VI. INDUSTRIES DERIVED FROM BRINE FROM SEAWATER DESALINATION PLANT

1. Industries Utilizing Seawater

Seawater contains a number of substances, of which sodium chloride, salts of magnesium, calcium, potassium, and bromine are important from the viewpoint of industry. Although the concentrations of these substances in seawater are very low, the entire resources contained in the tremendous amount of seawater are very large. For only three substances -- common salt (sodium chloride), magnesium, and bromine --, commercial technologies have been established and employed extensively. Direct recoveries of magnesium and bromine from seawater has become established seawater based industries.

Recovery of common salt from seawater is limited, with a few exceptions including Japan which uses electrodialysis processes, to areas where favourable conditions to use sun's heat exist; that is high temperatures and low precipitation. Researches have been made into the recovery of more valuable resources such as potassium salts and uranium, these are still in the developmental stage.

Despite the high potential value of seawater as a natural resource for various substances seawater contains, commercial recovery of these substances are constrained by the very low concentrations of these substances in seawater. Therefore, the presence of highly concentrated brine from seawater desalination plants may be considered to present an opportunity for the economic recovery of these substances, although no such attempt has been materialized yet.

Figure VI-1 schematically shows how various industries are derived from substances extracted from seawater. On Figure VI-1 are shown three basic seawater based industries which include salt manufacturing industry for the recovery of common salt from seawater, magnesium industry to extract magnesium in the form of magnesium hydroxide and process magnesium into magnesium clinker, and bromine industry to recover bromine from seawater and produce a variety of chemical compounds from bromine.

From salt manufacturing industry are derived soda industry and bittern utilization industry; the former to manufacture caustic soda and chlorine by electrolysis of salt and the latter to collect various substances contained in the bittern. There is an array of important chemicals produced by these industries such as common salt, magnesium salt, sodium hydroxide, chlorine, hydrochlric acid.

