bottom there will be low, smooth faced rocks and a lightly rolling, sandy sea bottom (see note). On the whole, a rather pure view.

N.B : All rocks and sand will be artificial.

D-3 Fishes found in the water of rocky shore of the South of Kuwait. On the walls and bottom of this tank complicated rock formations are arranged, to simulate the sea bottom of South Kuwait.

D-4 This tank, will show a view of symbiotic behavior, between Groupers and Wrasses. Decoration will be a rocky sea bottom.

D-5 Common sea fishes found in the sandy bottom of Kuwait water belonging to the different families. This tank should be separated into two sections by glass at the center of the tank and painted with two separate colors black and white.

D-6 Fishes of the coral reef are shown in this tank, and for visual effect, kept separate from those fish of E tanks. In pattern and view the coral will be composed of several types, found in the Arabian Gult.

D-7 Mudskippers found in the estuary. Walls will be flat and smoothly curved. Bottom will be flat and slightly rolling. The water level will be increased and decreased which modeled after natural tidal zone.

D-8 This tank will simulate to gradual change of lightness according with depth in natural sea by special artificial lighting.

D-9 Fishes which reside at the sea bottom. In this tank, the sea bottom will be slightly rolling and sandy, with several deeply recesses hollows, which will be filled with sand. The walls are curved in an undulating pattern.

D-10 Fishes caught together with shrimp by the operation of shrimp trawlers, live in a part of the Arabian Gulf which has a sea bottom pebbled with low, smooth-faced rocks and coral head. The tank will duplicate this,

N.B. ; Drum fish, which make sounds, are to be included in this tank. Tape recordings of the sounds will be played for viewers.

E-1 ~ E-3

Typical coral fishes commonly found in a coral reef in South Pacific. Large masses of horned coral, table coral and brain coral are to be arranged on side walls, back wall and tank bottom, at natural levels. Some parts of the tank bottom will be covered with coral sand.

G-1 Lungfishes. This will be an aqua-terrarium. These fishes live in marshy areas. As these fishes cannot co-exist, the water area of the terrarium will be separated into two by artificial rocks. The bottom of the tank will be muddy and rolling. The land is continuous and it will have recesses where large land and marsh plants are to be placed (see note). Regarding plants, it is essential that they not be contradictory to the distribution of fishes. In this regard, an investigation by experts will be necessary.

N.B.: These plants will be artificial.

G-2 Bichirs. Decoration : an exact replica of G-1.

G-3 Endemic small fresh water fishes. This tank will also be an aquaterrarium, with the terrarium separated into two parts, with a rolling, muddy bottom. The view of the land will be that of G-1.

G-4 Display of interesting nature of reproductive habits of these fishes, pairing, nest building, guarding eggs and young, in four small tanks, at least one of which will be active at any given time. The arrangement of the tanks will be two over two. The scene inside the tank will be smoothly walled and very plain.

G-5 Anabantids fishes, native in Tropical Asia, with peculiar air breathing organ. An aqua-terrarium which will be separated into two parts. The view will be that that of the bank of a stream or a swamp, and a pool. Fallen trees and roots, as well as plants will

be present, which will allow climbing perch to move from one part of the pool to the other. The bottom of the tank will be muddy.

G-6 Beautiful varieties of small-sized Cyprinid fishes. This will also be an aqua-terrarium which will be separated into two parts because of the varieties of fishes. This tank will also have a rolling, muddy bottom, while at the shore, water grasses will grow thick.

G-7 Representatives of Tropical Asia, medium and large size fishes. The back wall of this tank will be smoothly curved. The side walls will simulate a river bank, with low rocks and tree roots. The bottom will be rolling and muddy.

G-8 Archer Fish. Display of peculiar feeding behaviour ejecting water from its mouth at insects on leaves overhanging the water. This tank will be an aqua-terrarium, but with no separations. The walls will have rocky ledged, where living plants grow. The land portion will be heavily planted.

G-9 This will be aqua-terrarium for fishes as well as Amphibia, Retiles, and Birds, with the river portion of the model having several divisions. The river bed and shore line will have a muddy quality. From the bank up to the land, reed, and other plants will be arranged (see note). The display of fishes and plant life will be the primary display, although small birds, amphibia and reptiles will also be shown.

N.B : Planted foreground will be live plants, and in the background, artificial plants.

G-10 Representative species of Northern Eurasia. This tank will hold Pike and Trout. The scene will be that of a cold water lake, with the bottom covered with sand,

pebbled and mud. Rocks will be painted to give a very cold effect to the side walls.

G-11 Representative species of Northern Eurasia. Fishes of cold fresh water, for example, Sturgeon and Perch. This tank will also offer a scene of sharp, ragged edged rocks, covering the sides.

G-12 Very common species of Salmonidae, also commercially important. The back wall of this tank will be smoothly curved. The side walls, representing river walls, will be made of plain rock. The bottom of the tank will be rolling and covered with pebbles.

G-13 The largest Amphibia of the world. One of the important natural monument of Japan. This tank will offer a scene of sharp, ragged edged rocks, covering the sides, and the bottom.

G-14 "Living Fossils" in North America. Garpike and Bowfin. A view of the river basin and swamp. The bottom will be slightly rolling and muddy, and the side will show a muddy bank.

G-15 Native fishes of North America. The scene will be that of the bottom of a clear lake. The sides of the tank will show sharp rocks and the bottom will be covered with pebbles.

G-16 Blind Cave Characin. Adaptation of blind fishes living in subterranean water. The view in this tank will be one of subterranean water in a stalactite cave.

G-17 Beautiful varieties of viviparous killifishes. Small size fresh water fishes. This tank will show rocky shelving on the side walls, where living water plants will grow. The bottom of the tank will be rolling and muddy, and the back wall will be smooth and curved.

G-18 Piranha, Carnivorous Characin of Amazon River. The walls and bottom of this tank will show rocks, covered with mud (see note). The effect will be one of simplicity.

N.B : Mud will be artificial,

G-19 Giant Pirarucu. The largest freshwater fishes of the world. Because of the large size of this fish, the decoration of the tank will be very simple and pure. The curved walls and the bottom of the tank will be painted.

G-20 Beautiful tropical freshwater fishes of South America. This tank will be an aqua-terrarium, which will be separated into two parts. The tank will have a rolling, muddy bottom, and the land will be heavily planted.

G-21 Representatives of South American Freshwater fish fauna. An exact replica of G-20.

G-22 Electic Eel. This tank will be equipted with an oscilloscope so viewers will be able to see the electric discharge. This eel grows to a large size, so the tank will be decorated in a simple manner, with a muddy bottom and walls, as a river bed.

G-23 "Living Fossils" of Australia. This tank will be prepared for Australian Lungfishes. In the event that fishes are unobtainable at the time of the aquarium opening, this tank will be available for fishes of South America. Therefore, this tank will be very plain, the wall will be covered with rocks, and the bottom painted or pebbled.

H-1 - H-5

The decolation in the tank shall be determined in order to the program of the fish show.

I-1 - I-10

Goldfishes, The walls and bottom of these tanks will be covered with unglazed porcelain tiles.

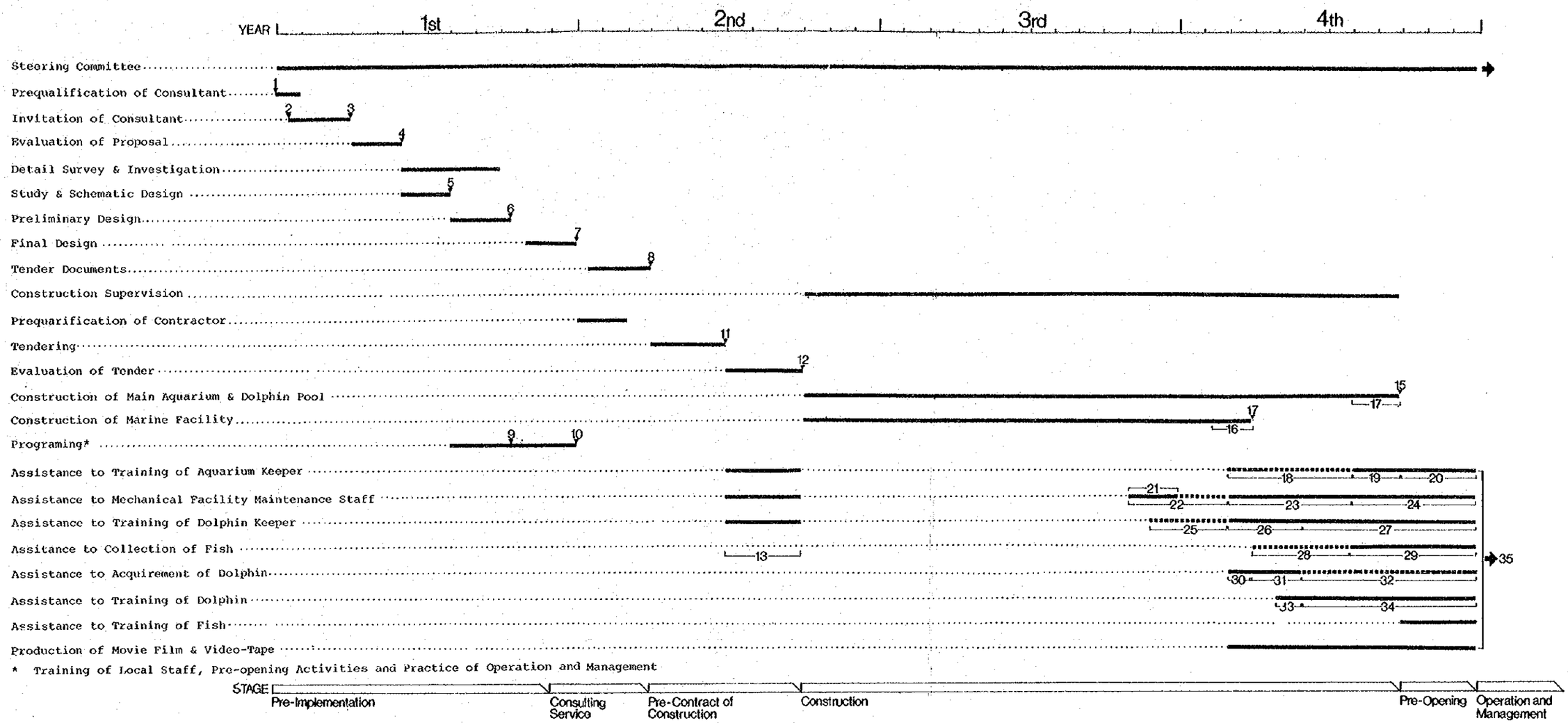
J-1 A glass-sided tank, designed to permit photographers to take pictures of people viewing the fishes. These photographs will give the eggect of people being in the tank with the fishes. Decoration: replica of E tanks.

L-1 Beautiful varieties of coloured carps in the large pond with rock garden.

N-1 - N-3 Dolphin Show :

For this exhibit, the shape of the pool will be an irregular oval, The walls will be smooth faced and stands will be provided for the viewers. There will be, as well, subterranean passages for spectators to view Dolphin through glass windows cut into the lower part of the pool. Artifical date palms and plant life will be provided along the pool for a natural setting. The dolphin show is to be performed from the famous 'Dhow' boat of Kuwait kept in the pool.

Fig.4 Implementation Schedule



* Training of Local Staff, Pre-opening Activities and Practice of Operation and Management

1 To establish the steering committee
2 Invitation letter to Consultants
3 Submission of proposal from Consultants
4 Awarding and determination of Consultant
5 Submission of Report
6 Submission of Preliminary Design
7 Submission of Final Design
8 Submission of Whole Tender Documents
9 Submission of Preliminary Programs
10 Submission of Detailed Programs
11 Submission of Tender
12 Tender awarded and determination of Contractor
13 Period of training for local staff in established aquariums
14 Pre-operation period
15 Completion of construction
16 Pre-operation period
17 Completion of construction
18 Preparation period of keeper training
19 Pre-operation period of training for keeper in Aquarium
20 Training of keeper in pre-openning period of Aquarium
21 Training of engineer by Contractor.
This period is to be a preparation period of training for engineer on the Kuwait Aquarium.
22 Preparation period
23 Training in Marine Facility
24 Training in full-operation
25 Preparation period of training for dolphin keeper
26 Training of dolphin keeper (for acquirement of dolphin)
27 Training of dolphin keeper with training of dolphin
28 Preparation period of collection of fish
29 Collection of fish
30 Investigation & Survey of dolphin
31 Capturing dolphin
32 Continuation of capturing of dolphin
33 Acclimatization of dolphin in marine facility
34 Training of dolphin
35 Operation & Management

(1) Because it is impossible to know how much time will be needed for the steering committee to appraise the consulting work at each stage, time for such appraisal has not been included in the above schedule. By the same token, no time has been included from contractor selection to actual contract conclusion either, since this too is an unknowable factor.

(2) Detailed surveys of the sea, land soil tests, and seabed soil tests must be done by the awarded consultants with the cooperation of Kuwait Government agencies. The marine facilities, the seawater intake facilities, the primary filter, and the primary reservoir must be studied based upon these results and preliminary drawings reflecting these findings submitted to the Govenment.

(3) Capturing of species in the Arabian Gulf and nearby waters is to begin in the latter three months of the offshore facilities' pre-operation period, and these fish then stored in these facilities. Also, the on-site training of keepers and plant maintenance personnel will begin simultaneous with the start of dolphin training.

(4) In the latter two months of the aquarium and dolphin pool pre-operation period, staff training is to begin and fish which will be transferred to their display tanks are to be so transferred.

(5) Expatriate staff assigned to cooperate with the operation and management of the aquarium should periodically visit the construction site as construction progresses having discussions the construction supervisory staff as well as steering committee.

(6) The construction period also includes surveys and mobilizations to be done by the contractor.

(7) Work is to begin in the pre-operation period on the various explanatory panels, photographs, explanations, pamphlets, etc.

(8) Though the considerations to the stage construction, each sector being constructed in different phase, are made, the implementation schedule is established on the basis of the three sectors being constructed at the same time.

In case the stage construction will be introduced; the above schedule must be modified accordingly.

The aquarium staff must have some experience in their assigned tasks prior to opening day. It is to be noted that the staffing plan given above is scaled for the minimum requirements of the Kuwait Aquarium and that, except for the keeper section, workers may be transferred on asked to do other work as circumstances require in order to economize on labor resources.

4-2 Training of the Staff and Preparatory Works

(1) Training in Established Aquariums

The training of key staff personnel in the keeper section is absolutely essential for the successful operation of the Kuwait Aquarium.

Number of trainers: 4 staff

Qualification: University graduates specialized in zoology or marine biology

Period of training: About 3 months

Subjects of training:

Ichthyology	Basic Studies
Aquatic Zoology	
Fish Pathology (including Treatment of Diseases)	Keeping of Animals
Nutrition and Feeding of Animals	
Water Chemistry (including Management of Fish Tanks)	
Collection of Animals	
Transportation of Live Animals	
Preparation of Explanatory Name Cards	
Keeping and Training of Dolphins	
Inspection of Selected Aquariums	

(2) Pre-opening Training and Preparatory Work for Opening

Pre-opening training is to be conducted for a period of seven months at the Kuwait aquarium under the supervision of expatriate specialists. During this period, the staff, having already received three months of basic training at existing

aquariums, will obviously work as assistants to these expatriate specialists. This pre-opening training will also continue after the aquarium is opened to the public, not ending unitl the local staff is fully able to take over the operation and management of the aquarium.

This seven-month pre-opening training period also includes training for the dolphins. This dolphin training can be begun at the off-shore marine pools till the dolphin show pool is ready. At least four dolphins will be needed for the shows. The process of training these dolphins is also an important part of training for the local staff. It is to be noted, however, that this seven-month period does not include time for the capture of dolphins, and this will require one month for basic surveys and two months for capture. The capture of dolphins is to be done by local fishermen under the supervision of three specialists experienced in capturing dolphins.

During this seven-month period, the expatriate experts are to act not only to train local staff but also to cooperate in those preparations needed for the opening of the aquarium. These preparations include collecting, writing explanations, and all the many other tasks.

Training for dolphin keepers and maintenance staff will begin one month before completion of the offshore pools. Four months prior to this seven months training before opening one expatriate supervision will come to the Kuwait aquarium to prepare for the training.

Training for keeper other than for dolphin keeper and maintenance staff will begin two months before completion of the aquarium and dolphin show pool, and will continue for five months including the preparation period for aquarium opening. Four months prior to this five-months' training, and thus nine months before the aquarium's opening, one expatriate supervision will go to the Kuwait aquarium to prepare for the training for aquarium keepers.

4-3 Work Required for Aquarium Operation

(1) Keeping of Animals

It is no exaggeration to say that whether the aquarium succeeds or fails depends upon the personal capabilities of management, especially those working for the animal keeping section. The aquarium staff must have a fairly high level of biological knowledge and must be professional in the subject as explained below.

i) Collection of animals for display

The work of the aquarium naturally starts with the collection of animals for display. It is important to select animal species considering their show value based upon the anticipated displays and the display policy of the aquarium. Most of the representative fish from each continent, as listed in this report, may be obtained today by means of purchasing from traders. Sea fish from Gulf waters may be collected with fishing boats and gear available locally. Those fish which cannot be obtained from fishermen or traders must be collected by the aquarium staff, or local fisherman under the supervision of the staff. In particular, marine invertebrates and small fish, indispensable for display but of no commercial value, must be caught by field collection. To maintain the faunal display of aqua-terrarium, collection may be done by the keepers or purchasing.

Exchanging animals with other aquariums will also be an effective and economical means of obtaining rare animals. For instance, the Australian Lungfish, which is strictly protected by the Government, may be obtained in exchange for Kuwaiti or Gulf fish.

Donation of animals from public sources is also a dependable means of collection.

It is to be noted that the work of collecting animals, except dolphins, must be started at least 3 months before

opening day to acclimate them to their new environment and confinement.

ii) Checking and curing diseases

Fish are just as prone to disease as are other living organisms, whether caused by poisoning, malnutrition, viral or bacterial infections, microscopic or macroscopic parasites, or other causes. All newly purchased or collected fish should be quarantined in a separate treatment tanks for about one week or more. Treatment of diseased fish is one of the main subjects assigned during the training of the staff.

iii) Nutrition and feeding of animals

Fish in aquarium live on fish meat, clam, shrimp, earthworm, insect, compound food, living fish, Artemia, etc., supplied by aquarium keepers. Aquarium keepers feed animals once a day for large carnivorous fishes and twice or more for young fish or small coral fish. The total amount of food rationed is only a few percent of the total weight of fish kept in tanks, as rapid growth is not an objective of aquarium display. Eutrophics or medicines are usually added to the food to prevent diseases.

iv) Breeding

Normal breeding of fish in captivity is a sign of good health. As reproduction is an instinct in all animals, it is an indication of unnatural living conditions, if animals do not breed in captivity.

Efforts to induce successful breeding, therefore, are a key to making aquarium keepers of high caliber.

It is often said that keeping techniques are perfected by inducing successful breeding. At the same time, successful breeding of rare fish will be a contribution to science.

v) Management of fish tanks

It is obvious that fish tanks must be kept as clean as possible for the purpose of display. Dead fish or debris must be removed as soon as they are noticed. On the average, each tank must be cleaned at least 4 times a year. Scrubbing off algae growths on inside surfaces of tank glass is also a routine task assigned to the keeper.

vi) Controlling water quality

To maintain optimum water quality for animals, regular analysis of water in fish tanks and in separate circulation systems and careful management of filter facilities are important tasks assigned to the aquarium keepers and engineers.

vii) Rearrangement of decorations and animals

The displays at Kuwait aquarium are to be left flexible for future enlargement, and they will be rearranged in time. What kinds of animals will be kept and how they will be arranged have already been discussed in detail, but the conbination of animals placed in the same tank must always be changed by the keepers because certain species grow so rapidly that they may be harmful to other fish, some species will have to be moved to more attractive display settings, and other developments.

viii) Presentation of name cards or labels

No aquarium display is complete without explanatory cards. The preparation of explanatory cards for the hundreds of animal species is a rather tricky job for the scientific staff. Handwriting is to be avoided on the cards, and they must be printed. The explanation given on the cards should be at the junior high school level. The following information must be included on the cards.

Kuwaiti name of the fish

Scientific name

English common name
Picture of the animal
Classification or group name
Size attained
Geographical distribution
Habitat
Habits
Fisheries and other uses

For panoramic or ecological displays, other explanations are also needed.

Such work should be started at least 6 months before opening day in order to make presentations scientifically accurate.

ix) Planning and implementation of special exhibitions
When the staff is familiar with the aquarium management and the displays are well organized, some special displays under special themes may be planned based upon research and experiments by the staff. Such work will enlarge and improve the displays in the aquarium.

x) Preparation of guide book and pamphlets
Pamphlets describing the aquarium must be prepared by opening day. When operation has begun and the displays are running smoothly, higher-quality guide books will have to be prepared.

xi) Research activities
Needless to say, a properly equipped aquarium is an ideal place for research in biology, especially for faunal studies of the Gulf where a number of species can be studied for precise identification, life history, and ecology. The facilities should also be open to use by scientists from other institutions.

xii) Other work
As the aquarium is a special institution, tools of ordinary

made are often unsuited for use. Aquarium keepers must therefore be trained in "make-it-yourself," for instance, hand nets for transferring fish from tank to tank, tools for cleaning inside glass windows, bottom filteration devices for small tanks, and many others. Clogging of circulation systems must be repaired by the keepers without delay.

(2) Maintenance of Machines

Tanks are usually more densely populated than the natural environment would be. Although inevitable for the purposes of exhibition, this means that any mechanical trouble in the circulation system may result in the death of animals because of a shortage of oxygen, a sudden change in water temperature, or any other reasons.

The staff must work to prevent such troubles through continuous inspection and quick reparis to machines. Unexpected troubles are virtually unavoidable, especially during the earlier period of operation when the staff has not yet been sufficiently trained in their operation. Accordingly, the staff should be able to effect temporary repair works and to design and supervise repair and construction works.

Taking all these matters into consideration, it is preferable to have experienced engineers cooperate with the Kuwaiti staff for an extended period after the start of operation until the staff is fully trained.

i) Circulation system

In each separate system, excepting small tanks set on tables, the water in the tanks is pumped through filters and heat-exchangers. For the purification of water, closed filters or open sand filters will be used. The heat-exchanger consists of pieces of titanium pipes which are anticorrosive in sea water and a chamber. Sea water or fresh water purified by filters flows inside the pipes while cold water (from the refrigerator,

during summer) or hot water (from the boiler during winter) flows outside of the pipes. By regulating the temperature of the outside water flow, each system should maintain the proper temperature.

Checking pressure gauges or flow meters indicating the state of clogging of the sand layer in filters, engineers operate pumps for washing the sand. This work must be done in close liaison with the scientific staff in charge of water analysis.

ii) Refrigerators and boilers

Refrigerators and boilers are operated in order to supply cold and hot water to heat-exchangers in the circulation systems and also to cool or heat the galleries and offices in the aquarium. The thermostatical equipment must be checked every hour and must be promptly repaired should any trouble develop.

iii) Electrical equipment

The management of electrical facilities includes mercury lamp lighting for tanks, generator operation for emergencies, checking control panels for water temperature, control panels for plant operation, transformers and fuses in the electrical room, and other work.

iv) Design and supervison

Any deffects in the machines which is beyond the aquarium engineers must be contracted to professional engineers outside. The maintenance of refrigerators, lifts, and other such equipment is typical of this outside work. The design and supervision of such contract work by the aquarium staff is extremely important.

v) Inspection work

Machines and equipment such as listed below must be kept in good order and working at full capacity: some 50 pumps in total for circulation systems, sea and fresh water reservoirs, fire hydrants, and sand washing in

filters, air blowers to supply air to fish tanks, ball taps and electrode, a large number of valves, and fire alarm boxes. Tools needed for repairs must be kept in good order and ready for use at any moment.

(3) Public Relations and General Affairs

The work assigned to this section is generally that dissemination of knowledge and information not covered by the duties assigned aquarium keepers. The reception of visitors is another duty of this section. Administrative work outside the other two sections is also charged to this section.

i) Works of the public

Animals living in captivity are one of the best teaching materials for biology or natural history. In cooperation with school teachers, the children can learn much from viewing the animals alive in tanks. While the name cards and other information put up in front of displays are prepared by the biological staff, they will have greater educational potential if this section assists in their preparation. Other work here also includes announcements for visitors, assisting handicapped persons, telephone services, making billboards of various sorts, etc.

ii) General affairs

The types of business falling under general affairs are not much different from those of ordinary Government offices (see below). However, it may be pointed out that the budget required for the opening year should be carefully estimated by the staff of the preparatory organization.

1. Management of personnel duties
2. Designation of working times for personnel
3. Drafting of monthly and annual reports
4. Liaison with other Government offices
5. Payment of salaries for the staff

6. Payment of wages for temporary workers
7. Negotiation of outside work contracts
8. Budget planning and execution

iii) Other works

Following are the routine work required of this section: general management of aquarium building to meet legal regulations, opening and closing the aquarium, overseeing entrusted work such as cleaning of the galleries, cafeteria, and souvenier shop; disposal of rubbish and garbages, maintenance of aquarium garden, and management of ticket office.

5. PRELIMINARY COST ESTIMATES

This chapter deals with the construction and other implementation costs of this project as described above.

These are very rough estimates drawn up for convenience's sake to serve as guidelines for the Government of Kuwait in budgeting for execution of this project. It is to be noted especially, however, that these estimates cover only those items for which forecasts are possible at present.

5-1 Construction Cost

The outline of construction costs is as follows.

A. Main Aquarium — KD 5,400,000/-

The estimate is made in following basis:

1. Anticipated total floor area : 12,000 Sq.m.
2. Assumed construction cost per Sq.m. of floor area : KD 450/-

B. Dolphin Show Pool — KD 1,280,000/-

The estimate is made in following basis:

1. Anticipated total floor area : 3,200 Sq.m.
2. Assumed construction cost per Sq.m. of floor area : KD 400/-

C. Marine Facility — KD 728,000/-

The estimates is made in following basis:

1. Anticipated total floor area : 1,600 Sq.m.
2. Assumed construction cost per Sq.m. of floor area : KD 450/-

5-2 Design and Engineering Fees — KD 481,000/-

The consultant fees for preparation of "Book of Tender" are calculated in 6.5% of construction costs.

5-3 Land and Offshore Survey

The survey is mainly devided two parts, one is soil investigations which are of land and offshore, and other is oceanographic surveys.

Here, in the practical point of view at present, a cost of soil investigations is calculated as an assumed cost based upon the cost in Japan, and as for the oceanographic survey, total man-month of researchers for field work and other items of cost incurred to are only described also as reference.

A. Land Survey

i) Soil Investigation : KD 12,000/-

12 nos. 15m deep boring test, including sampling and laboratory analysis

B. Offshore Soil Investigation

i) Soil Investigation : KD 17,500/-

6 nos. 15m deep boring test including sampling and laboratory analysis

C. Oceanographic Survey

- Total man-month : 18
- Breakdown :
  - 4 nos. of Expatriate Researcher
  - 8 nos. of Local Assistant
  - 1.5 month field work

D. Other Items of Cost for Oceanographic Survey

- 3 nos. of boat for the field work
- International airfare for expatriate researchers
- Living expense in Kuwait for expatriate researcher
- Miscellaneous supplies
- Hiring 3 nos. of boat for the field work
- Laboratory analysis
- Reports making
- Other miscellaneous expense

5-4 Other Consulting Services

Consulting services other than "Design and Engineering" i.e. construction supervision, assistance to the staff training, and assistance to the operation and management is to be normally calculated on the basis of man-month.

Therefore, as references the assumed total man-month for each work component, in the practical point of view at present, is calculated and other items of cost incurred are described.

A. *Construction Supervision Fees*

Construction supervision fees are calculated by applying the man-month rate to the number of supervisory staff.

- Total man-month : 200
- Period of work : 24 months
- Other costs i.e. international airfare and living expense in Kuwait for expatriate staff and other miscellaneous expense are included.

B. Programing Fees

Programing fees are calculated by applying the man-month rate to the numbers of experts involved.