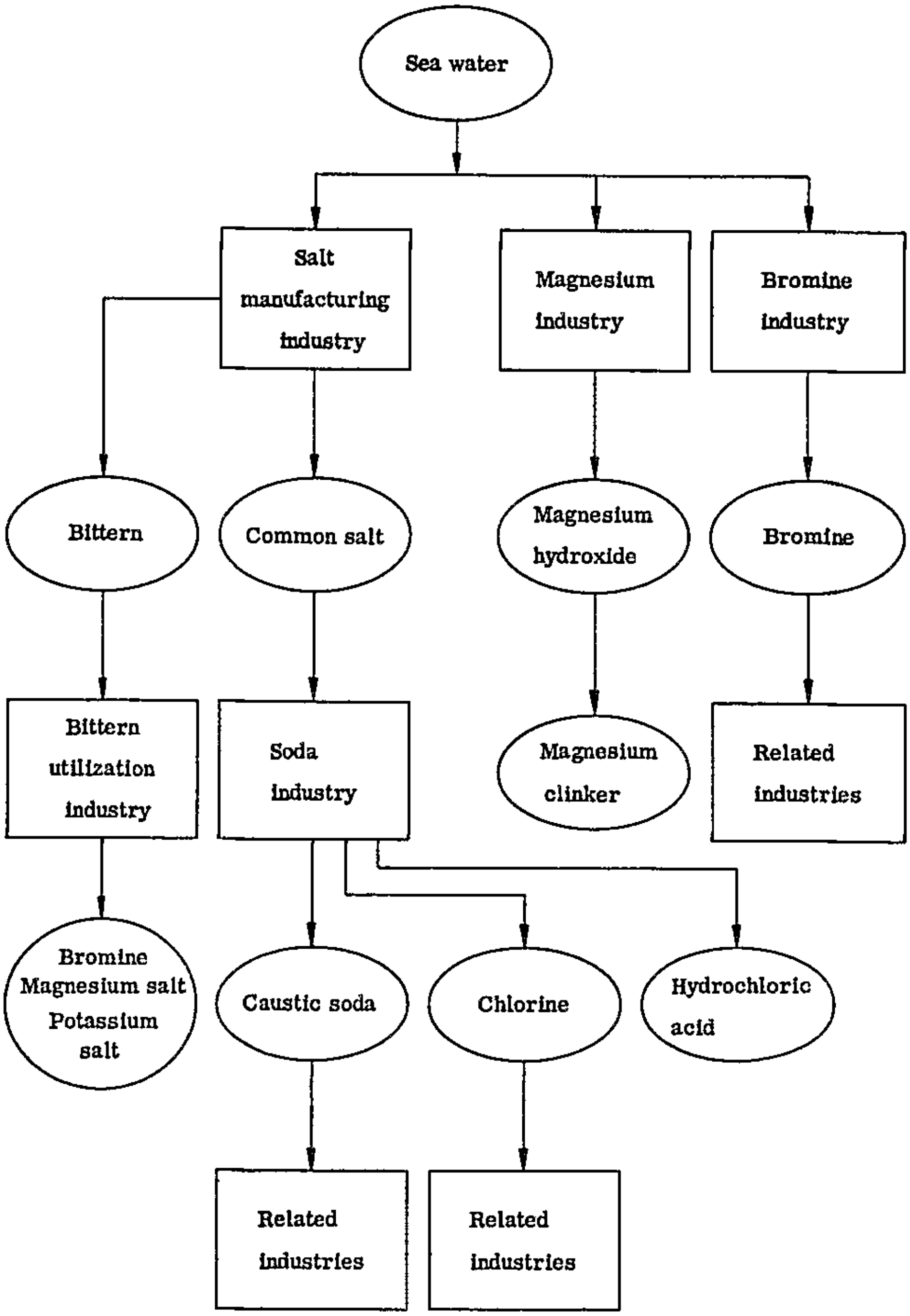

Figure VI-1 Schematic Structure of Industries Utilizing Seawater

2. Current Status of Seawater Desalination and Concentrated Brine Utilization

The desalination plant at Al Ghubra in the suburbs of Muscat is the only large scale seawater desalination plant now operating in Oman. This dual purpose plant, in which desalination and electric power generation are combined, was completed in November 1975 and has been operating satisfactorily since February 1976, when the plant went into full operation.

This plant uses long-tube 20-stage flash evaporation process whose design capacity is from four to six million imperial gallons per day depending on operating conditions. When the plant is operated with a brine temperature in excess of 90°C, deposit of scale must be controlled by adjustment of pH with sulfuric acid dosing, but the plant has so far been operated with the brine temperature less than 90°C. The deposit of scale has been controlled by injection of polyphosphate. The average operation load has been about four million imperial gallons of desalinated water per day.

The power generation part of the plant consists of four steam turbin generators, three rated at 8.5 mega watts and one at 50 mega watts.

The desalination plant, when operating at a rate of four million imperial gallons per day, discharges about 6.6 million imperial gallons (30,000 cubic metres) per day of concentrated brine with a salinity of about 1.6 times that of natural seawater at a temperature of about 42°C. The high salinity and high temperature may be considered to represent advantages for the extraction of various substances from such brine. The recovery rate of bromine rises as temperature rises. Another conceivable advantages is that elimination of dissolved carbon dioxide from seawater in the pretreatment to desalination helps to produce purer magnesium, or magnesium free from calcium contamination. Actually the concentrated brine discharged by the Al Ghubra desalination plant is diluted down to the salinity of seawater and discarded to the sea without being utilized. No attempt has been made to commercialize recovery of various substances from concentrated brine discharged by a desalination plant. This may be attributable to the fact that most desalination plants have been installed in the areas where demands for these chemicals are not very high.

3. Concentrated Brine-Based Salt and Salt Utilizing Industries: Conditions of Feasibility

1) Market and Demand for Products

The size of Omani demand for common salt, magnesium, and bromine, as well as for caustic soda and chlorine cannot be accurately estimated without conducting a detailed investigation. What was discovered as a result of the recent survey was that Oman imports very little chemical products, and that industries based on such substances are almost non-existent in Oman, and that industrialization has just started on Oman. From these findings it may be inferred that Oman has little demand for such substances.

Oman imported in 1976 9.4 million RO of chemical products which accounted for only 3.7 percent in value of her total imports. Oman conceivably relies on import for the supply of common salt. In 1976 Oman imported 110,000 RO value of salt, or 3,000 tons.