- Total man-month : 20
- Period of work : 5 month
- Other miscellaneous expense

C. Fees of Assistance to the Operation and Management

1. Training in The Established Aquarium
   4 nos. of Trainee
   Period of work : 3 month

2. Assistance to pre-operation and pre-opening activities in Kuwait.

   i) Keeper Training
   - Total man-month : 19
   - Expense of international airfare and living expense in Kuwait etc. :

ii) Maintenance Engineer Training
- Total man-month : 19
- Expense of international airfare and living expense in Kuwait etc. :

iii) Dolphin Keeper Training
- Total man-month : 34
- Expense of international airfare and living expense in Kuwait etc. :

iv) Collection of Fish
The above is rendered by trainers of fish keeper. However it will also be necessary some costs to employ local fisherman for this task.

v) Acquirement of Dolphin
- Total man-month : 5
- Expense of international airfare and living expense in Kuwait etc. :

In addition, it will also be necessary some costs to employ local fisherman for this task.

vi) Training of Dolphin
The above is rendered by the trainers of dolphin keeper.

vii) Training of Fish
The above is rendered by the trainers of fish keeper.

5-5 Costs of Purchasing Fish KD 25,000/-

Fishes to be displayed except obtainable in the Arabian Gulf shall be purchased.

The cost of the above is calculated on these cost in Japan for only reference. Therefore, the cost does not include cost of shipping to Kuwait. List of the above fishes are shown on Appendix.

Although it will be necessary to employ fishermen to catch fish available in the Arabian Gulf or to purchase such fish from them, these figures are omitted here because of the lack of adequate data.

5-6 Other Operation and Miscellaneous Cost

It is not practical at this stage to estimate costs in this category. Therefore, estimates are omitted here.

Nevertheless, it is possible to list some of the major items in this category.

A. Books and reference materials
B. Chemicals
C. Fabrication and purchase of instruments
D. Film production
E. Video-tape production
F. Background music tape production
G. Pamphlet and guide production
H. Production and printing of books
I. Explanation panel production
J. Species replenishment
K. Other miscellaneous expenses
L. Expense or/and cost for assigned local staff including trainee

N.B. Regarding the production costs for the six films noted earlier and the video-tapes, it is possible to hazard an estimate of KD 200,000 with all projection equipment and T.V. sets.

5-7 Research Laboratory

For reference, the minimum requirements of special furnitures, furnishings, equipments and tools are itematized below.

A. Testing table
B. Dissecting table
C. Microscope
D. Dissecting microscope
E. Photo-electric Ph meter
F. Water sampler
G. Balance
H. Micro projector
I. Camera
J. Enlarger
K. Photo drier
L. Copy stand
M. Oxygen bombe
N. Diving apparatus
O. Refregerator for specimens

APPENDIX-I

Former Report by Mission

Because this mission continued where the first and second missions left off, the main text of the report submitted by the first mission, one of the most important reports to date, is appended here for reference.

INTRODUCTION

In response to the request of the Ministry of Public Works of the Government of Kuwait for the envisaged National Aquarium to be built in Kuwait, an expert mission of three Japanese namely Dr. Fujio YASUDA, Mr. Yoshitaka ABE, and Mr. Koichi YANO visited Kuwait during the period of February 11th to 19th in 1974.

The mission prepared the present report at the request of the Ministry of Public Works, treating the subject tentatively giving a rough sketch of the Kuwait Aquarium (Part One), and general survey of the problems (Part Two).

Since this is a master plan, needless to say, another discussion in detail with the Kuwait Government Officials must be made for finalization.

It is hoped that the present report will be a step nearer towards acheiving a successful venture.

The preliminary design of the aquarium was made in cooperation with M/S Ishida Design Office Co., Ltd. who have had considerable experiences in such type of design works.

The members of the mission express their deep sense of gratitude to Mr. Salem I. Al-Mannai, of the Ministry of Public Works and his assistants, Mr. Al-Assousi, Mr. Bader Al-Naqui, and staff of the Kuwait Institute for Scientific Research, Mr. Katsuji Tainaka and Mr. Hiromu Ikenoue, for their kind hospitality during their fruitful stay in Kuwait.

Dr. Fujio YASUDA, Tokyo University of Fisheries
Yoshitaka ABE, Ueno Zoological Garden Aquarium
Koichi YANO, Saito Shozo Shoten Co., Ltd.

PART ONE: GENERAL CONCEPT OF THE PROJECT

PRIMARY REQUISITES OF THE KUWAIT AQUARIUM

The mission had several meetings with the staff of Kuwait concerning the aquarium project, and exchanged valuable opinions on the general problems in contriving the scheme.

The members of Kuwait side stated their own ideas and ambitions for this project for which the mission gave frank opinions of the pros and cons of the project. Consequently, the primary requisites necessary for the Kuwait Aquarium is briefly summarized as follows.

1) Kuwait Aquarium should be of a very high standard one and the most suitable for the State of Kuwait of 800,000 population, carrying the functions, such as amusement of public, education of public, and research activities. Special emphasis should be placed upon the function of amusement or recreation of public.

2) The project is to be carried out near the premises adjoining the site of the Japanese Garden Project in Salimiyah.

3) The kinds of animals to be displayed in the aquarium are not limited to the local marine invertebrates and fishes of the Arabian Gulf, but extended to the representative fresh water fishes with show value from every continent of the world, including those of the Tigris and Euphrates Rivers.

4) The show pools for marine mammals such as dolfins and smaller whales will be excluded at the start of the scheme though the site for future construction is reserved at the premises of the aquarium, because they require additional or separate facilities from those for fishes.

5) The facility of a giant marine tank with the capacity of several hundred cubic meters of water to contain sharks, rays, and schools of migratory fishes is preferably equipped as an introduction into aquatic world. A pond for the beautiful varieties of colored carps, as well as table tanks for goldfishes, are to be located in the miniature Japanese Garden proposed in the cafeteria.

6) The latest technics and facilities such as radio guide, underwater TV, oscilloscope for electric fishes, apparatus to hear sounds in water, micro-projector for microscopic organisms etc., are widely adopted to the unique displays and explanation of the animals.

7) For educational purposes, the aquarium needs, exhibition galleries for the introduction of fisheries of Kuwait, increase in biological

knowledge on aquatic animals, and a combined movie theatre and lecture hall.

8) The research laboratories for the aquarium staff, specimen rooms, a breeding room, special tanks for the treatment of animals and a library are needed for the function of research activities. The pier to bring the collection vessels alongside of the aquarium is one of the prime necessities for running the aquarium.

9) The incidental facilities such as parking, refreshment shop and booth selling souvenirs or guide book of the aquarium are also necessary.

Table 1. The arrangement of display and kinds of animals along the gallery of Kuwait Aquarium. The Alphabet and figures of the displays correspond to those in the drawings.

NAME OF DISPLAY	KIND OF ANIMAL Kuwait name or common name-scientific name	SIZE OF TANK width x depth x height (m)	Volume (m^3)	REFERENCE
A. Sea fishes of the Arabian Gulf				
A-1 Migratory fishes	Zobaidy-Pampus argenteus, Halway-Formio niger, Hamam-Caranx spp., Khubbat-Scomberomorus guttatus, Beyah-Liza macrolepis, Lihlah-Chorinemus lysan, etc.	8 x 5 x 2.5	100	An attractive display as an introduction to aquatic world.
A-2 Fishes of coral reef	Anfooz-Pomacanthus maculosus, Pomacanthus imperator, Chaetodon obscurus, Heniochus acuminatus, Hamer-Milloidichthys auriflamma, Terr-Parapercis nebulosa, Meelaz-Stethojulis interrupta, Velvet Damselfish-Pomacentrus sindensis, Sail-finned surgeonfish-Zebrasoma xanthurus, Deyayah-Pterois volitance, E'-Nezah-Chelemodon patoca, etc.	5 x 2.5 x 2	25	Typical coral fishes found in the waters of South of Kuwait. The tank to be decorated of coral reef.
A-3 Fishes of estuary	Boshalanbo-Periophthalmus waltoni, Cryptocentrus filifer, Pseudapocryptes dentatus, Boefchach-Thryssa mystax, Shing-Scatophagus argus, Mud Crab, etc.	2 x 2 x 1.2	4.8	Artificial tidal zone modelled after the nature of the Kuwait Bay.
A-4 Fishes of rocky shore	Hamoor-Spinepherus tauvina, Naisarah-Lutjanus spp., Sheiry-Lethrinus spp., Fasker-Acanthopagrus bifasciatus, Yanam-Plectorhynchus schotaf, Mochwah-Diplodus noct, Mozaizy-Acanthopagrus berda, etc.	5 x 2.5 x 2	25	Fishes found in the water of rocky shore of the south of Kuwait. The tank with the decoration of rocks and caves.
A-5 Fishes of sandy shore	Teeb-Therapon theraps, Andag-Argyrops spinifer, Chimh-Arius thalassinus, Ghazal-Polydactylus sextarius, Bassi-Nemipterus japonicus, Hayyasa-Chiloscyllium griseum, Suboor-Hilsa ilisha, Makool-Tylosurus leiurus, etc.	5 x 2.5 x 2	25	Fishes caught together with shrimp by the operation of shrimp trawlers from the sandy bottom of the Arabian Gulf.
A-6 Small-sized sea fishes:	Kofash-Bothus pantherinus, Psettodes erumei, Merlak-Pardachirus marmoratus, Kasoor-Saurida undosquamis, Bwharah-Platycephalus indicus, etc.	5 x 2.5 x 2	25	Display of the protective colour change of sandy bottom dwellers; flounders, flatfishes, etc.

	NAME OF DISPLAY	KIND OF ANIMAL Kuwait name or common name-scientific name	SIZE OF TANK width x depth x height (m)	Volume (m^3)	REFERENCE
A-7	Small-sized sea fishes	Masoom-Sillago sihama, Manchoos-Allanetta forskali, Eshmahy-Jonius aneus, Fattrah-Torpedo penthera, Siny-Leiognathus spp., Badah-Gerres spp., etc.	2 x 2 x 1.2	4.8	Common sea fishes found in the waters of Kuwait belonging to different families.
A-8	Small-sized sea fishes	Nakkaka-Batrachus grunniens, Firyalah-Minous monodactylus, Spotted Seahorse-Hippocampus kuda, Cholaib-Eldow-Triacanthus biaculeatus, etc.	2 x 2 x 1.2	4.8	Common sea fishes found in the waters of Kuwait belonging to the different families.
A-9	Giant marine tank	Yaryoor-Carchrhinus menisorrah, Lokhmah-Himantura uarnak, Balando-Rhynchobatus djiddensis, Lazzag-Echeneis naucrates, Sikin-Rachycentron canadus, Hiff-Chirocentrus dorab, Thelah-Chorinemus lysan, Nakroor-Pomadasys argenteus, Newaiby-Otolithes argenteus, Hamrah-Lutjanus coccineus, Sea Turtles, etc.	18 x 5 x 6	540	A dynamic display by a giant marine tank containing schools of migratory fishes and large fishes found in the Arabian Gulf.
B.	Marine invertebrates				Marine invertebrates found in the coastal waters of Kuwait.
B-1		Octopus or Sea squids	1 x 1 x 0.8	0.8	
B-2		Shrimp and Crab	1 x 1 x 0.5	0.5	
B-3		Sea Snail	1 x 1 x 0.5	0.5	
B-4		Sea Urchin and Starfish	1 x 1 x 0.5	0.5	
B-5		Coral, Jellyfish and Sea Anemone	1 x 1 x 0.5	0.5	
C.	Freshwater fishes of the world				
C-1	Freshwater fauna of Tigris-Euphrtes Basin	Cyprinids fishes: A'djzan-Barbus subquicunciatus, Gattan-Barbus xanthopterus, Shilik-Aspius vorax, etc. Catfishes: Djirri-Silurus triostegus, etc. Frogs and Toads: Birds: Reptiles:	20 x 4 x 0.5	40	Aqua-terrarium for fishes as well as Amphibia, Reptiles, and Birds of Shatt-Al-Arab Region. The tank with thick vegetation of date palms and other plants.
C-2	Freshwater fishes of Africa	Lungfishes-Protopterus aethiopics, Protopterus annectens, Protopterus dolloi, Bichir-Polypterus bichir, etc.	1.5 x 2 x 1.2	3.6	"Living Fossils" of Africa.

	NAME OF DISPLAY	KIND OF ANIMAL Kuwait name or common name-scientific name	SIZE OF TANK width x depth x height (m)	Volume (m^3)	REFERENCE
C-3	Freshwater fishes of Africa	African Knifefish-Notopterus nigri, Mormyrids fishes-Gnathonemus petersii, Gymnarchus niloticus, Heterotis-Heterotis niloticus, Butterfly Fish-Pantodon buchholzi.	2 x 2 x 1.2	4.8	Endemic freshwater fishes in Africa.
C-4	Freshwater fishes of Africa	Congo-tetra-Micralestes interruptus, Distichodus-Distichodus sexfasciatus, Up-side Down Catfish-Synodontis nigriventris Jewel Fish-Hemichromis bimaculatus, etc.	1.5 x 2 x 1.2	3.6	African Characins and others.
C-5	Freshwater fishes of Tropical Asia	Climbing Perch-Anabas testudineus, Kissing Gourami-Helostoma temmincki, Giant Gourami-Osphronemus goramy, Pearl Gourami-Trichogaster leeri, etc.	2 x 2 x 1.2	4.8	Anabantids fishes, native in Tropical Asia, with peculiar air breathing organ.
C-6	Freshwater fishes of Tropical Asia	Rasbora - Rasbora heteromorpha, Indian Glass Fish-Chanda ranga, Sumatra-Barbus tetrazona tetrazona, Red-tailed Black Shark-Labeo bicolor, etc.	2 x 2 x 1.2	4.8	Beautiful varieties of small-sized Cyprinid fishes.
C-7	Freshwater fishes of Tropical Asia	Knife Fish-Notopterus chitala, Silver Barb-Barbus schwanenfeldi, Giant Danio-Danio malabaricus, etc.	2 x 2 x 1.2	4.8	Representatives of Tropical Asia.
C-8	Freshwater fishes of Temperate Asia and Europe	Carp-Cyprinus carpio, Grass Carp-Ctenopharyngodon idellus,	2 x 2 x 1.2	4.8	Very common species of Cyprinidae, also commercially important.
C-9	Freshwater fishes of Temperate Asia and Europe	Sturgeon-Acipenser spp., Perch-Perca flavescens.	2 x 2 x 1.2	4.8	Representative species of Northern Eurasia.
C-10	Freshwater fishes of Temperate Asia and Europe	Pike-Esox lucius, Brown Trout-Salmo trutta, etc.	4 x 3 x 1.2	14.4	Representative species of Northern Eurasia.
C-11	Freshwater fishes of North America	Garpike-Lepisosteus spp., Bowfin-Amia carva.	2 x 2 x 1.2	4.8	"Living Fossils" in North America.
C-12	Freshwater fishes of North America	Blue-gill Sunfish-Lepomis spp., Sucker-Catostomus spp.	1.5 x 2 x 1.2	3.6	Native fishes of North America.
C-13	Freshwater fishes of Central America	Swordtail-Xiphophorus helleri, Platy-Xiphophorus maculatus, Guppy-Lebistes reticulatus, Four-eyed fish-Anableps anableps, etc.	1.5 x 2 x 1.2	3.6	Beautiful varieties of viviparous killifishes.
C-14	Freshwater fishes of South America	Piranha-Rooseveltiella nattereri	2 x 2 x 1.2	4.8	Carnivorous Characin of Amazon River.

	NAME OF DISPLAY	KIND OF ANIMAL Kuwait name or common name-scientific name	SIZE OF TANK width x depth x height (m)	Volume (m^3)	REFERENCE
C-3	Freshwater fishes of Africa	African Knifefish-Notopterus nigri, Mormyrids fishes-Gnathonemus petersii, Gymnarchus niloticus, Heterotis-Heterotis niloticus, Butterfly Fish-Pantodon buchholzi.	2 x 2 x 1.2	4.8	Endemic freshwater fishes in Africa.
C-4	Freshwater fishes of Africa	Congo-tetra-Micralestes interruptus, Distichodus-Distichodus sexfasciatus, Up-side Down Catfish-Synodontis nigriventris Jewel Fish-Hemichromis bimaculatus, etc.	1.5 x 2 x 1.2	3.6	African Characins and others.
C-5	Freshwater fishes of Tropical Asia	Climbing Perch-Anabas testudineus, Kissing Gourami-Helostoma temmincki, Giant Gourami-Osphronemus goramy, Pearl Gourami-Trichogaster leeri, etc.	2 x 2 x 1.2	4.8	Anabantids fishes, native in Tropical Asia, with peculiar air breathing organ.
C-6	Freshwater fishes of Tropical Asia	Rasbora - Rasbora heteromorpha, Indian Glass Fish-Chanda ranga, Sumatra-Barbus tetrazona tetrazona, Red-tailed Black Shark-Labeo bicolor, etc.	2 x 2 x 1.2	4.8	Beautiful varieties of small-sized Cyprinid fishes.
C-7	Freshwater fishes of Tropical Asia	Knife Fish-Notopterus chitala, Silver Barb-Barbus schwanenfeldi, Giant Danio-Danio malabaricus, etc.	2 x 2 x 1.2	4.8	Representatives of Tropical Asia.
C-8	Freshwater fishes of Temperate Asia and Europe	Carp-Cyprinus carpio, Grass Carp-Ctenopharyngodon idellus,	2 x 2 x 1.2	4.8	Very common species of Cyprinidae, also commercially important.
C-9	Freshwater fishes of Temperate Asia and Europe	Sturgeon-Aciperser spp., Perch-Perca flavescens.	2 x 2 x 1.2	4.8	Representative species of Northern Eurasia.
C-10	Freshwater fishes of Temperate Asia and Europe	Pike-Esox lucius, Brown Trout-Salmo trutta, etc.	4 x 3 x 1.2	14.4	Representative species of Northern Eurasia.
C-11	Freshwater fishes of North America	Garpike-Lepisosteus spp., Bowfin-Amia carva.	2 x 2 x 1.2	4.8	"Living Fossils" in North America.
C-12	Freshwater fishes of North America	Blue-gill Sunfish-Lepomis spp., Sucker-Catostomus spp.	1.5 x 2 x 1.2	3.6	Native fishes of North America.
C-13	Freshwater fishes of Central America	Swordtail-Xiphophorus helleri, Platy-Xiphophorus maculatus, Guppy-Lebistes reticulatus, Four-eyed fish-Anableps anableps, etc.	1.5 x 2 x 1.2	3.6	Beautiful varieties of viviparous killifishes.
C-14	Freshwater fishes of South America	Piranha-Rooseveltiella nattereri	2 x 2 x 1.2	4.8	Carnivorous Characin of Amazon River.

	NAME OF DISPLAY	KIND OF ANIMAL Kunrait name or common name-scientific name	SIZE OF TANK width x depth x height (m)	Volume (m^3)	REFERENCE
C-15	Freshwater fishes of South America	Giant Pirarucu-Arapaima gigas, Arawana-Osteoglossum bicirrhosum.	5 x 2.5 x 2	25	The largest freshwater fishes of the world.
C-16	Freshwater fishes of South America	Neon Tetra-Hyphessobrycon innesi, Silver Hachet Fishe-Carnegiella levis, Metynnis-Metynnis roosevelti, etc.	1.5 x 2 x 1.2	3.6	Beautiful tropical freshwater fishes of South America.
C-17	Freshwater fishes of South America	Armoured Catfish-Callichthys callichthys, Angel Fish-Pterophyllum emekei, Anostomus-Anostomus anostomus, etc.	1.5 x 2 x 1.2	3.6	Representatives of South American Freshwater fish fauna.
C-18	Freshwater fishes of Australia	Australian Lungfish-Neoceratodus forsteri.	1.5 x 2 x 1.2	3.6	"Living Fossils" of Australia.
C-19	Giant Salamander	Giant Salamander-Megalobatrachus japonicus.	1.5 x 2 x 1.2	3.6	The largest Amphibia of the world. One of the important natural monument of Japan.
D.	Ecological Display				
D-1	Feeding behaviour of Archer Fish	Archer Fish-Toxotes jaculator.	2 x 2.5 x 1.2	6	Display of peculiar feeding behaviour ejecting water from its mouth at insects on leaves overhanging the water.
D-2	Electric discharge of Electric Eel	Electric Eel-Electrophorus electricus.	2 x 2 x 1.2	4.8	The tank with oscilloscope and volt meter.
D-3	Blind cave fishes	Blind Cave Characin-Anoptichthys jordani, Blind Barb-Caecobarbus geertsi.	1.5 x 2 x 1.2	3.6	Adaptation of blind fishes living in subtrranean water. The tank with decolation of stalactite cave.
D-4	Spawning behaviour of Tilapia and other Cichlids fishes	Mouth Breeder-Tilapia spp., Jewel Fish-Hemichromis bimaculatus, etc.	2 x 2 x 1.2	4.8	Display of interesting nature of reproductive habits of these fishes, pairing, nest building, guarding eggs and young.
D-5	Symbiosis behaviour of Anemone Fishes	Clown Fish-Amphiprion percula, Anemone Fishes-A. frenatus, A. xanthurus.	1.5 x 2 x 1.2	3.6	The most striking examples of symbiosis between fish and lower invertebrates.
E.	Exhibition gallery				Educational exhibition or special display based on the researches and experiments, and display of microscopic organisms by micro projectors or TV.
E-1-10	Goldfishes	Goldfishes-Carassius auratus auratus	0.9 x 0.45 x 0.45	about 0.1m^3	Beautiful varieties of Goldfishes in 10 special table tanks.

NAME OF DISPLAY	KIND OF ANIMAL Kuwait name or common name-scientific name	SIZE OF TANK width x depth x height (m)	Volume (m^3)	REFERENCE
F. Exhibition gallery				Photo exhibition gallery.
G. Lecture hall Movie theatre				Three hundred seats. Showing films of marine biology and fisheries science.
H. Japanese Garden				Beautiful varieties of coloured carps in the Japanese garden pond.
H-1 Colored Carps	Colored Carps-Cyprinus carpio.	5 x 5 x 0.5	12.5	
I. Dolfin show	Dolfins and smaller whales			The facilities for dolfin show similar to those in Hawaian Sea Life Park. The pools with glass windows at its side. The dolfin show is to be performed from the famous 'Dhow' boat of Kuwait kept in the pools.
I-1		15 x 10 x 5	750	
I-2		10 x 5 x 5	250	

THE OUTLINE OF THE KUWAIT AQUARIUM

The aquarium having all the facilities as mentioned above is believed to be of high standards, and one of the largest and most educational aquariums in the world.

The scheme of the project, needless to say, must be worked out according to their desires and opinions of the staff of Kuwait, however, at the same time, it must be proper and practical.

Thus the main point was how to reflect and formalize those requisites in a practical scale for the Kuwait Aquarium.

The facilities of dolfin pools were throughly discussed in every detail in the present report, though they are considered at present as a future extention.

The total floor area of the acquarium building exclusive of the dolfin pools is about 8,640 m^2. Animals are exhibited in 38 glass-fronted wall tanks for fishes, 2 special floor pools for dolfin show, 1 floor pool for colored carps, and about 10 table tanks for goldfishes. The arrangement of displays along the gallery is shown in Table 1. The total amount of water circulating in the systems including reserve tanks is estimated around 1,000 cubic meter. The volume of water in the circulation system of the dolfin pools is about 1,000 cubic meters.

The following is explanatory data prepared by the aquarium architects on the outline of the aquarium building (Figs and Table 2).

The building consists of two different facilities, namely the aquarium and the show pool. In order to connect these two blocks both functionally and architecturally, a spacious hall which is accessible directly from open space of the site is to be designed. The hall provided with staircases and lounge on the second floor serves not only as an entrance hall but as a lobby for the visitors.

Although the building is designed as one unit, it would be possible to execute the construction work in two stages, the aquarium and the show pool separately.

During planning, the following fundamental conditions have been taken into consideration in designing the aquarium.

a) Smooth flow of visitors along the predetermined route to the exit must be ensured. The passage route of visitors should not have any hindrance on the way.

b) Exhibits should be arranged using diversified display methods so as to attract the visitors throughout their trip in the aquarium.

c) The breeding sections and the administrative rooms should be so

arranged that both breeding and management works may be carried efficiently and independently. To assure satisfactory breeding, particular attention should be given to the movements, preservation and preparation of feeds as well as securing sufficient space for breeding.

Outline of building

Aquarium*: 3-storied, including machine room and filter space on the ground floor mainly reinforced concrete structure.

Show Pool: 2-storied, including pools, reservoir and filter space on the ground floor mainly reinforced concrete structure except roof in steel structure.

Table 2. Floor Area in Square Meter

	Aquarium*	Show Pool	Total	Remarks
Ground Floor	1,130.00	900.00	2,030.00	Pilotti not included
1st Floor	2,835.00	1,000.00	3,835.00	Surface of pools not included
2nd Floor	1,250.00	-	1,250.00	
3rd Floor	3,200.00	400.00	3,600.00	
Pent House	225.00	-	225.00	
Total	8,640.00	2,300.00	10,940.00	

* Entrance hall included

APPENDIX-II

Records of the Under-water Reconnaissance

Appended here for reference are the details of the underwater reconnaisance, considered one of the highlights of the reconnaissance work done by the mission.

1. NAME OF RECONNAISSANCE

Sea oceanographic survey of seawater intake facilities in connection with aquarium construction.

2. RECONNAISSANCE SITE

Offshore area facing to the site for aquarium at Salimiyah, Kuwait.

3. PURPOSE OF RECONNAISSANCE

To collect basic information on sea and weather conditions as necessary for the construction of seawater intake facilities in connection with the aquarium. There is also a need to clarify the fastors that will influence the marine environment (temperature, currents, and quality of the water, nature of the seabed, and biota) when implementing the projects.

4. FIELD RECONNAISSANCE

4.01 Purpose

The field reconnaissance was conducted in advance of the detailed survey to establish the following three factors:

(1) Plans for seawater intake facilities suited to the water in the offshore site.

(2) Determination of the items to be included in the detailed survey.

(3) Determination of the date of the detailed survey.

4.02 Items Investigated

The reconnaissance covered the following three items:

(1) Investigating of seacoast at the proposed aquarium site.

(2) Investigating of offshore area facing to the proposed aquarium site.

(3) Collecting of existing reference materials.

4.03 Date of Reconnaissance and Items Investigated

From : December 13, 1975

To : December 22, 1975

Date	Items Surveyed
Dec. 12	Depart Japan, arrive Kuwait
" 13	Survey of waterfront at the proposed aquarium construct site
" 14	"
" 15	"
" 16	Survey of sea bottom observation at offshore area facing to the proposed aquarium construction site
" 17	Collecting of existing reference materials
" 18	Survey of sea bottom observation at offshore area facing to the proposed aquarium construction site
" 19	Survey of seacoast at the proposed aquarium construction site
" 20	"
" 21	Survey of sea bottom observation at offshore area facing to the proposed aquarium construction site
" 22	Collecting of existing reference materials
" 23	Depart Kuwait

4.04 Location of Reconnaissance

Offshore area facing to the proposed aquarium site at Salimiyah as indicated in Fig. 1-2

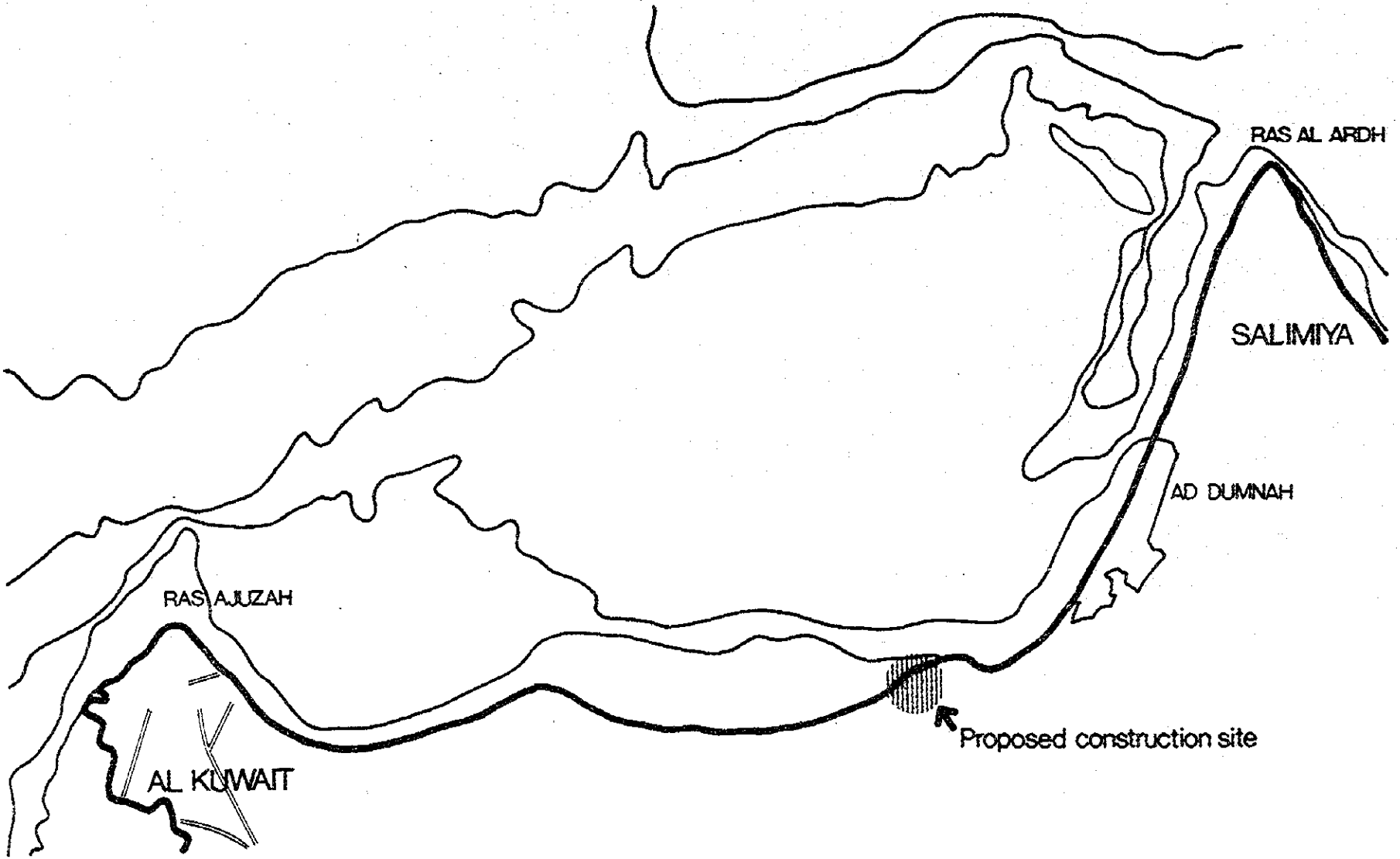


Fig. 1 Offshore area facing to the proposed construction site

4.05 Sea and Weather Conditions

	Wind			Sea
Dec. 13	North wind,	wind velocity of	5	Wave height of 0.5m
" 14	"	"	0	
" 15	"	"	0	
" 16	"	"	0	
" 17	"	"	0	
" 18	"	"	0	
" 19	"	"	8	Wave height of 0.7m
" 20	"	"	0	
" 21	"	"	0	

4.06 Tide

Date	Time	Tide level (m)	Date	Time	Tide level (m)
Dec. 13	01:49	1.5	Dec. 19	06:50	0.1
	07:35	2.3		13:35	3.0
	13:14	1.4		18:29	1.5
	19:40	3.1		23:39	3.6
Dec. 14	03:05	1.3	Dec. 20	07:25	0.0
	09:18	2.3		14:12	3.0
	14:12	1.6		19:12	1.5
	20:23	3.2			
Dec. 15	04:06	1.0	Dec. 21	00:18	3.6
	10:34	2.4		08:00	0.1
	15:11	1.6		14:46	3.4
	21:05	3.3		19:54	1.4
Dec. 16	04:56	0.8	Dec. 22	00:59	3.6
	11:30	2.6		08:35	0.0
	16:06	1.7		15:19	3.1
	21:45	3.4		20.36	1.4
Dec. 17	05:37	0.5			
	12:16	2.8			
	16:57	1.6			
	22:24	3.5			
Dec. 18	06:15	0.3			
	12:57	2.9			
	17:45	1.6			
	23:01	3.6			

Source: Tide Table, Customs and Ports Department, Ministry of Finance and Oil, Government of Kuwait, Government Printing Press, 1975.

4.07 Survey Method

	Item surveyed	Survey method
1	Survey of seacoast at proposed aquarium construction site	Survey of coast made at low tide covering mainly soil, biota, coastal topography, and the taking photographs
2	Survey sea bottom observation at offshore area facing to the proposed aquarium site	Three survey lines were established extending from the shore into the sea and surveys made of the nature of the seabed, water quality (transparency), biota, and seabed topography along each line. Photographs were also taken.
3	Collecting of existing reference materials	Materials were collected relevant to the condition of the sea, weather data, nature of the soil, etc.

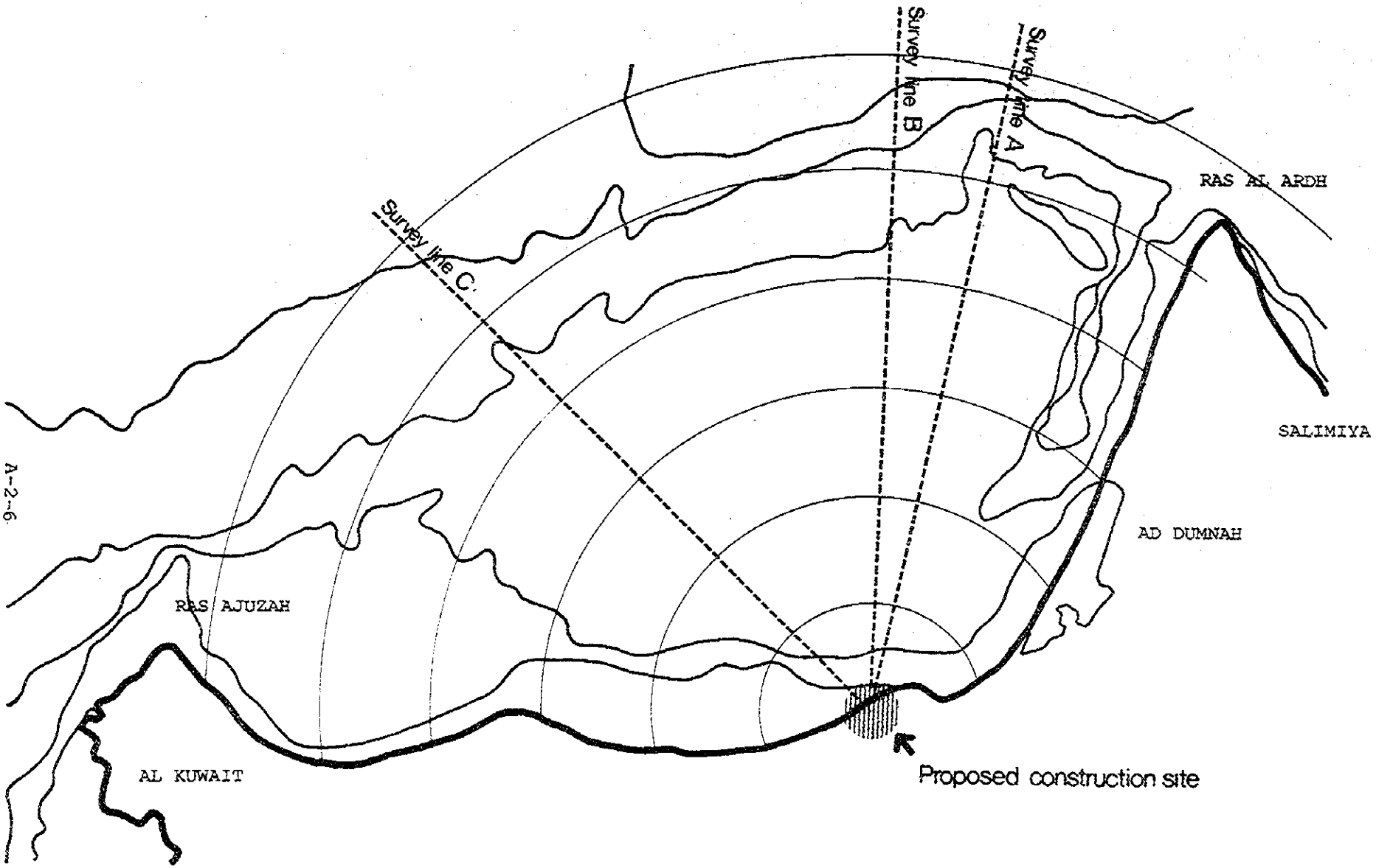


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Fig. 2 Map of sea area survey lines

5. Survey

5.01 Survey of offshore area facing to the proposed aquarium site

A. Nature of beach

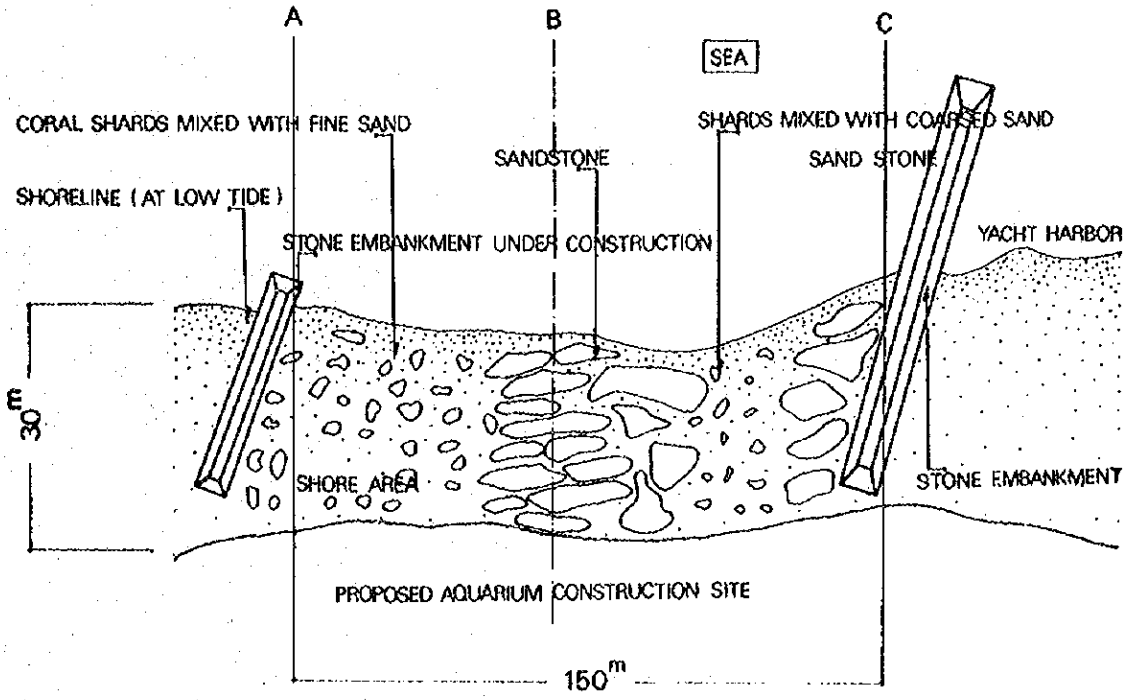


Fig.3 Nature of beach of the aquarium site

Results

	Nature of the soil	Biota	Others
Line A to line B (from the stone embankment under construction to the center of the proposed construction site	1. Weathered coral shards (100-200mm in diameter) thoroughly mixed in the fine sand stratum 2. Continuous sandstone (coral sandstone) deposits extending 30m to each side of survey line B	No evidence of plant or animal life adhering to the seabed	Refer to photographs of A-(1) and A-(2)
Line B to line C (from the center of the proposed construction site to the stone embankment	1. Sandstone (coral sandstone) covers the area around survey line B and stone embankment 2. Continuous band of weathered coral shards (100-200mm in diameter) lie in the coarse sand among the rocks	Barnacles (about 5-10 mm) are attached to the tops of rocks	Refer to photographs of B-(1), B-(2) and C-(1) - (8)

B. Nature of Seabed

Survey Line	Position	Nature of soil and seabed topography	Water quality	Biota	Photography
A	Depth was surveyed from the shore to a point 4 km off-shore using pitch readings				
B	From the shore to a point 200 m off-shore	a 10-15mm layer of fine sand lies atop the layer of coral shards (100-500mm in diameter)		Sargassum (20-30mm in length) adhere to the coral shards	See D (1) and (2)
	200-500m off-shore	The seabed is a flat with a layer of silt (blueish clay)	Transparency is about 1.5-2.0m, and much suspended matter is present	No living things deemed adhering to the seabed	See D (3) and (4)
	900-1,500m off-shore	The seabed is flat with a layer of silt more than 2.0m	Transparency is about 1.5-2.0m, and much suspended matter is present	No traces of life	See D (5)
	3,000-4,000m offshore	The seabed is flat with a layer of silt more than 2.0m	Transparency is about 1.5-2.0m, and much suspended matter is present	No traces of life	See D (6)

C	From the shore to 50m offshore	The seabed is flat, with coral shards scattered on the course sand		Sargassum and barnacles (5-10m) live on the shards	See E (1) and (2)
	3,000-4,000m offshore	The seabed is flat, with a layer of silt more than 2m	Transparency is about 1.5-2.0m, and much suspended matter is present	No traces of life adhering to the seabed	See E (3)

The seabed consists of the following four varieties:

1. Silt
2. Coral rock
3. Sand
4. Gatch

Silt covers the entire bottom of Kuwait Bay, and is up to seven meters thick in places. There is much coral rock in the harbor as well, 0.5~0.8m thick. Above the coral is a layer of sea shells, silt, clay and the like, 2~4 meters thick. Coral lies atop the mixed soil.

Rocks collected along the seacoast are as shown in photograph F (1)~(4). They are soft rocks, being coral sandstone. They belong to a relatively recent geological period; all those in photographs A, B, C, and D being of the same period. They are all of the same quality but vary in nature so as to require future study.

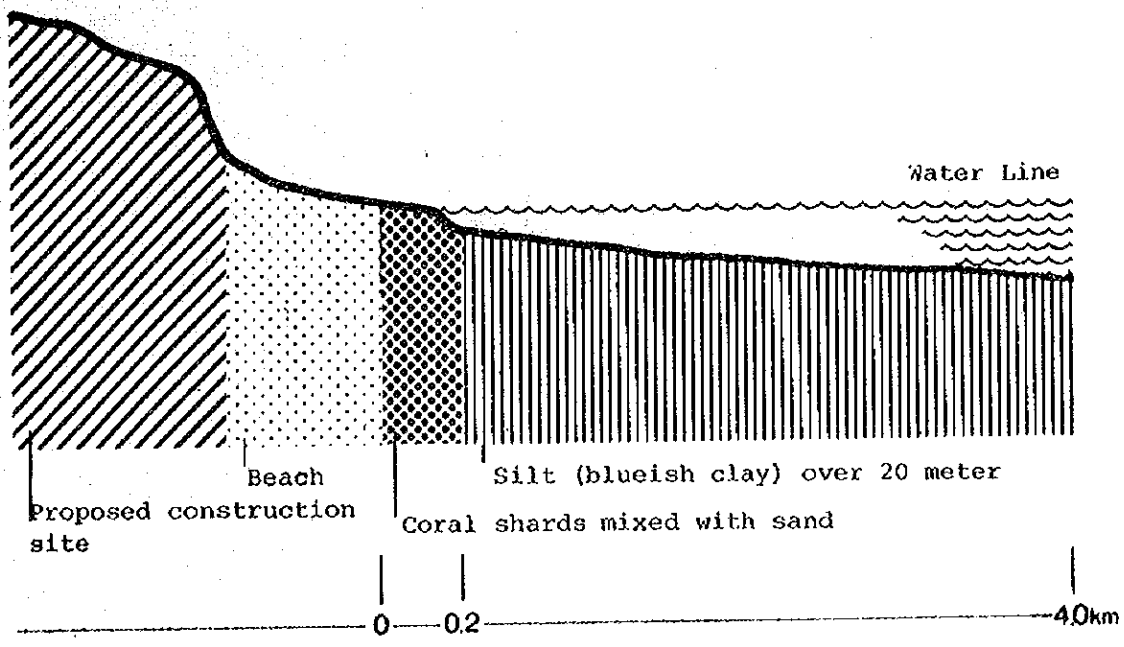


Fig.4 Topography of the seabed along survey line B

5.02 Water Quality, Water Temperature, Sea Conditions, and Weather Conditions as seen from Existing Reference Materials

A. Water Quality and Water Temperature

Ca (ppm)	Mg (ppm)	Na (ppm)	Cl (ppm)	SO4 (ppm)	$Ca(HCO_3)^2$ (ppm)	CaSO4 (ppm)
593	1,754	12,700	23,340	3,240	224	1,827

MgSO4 (ppm)	MgCl2 (ppm)	Nacl (ppm)	PH	Electrical conductivity at 20°C (in $\mu\Omega/cm^3$)	Relative content (3.2-4.0% salinity)		Maximum water temperature (°C)
					Summer	Winter	
2,439	5,018	32,288	8.2	72,500	1.0358	1.0279	35

Source: "Temperature and Analysis of Seawater at Shuawikh"

Average Water Temperature

Month	1	2	3	4	5	6	7	8	9	10	11	12
Average water temperature (°C)	16	17	20	23	28	30	32	33	31	27	23	17

B. Condition of the Sea

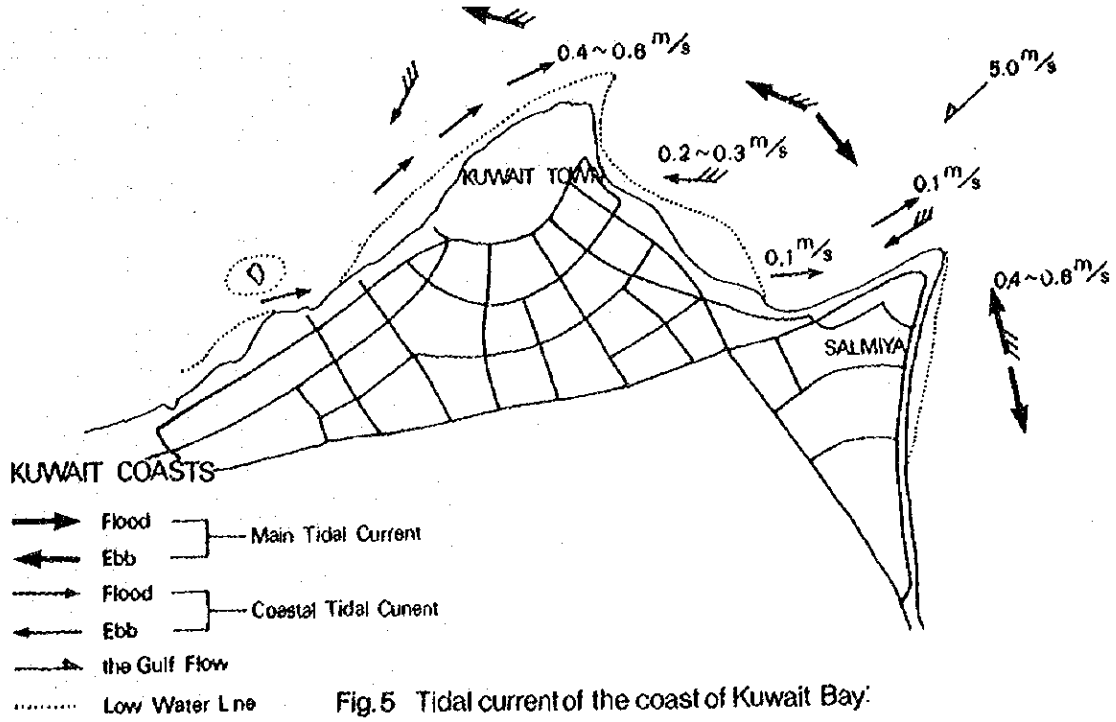


Fig.5 Tidal current of the coast of Kuwait Bay

C. The main tidal current flows through the sea off Salimiyah. At high tide it moves from Ra's Al Ard to Kuwait Town, and at low tide from Kuwait Town to Ra's Al Ard. Another current, branching off from the main current, passes along the coast. At high tide it flows from Ra's Al Ard to Kuwait Town via Salimiyah, and at low tide it flows in the opposite direction. The speed of the current is about 0.1m/s in the vicinity of Salimiyah and about 1.0 m/s in the area of Ra's Al Ard. There is little vertical flow.

D. Tides

Spring mean HHW	+ 3.58 m
Average mean HHW	+ 2.94 m
Average mean LHW	+ 2.32 m
Average mean HLW	+ 0.90 m
Average mean LLW	+ 0.05 m
Spring mean LLW	- 0.72 m

However the land map standard is 0.47 m above the water map standard.

E. The sea condition

The wind is calm most of the year, but the north winds cause waves of about 1.0 - 1.8 meters. This continues for periods of 2 - 3 days. Strong south winds may also cause large swells for extended periods. (This information provided by divers from an Ocean Works of Asia, Inc.)

F. Weather

The climate is tropical throughout the year. Between December and February, the daytime atmospheric temperature is about 15°C, falling to about 10°C at night. The amount of rainfall is small, it raining only about 10 days per each year. As for seasonal winds, north and northwest winds are strong in winter and long windless periods occur in summer. North and northwest winds are also strong in early spring, sandstorms occur, and the sea water becomes unclear. The above table showing wind speeds and directions shows that north and northwestern winds occur frequently.

When the wind is strong, sand from the seabed is stirred up to turbid the sea from the shore to about 500m offshore.

The frequency (percentage) of various wind directions and wind speeds at Kuwait International Airport are as follows (from 1962 to 1972).

Atmospheric Temperature

Month	1	2	3	4	5	6	7	8	9	10	11	12
Max. temp. (°C)	26	33	39	42	48	48	49	49	46	42	37	31
Average high	18	21	26	31	37	43	44	44	41	35	26	20
Average temp.	13	16	20	25	31	35	37	36	33	27	20	15
Average low	8	10	14	19	24	28	29	28	24	19	14	9
Min. temp.	-3	0	5	9	14	22	23	21	17	11	6	-1

Wind direction / Wind speed	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Total
0 - 3	1.73	0.73	0.62	0.58	0.86	0.48	1.39	1.55	2.12	1.18	1.25	1.01	2.06	1.87	2.07	1.60	21.46
4 - 7	2.45	0.82	1.03	0.80	1.40	1.24	1.27	1.75	2.67	1.00	0.84	0.63	1.93	2.87	4.01	2.81	27.52
8 - 12	2.73	0.54	0.58	0.60	1.34	1.48	1.24	1.18	1.19	0.29	0.26	0.20	0.58	1.85	3.63	3.83	21.52
13 - 18	2.78	0.41	0.23	0.37	1.18	1.82	1.41	0.83	0.42	0.14	0.12	0.08	0.25	0.85	4.14	4.93	19.99
19 - 24	0.96	0.05	0.02	0.04	0.16	0.68	0.72	0.34	0.13	0.01	0.02	0.02	0.04	0.25	1.49	2.07	7.00
25 - 31	0.29		0.01	0.01	0.02	0.52	0.27	0.12	0.06	0.01		0.01	0.03	0.10	0.42	0.67	2.14
Over 32	0.04					0.02	0.01	0.01	0.01				0.01	0.03	0.07	0.17	0.37
Total	10.98	2.55	2.49	2.40	4.96	6.20	6.31	5.78	6.60	2.63	2.49	1.95	4.90	7.85	15.83	16.08	10000

6. CONCLUSIONS

The following can be concluded from the above preliminary study and existing reference materials.

6.01 Nature of the Soil

A. Seacoast : Stratum 0.5 ~ 0.8m thick yielding coral rock and coral shards.

B. Sea bottom : Continuous stratum of blue silt at least 2m thick.

6.02 Quality of the Water

There is considerable suspended matter and transparency is about 1.5 ~ 2.0m.

The seawater is much more concentrated than that of open sea.

6.03 Water Temperature

Maximum water temperature is 35°C.

6.04 Currents (in the vicinity of Salimiyah)

High tide - Flows from Ra's Al Ard close by the coast at Salimiyah to Al Kuwait at a speed of about 0.1 m/s.

Low tide - Flows in the opposite direction at the same speed as at high tide.

There is little vertical flow.

6.05 Waves

Maximum height - about 1.0 ~ 1.8m with north and northwest winds.

Turbidity - The sea becomes quite muddy with north and northwest winds because the seabed is stirred up. This turbidity extends from the shoreline to about 500m offshore.

6.06 Biota

Barnacles grow along the seacoast, and Saragassum grow in the sea.

6.07 Weather

Climate -	Tropical throughout the year.
Rainfall -	Little, rain falling only about 10 days per year.
Wind direction and speed -	Windless in summer, rather strong winds of about 4-18 in winter. Wind direction is north or northwest.
Atmospheric temperature -	Maximum temperature is 49°C (during July and August. Minimum is 3°C in January.) Average is approximately 26°C.

7. REFERENCES

7.01 Detail Survey

The field reconnaissance and existing reference materials do not provide sufficient basic information for construction structures in the sea. Thus the detailed survey will cover the following items so that plans can be drawn up on the basis of complete information.

Survey items

1. Currents
2. Sea depth sounding
3. Water quality
4. Water temperature
5. Seabed
6. Sea life
7. Currents and weather
8. Land surveys
9. Equipment to be used in construction

7.02 Seawater Intake Facilities

Construction of such facilities seems feasable since the sea is shallow for a great distance from the shore and the seabed is comprised of silt. The preliminary design must be drawn up in accordance with the results of the survey.

APPENDIX-III

Fish Purchased and Exchanged

Reference material on the purchase of important aquarium fish is appended here.

Group of Display and Name of Fishes	Size	Number
L. Coloured Carp	Adult	50
I. Goldfishes		
Wakin	Adult	20
Fringetail	"	20
Lionhead	"	10
Oranda	"	10
Shubun-kin	"	20
Calico Oranda	"	10
Hanabusa	"	5
Bubble-eye	"	5
Peal Scale	"	10
Black Telescope-eye Goldfish	"	10
Telescope-eye Goldfish	"	10
Celestial-eye Goldfish	"	20
Jikin		5
Fresh Water fishes of the World		
G 1-4 Africa:		
African lungfish	Young, 30cm	2
Bichir, Polypterus	15 cm	10
African Knifefish	10 cm	40
Elephant Nose	Adult	50
Butterfly Fish, Pantodon	"	20
Congo-tetra	"	100
Disticodus sp	Young	20
Up-side-down Catfish	Young, 5cm	100
Jewel Fish	"	50
Egyptian Mouth Breeder	" 3 cm	100
Nile Mouth Breeder	" 10 cm	100

G 5-8	Tropical Asia:		
	Climbing Perch	Young, 5 cm	50
	Kissing Gourami	" "	50
	Giant Gourami	" "	30
	Pearl Gourami	" 3 cm	100
	Blue Gourami	" "	100
	Rasbora	" 2 cm	300
	Indian Glass Fish	" "	500
	Sumatra	"	100
	Red-tailed Black Shark	" 3 cm	50
	Knikfish	20 cm	30
	Silver Barb	Young, 5 cm	100
	Silver Shark	"	100
	Giant Danio	" 2 cm	50
	Grass Catfish	" 6 cm	100
	Archer Fish	" 5 cm	50
G 9, 10, 11, 13	Temperate Asia & Europe:		
	Trout	Young, 20 cm	10
	Grass Carp	" 20 cm	10
	Tench	" 5 cm	50
	Sturgeon	"	20
	Perch	" 20 cm	20
	Pike	" 30 cm	15
	Brown-trout	" 20 cm	30
	Ayu	" 10 cm	100
G 14-16	North America:		
	Garpike	Young, 30 cm	10
	Bowfin	" 20 cm	4
	Blue-gill Sunfish	" 10 cm	100
	Sucker	" "	10
	Blind cave Characin	Young	200

G 17	Central America:		
	Swordtail	Adult	200
	Platy	"	200
	Guppy	"	100
	Four-eyed fish	"	20
G 18-22	South America:		
	Piranh	Young	100
	Pirarucu	" 20 cm	20
	Arowana	" "	10
	Neon Tetra	Young	1,000
	Silver Hachetfish	"	100
	Metynnis	"	100
	Armoured Catfish	"	100
	Angelfish	"	200
	Anostomus	"	50
	Hemiodus	"	100
	Lepidosiren (S.A.Lungfish)	"	2
	Electric Eel	30 cm	5
	Sternarchus	10 cm	30
	Red Tailed Catfish	30 cm	3
	Leaffish	5 cm	50
	Astronotus	10 cm	30
	Discus	10 cm	20
G 23	Australia:		
	Australian Lungfish	50 cm	5
	Rainbow Fish	10 cm	30
C & D-1, H1-5	Marine Invertebrates & Seafishes from Temperate Sea		
	Oplegnathus fasciatus	Young	50
	Oplegnathus punctatus	"	50
	Girella punctata	"	100
	Wolffish	Adult	5
	Box Fish	"	30
	Pinecorn Fish	"	100

	Sping Lobster	Adult	10
	Spider Crab	"	30
	Chelidonichthys kumu	"	50
	Antennarius tridens	"	30
G.	Amphibia and Reptiles		
	Giant Salamander	Adult	
	Pipa pipa	"	10
	Tenopus laevis	"	50
	Rana catesbeiana	"	10
B 1-3	Coral fishes from tropical pacific		
	Grammistes sexlineatus	Young	5
	Clown Fish	Adult	200
	Anemone Fish	"	100
	"	"	100
	Chrysiptera assimilis	"	1,000
	Chromis caeruleus	"	1,000
	Daccyllus trimaculatus	"	200
	Abdefduf sp	"	1,000
	Julis gaimardi	Young	20
	Labroides dimidiatus	Adult	30
	Scarus spp	"	100
	Microcanthus strigatus	"	500
	Monoductylus argenteus	Young	50
	Chaetodon auriga	Adult	300
	Chaetodon collaris	"	100
	Chaetodon ephippium	"	50
	Chaetodon lunula	"	20
	Chaetodon melanotus	"	100
	Chaetodon speculum	"	50
	Chaetodontoplus septentrionalis	"	50
	Euxiphipops sexstriatus	"	100
	Forcipiger longirostris	"	100
	Heniochus acuminatus	"	200

Heniochus permunatus	Adult	30
Pomacanthus imperator	"	50
Pomacanthus semicirculatus	"	50
Pygoplistes diacanthus	"	30
Acanthurus olivaceus	"	100
Callicanthus lituratus	"	100
Naso unicornis	Young	10
Paracanthus hepatus	"	100
Siganus vulpinus	Adult	100
Balistes aculeatus	"	30
Balistes conspicillum	"	30
Pterois volitance	"	50

APPENDIX-IV

Marine Survey Plan

The following section deals with the necessary marin survey items and methods for the future. Because it is assumed that these surveys will be conducted by the selected consultants, it is prerequisite that the selected consultants be fully cognizant of the methodological details of surveys based upon this basic policy at the time the consultant contract is awarded. Accordingly, this basic survey policy should be attached as an appendix to the terms of reference and distributed to consultants. This appendix should be attatched to the "Terms of Reference" as Annex when distributed.

1. Name of Survey: Oceanographic survey for construction of offshore facilities of Kuwait Aquarium

2. Location of Survey: The entire body of seawater frowting the proposed site of Kuwait Aquarium

3. Purpose of Survey: To conduct various oceanographic surveys and data collection necessary for construction of offshore facilities for the proposed aquarium.

4. Items to be Surveyed:

4.01 Water temperature
4.02 Water quality
4.03 Water current
4.04 Weather
4.05 Nature of seabed
4.06 Sea depth sounding
4.07 Biota
4.08 Land survey (establishing position of tides)
4.09 Undersea survey

5. Method of Survey

5.01 Water temperature survey

A. No. of points : 20
B Depth of survey : 1 m pitch
C. Survey instruments : Thermistor electric water temperature gauge

5.02 Water quality survey

A. No. of points : 20
B. Sample depths : Three locations -- water surface, 3 meters below the surface, and 1 m from the seabed
C. Instruments employed in obtaining water : Appropriate water sampler

D. Items analyzed : Analysis should be made on health related items pH, Cl, and COD in compliance with JIS K0102 or/and other equivalent oceanographic observation standard.

5.03 Water currents survey

A. Two locations using, appropriate current meter and 15 day and night observations

B. Three locations at 1 m pitch using 12-hour

C. Current meter fixed-point observation

5.04 Weather survey

A. Atmospheric temperature, humidity, wind direction, and speed

5.05 Seabed nature survey

A. No. of points surveyed : 20

B. Seabed extraction : Boring (about 8 m deep)

C. Items analyzed : Analysis should be made on composition and viscosity, COD Sulphates, and seabed fanna in compliance with JIS K0120 and/or equivalent oceanographic observation standard.

5.06 Depth survey

A. Surveying lines : 8 lines, 7 km offshore

B. Surveying instruments : Acoustic depth sounder

5.07 Biota survey

A. No. of points : 5

B. Collection : Collection of flora and fauna on the shore and the seabed,

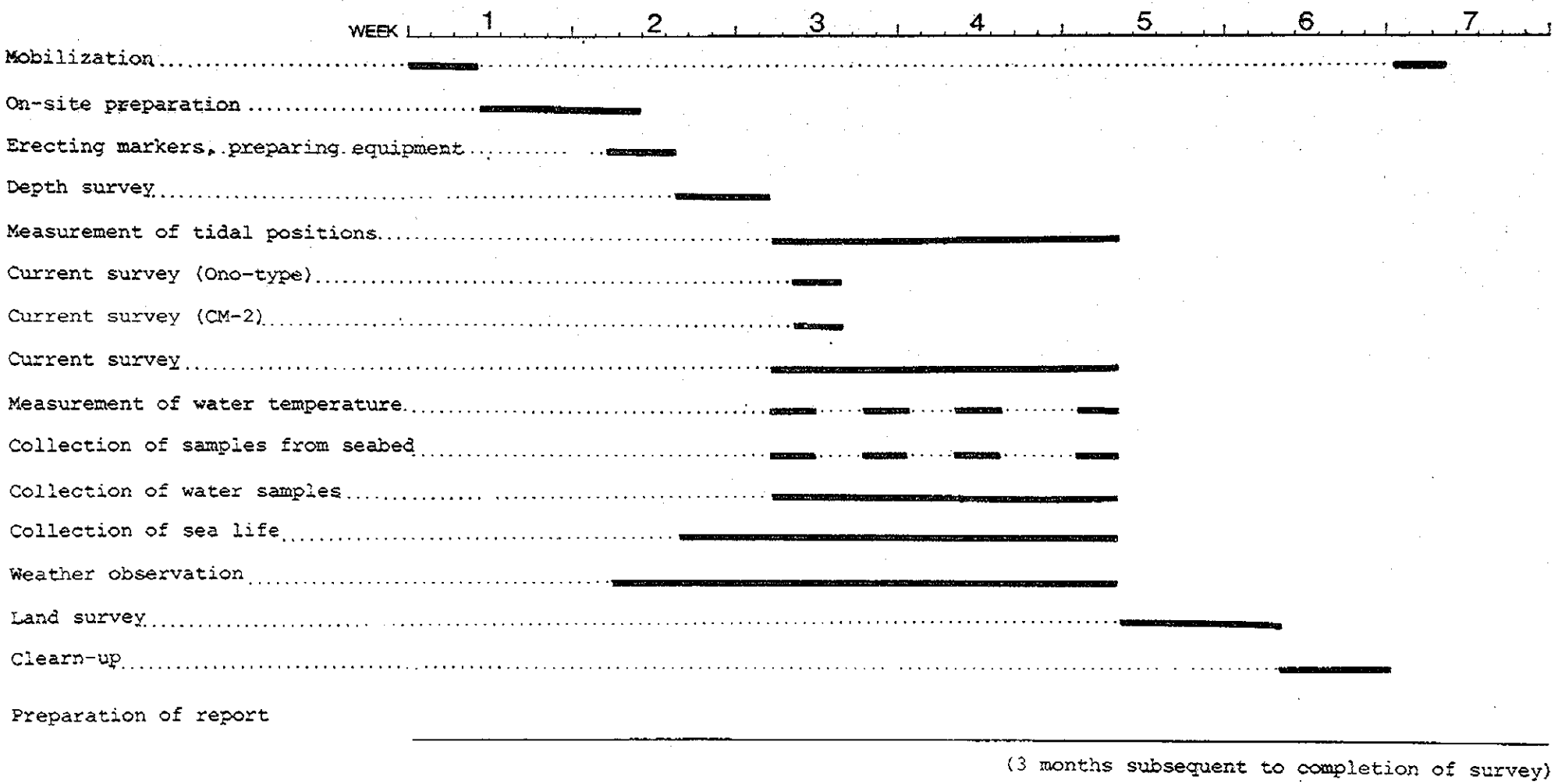
5.08 Land survey (establishing position of tides)

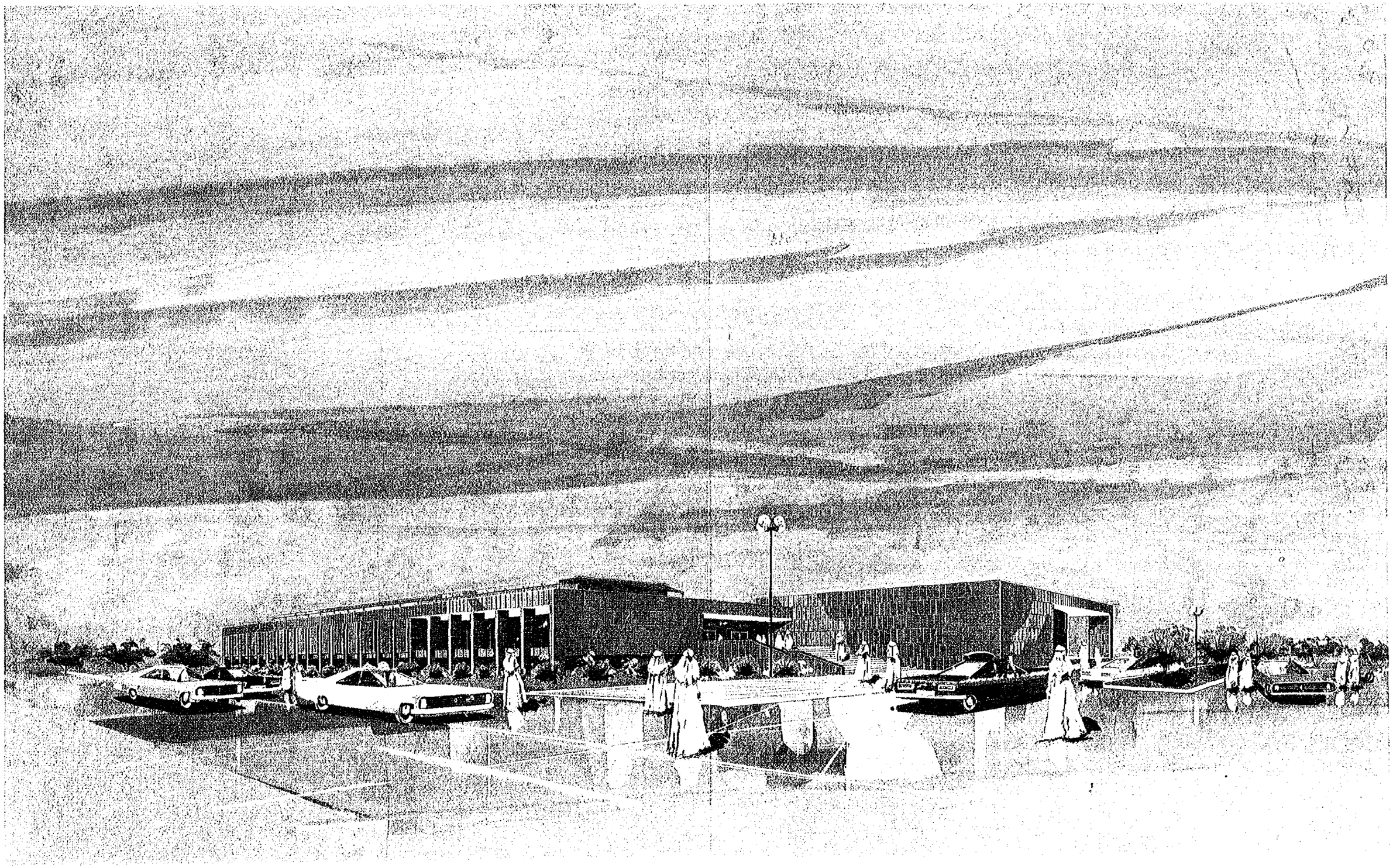
Establishment of indicators for measurement of tidal position and survey ship position with reference to designated bench marks

5.09 Undersea survey

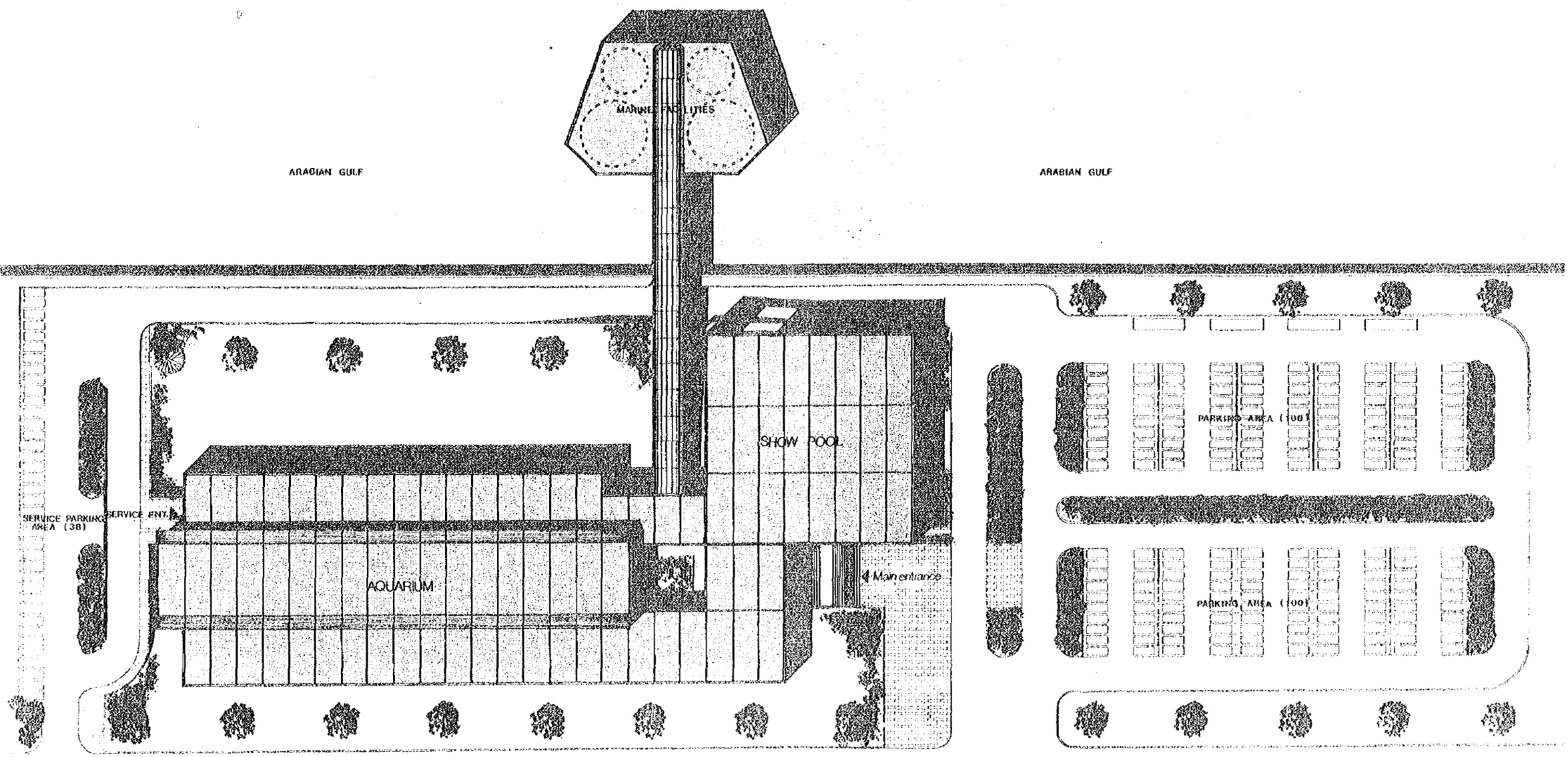
Underwater photography to determine seabed conditions in the area of the plan

Schedule of Oceanographic Survey



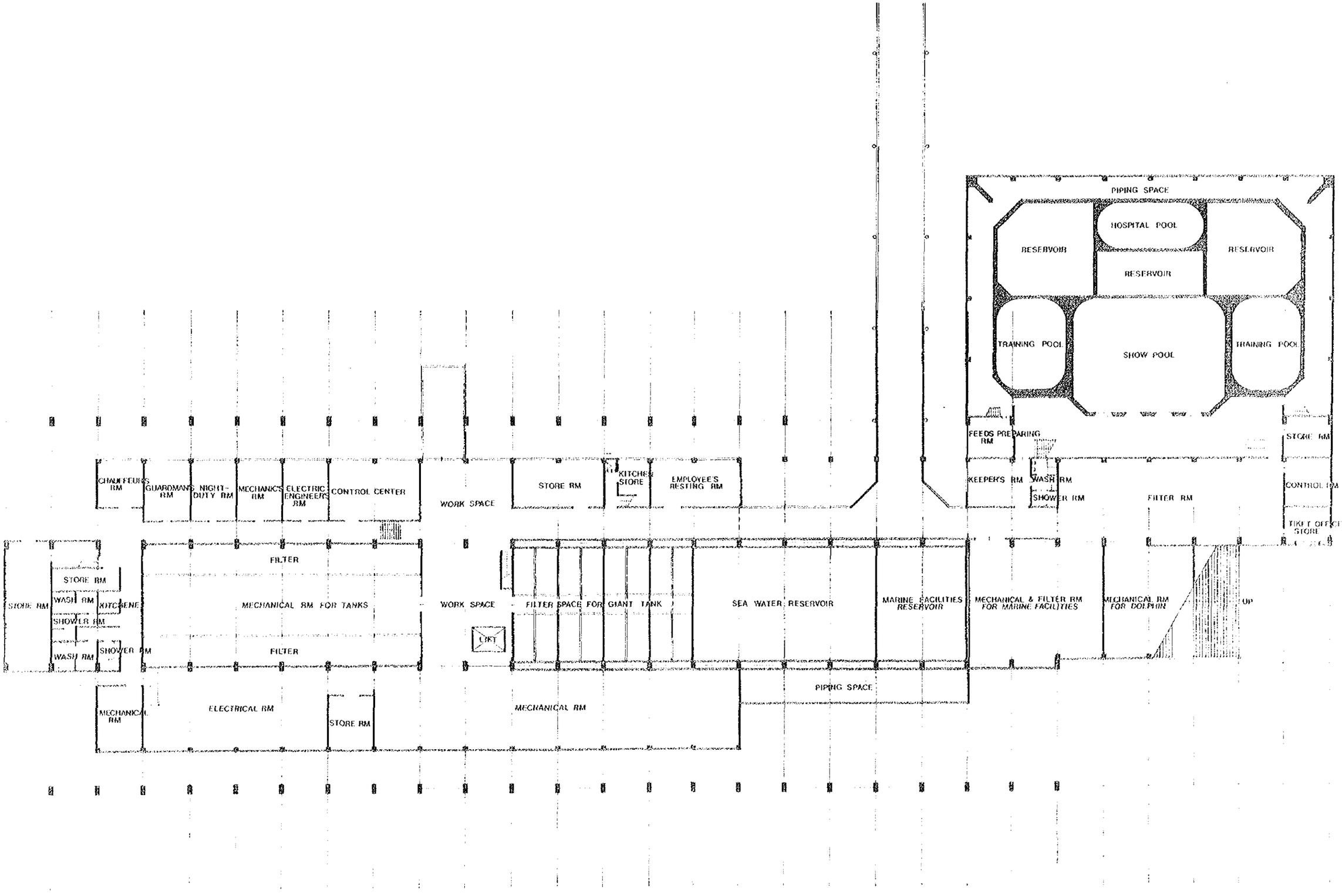


THE KUWAIT AQUARIUM



PLOT PLAN

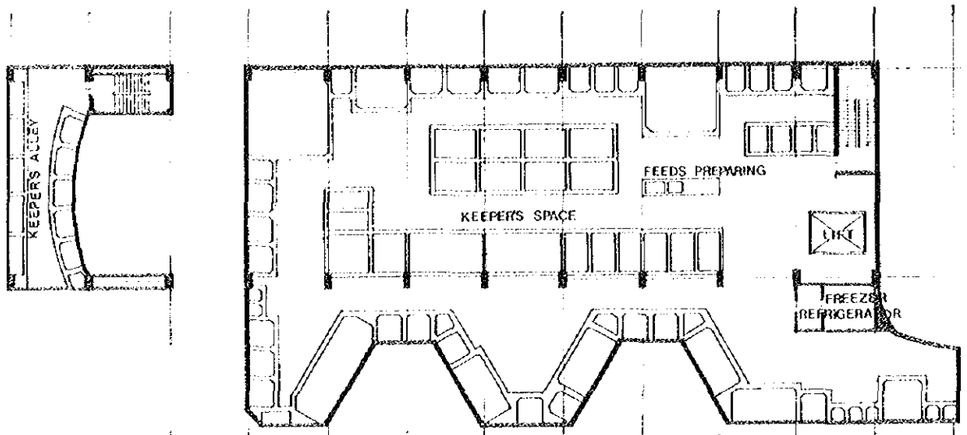
THE KUWAIT AQUARIUM



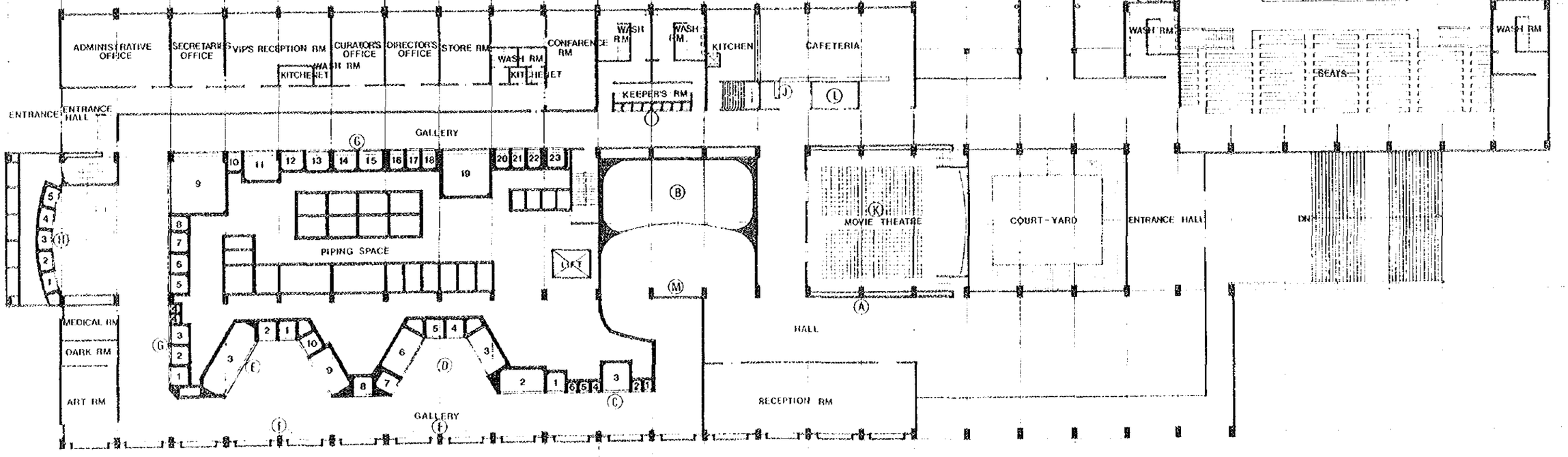
GROUND FLOOR PLAN

THE KUWAIT AQUARIUM

NOT TO SCALE



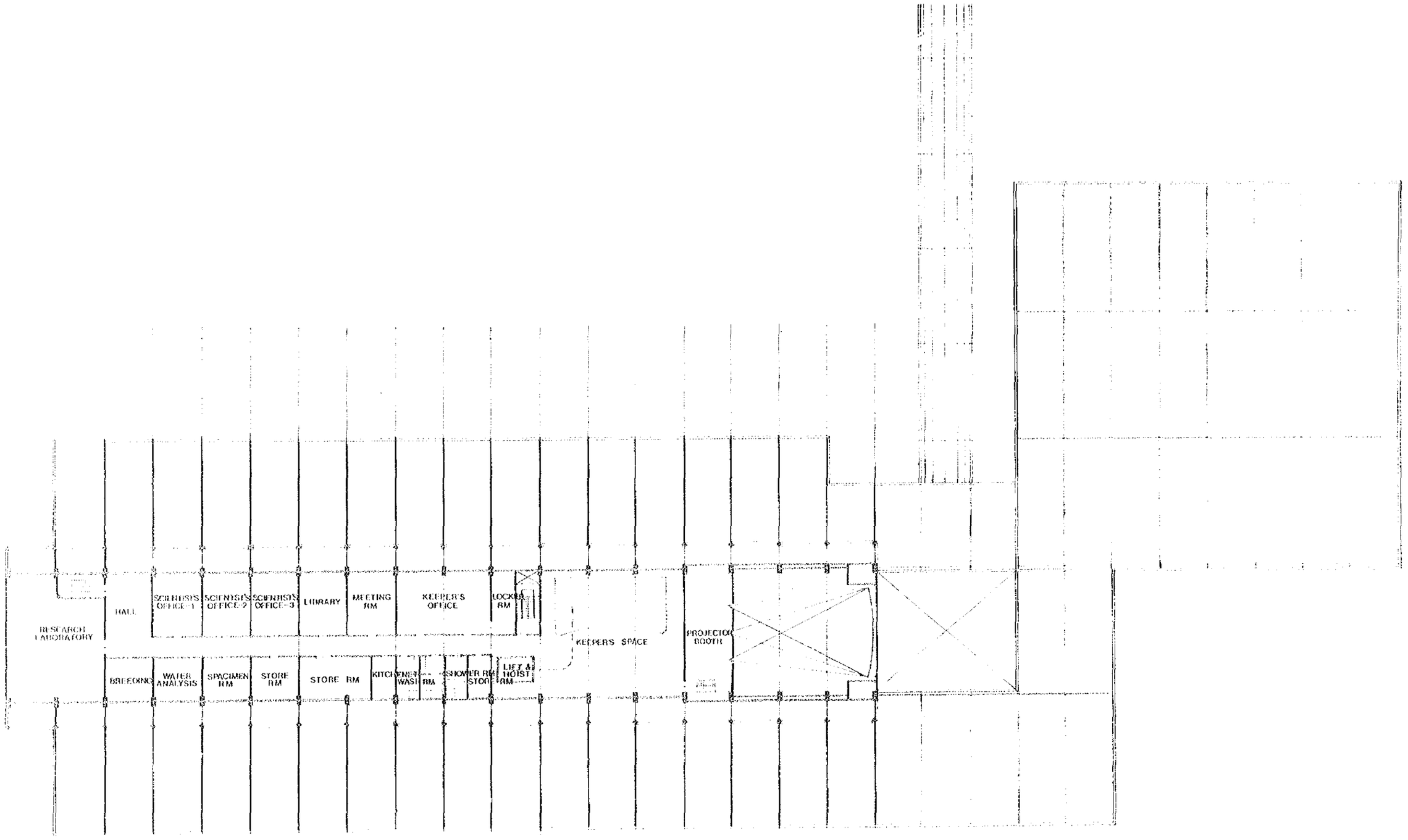
MEZZANINE FLOOR PLAN



FIRST FLOOR PLAN

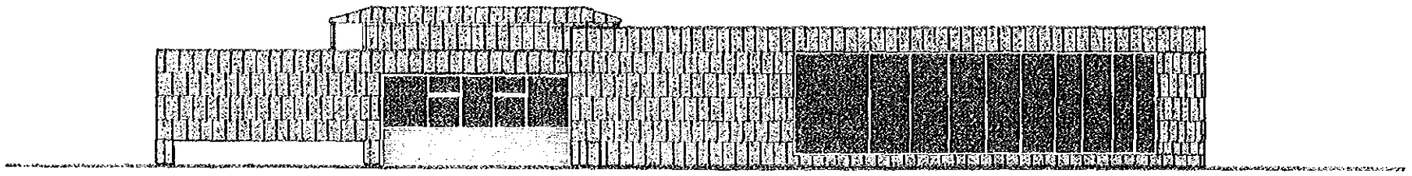
THE KUWAIT AQUARIUM

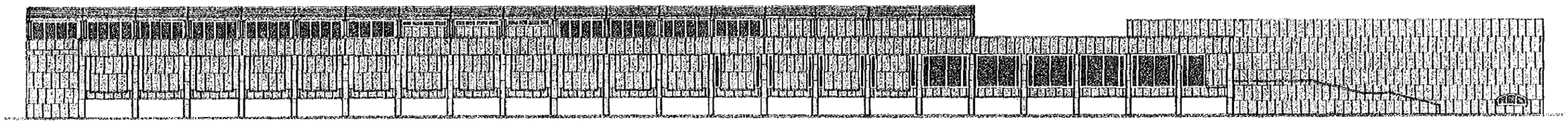
NOT TO SCALE



SECOND FLOOR PLAN

THE KUWAIT AQUARIUM





ELEVATION

THE KUWAIT AQUARIUM

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