Unless extensive industrialization and the rise of a large scale petrochemical industry take place in Oman concurrently in the future, demand for these substances will remain practically non-existent, and these industries may not be expected to grow fast.

Industrial salt, magnesium, bromine, caustic soda, and chlorine, which are basic industrial raw materials, are demanded almost entirely by industrialized nations. Recovery of these substances, except industrial salt, is technology intensive, and is practiced only by industrialized nations where large demands exist, on scales large enough to be economical.

Particularly in the case of bromine, demands are concentrated in the United States, the European countries and Japan and productions in the United States, Japan and Israel as shown by Table VI-1.

Soda industry needs to be located in or close to an area where the consumption of chlorine is large, because chlorine, which is produced by the electrolysis of common salt, is so dangerous a substance that its transportation in a large quantity by boat is prohibited in the United States. If a technology to insure safety during marine transportation of chlorine should be developed, it would require a chemical tanker of special specifications and, therefore, cost very high.

Table VI-1 World Demand and Supply of Bromine (1976)

(Metric Tons)

Supply Capacity		Demand	
U. S. A.	230,000	U. S. A.	200,000
Japan	20,000	Japan	15,000
Israel	44,000	Europe	30,000

(Source) JICA MISSION

In the light of the foregoing discussions, it is obvious that Oman would have to export almost entire quantity of the products, if seawater utilization industry is established in Oman where domestic demands are negligibly small. In order to be able to export the products, the products must be competitive both in price and quality with their counterparts produced by industrialized countries. It would not be easy to compete with the products produced on a large scale by economically managed and operated plants.

2) Production Technology and Manpower

As stated in Sub-Chapter 1 above, technology for the economical recovery of the dissolved substances from seawater has not been commercially established except for only common salt, magnesium, and bromine. Caustic soda and chlorine produced by electrolysis of common salt are important raw materials for chemical.

(1) Recovery of Common Salt

Production of common salt is generally limited to the areas where high temperature, dry climates and natural winds permit what is termed open-pan method to be extensively employed. The open-pan method requires a wide piece of land to place a reservoir, an evaporation pond, and a crystallization pond in series. Seawater becomes concentrated and yields crystalline of salt as seawater flows from the reservoir to the crystallization pond.

The recovery of salt by this method has been rationalized and advanced by the use of larger salt farms and the mechanization of process, but it still remains to be a rather labour-intensive industry. In countries where climate is not adequate for the open-pan method, Japan for example, the open-pan method has fallen into disuse. Instead, more technology intensive methods involving heating, electrodialysis and ion exchange, and crystallization by means of vacuum evaporation are becoming more accepted.

In areas other than recovery of common salt, the recovery of magnesium and bromine from seawater and electrolysis of common salt for the production of caustic soda and chlorine have been established as technologically advanced industries in more industrialized nations producting these products on a large scale.

(2) Recovery of Magnesium

Magnesium is usually recovered from seawater in the form of magnesium hydroxide ($Mg(OH)_2$) by adding alkalis. This process is summarized by Figure VI-2.

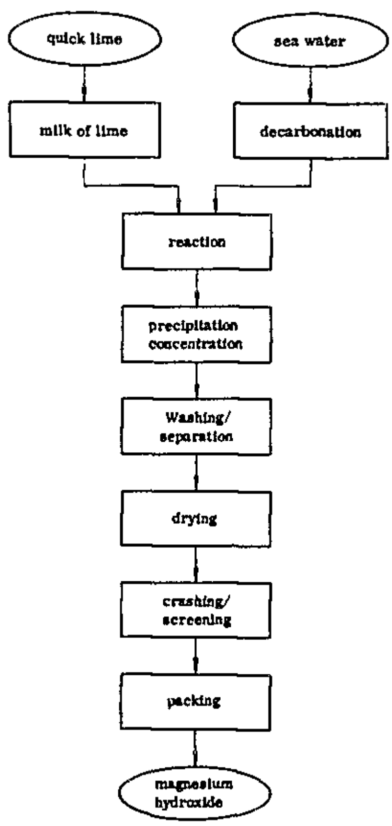

Figure VI-2 Recovery Process of Magnesium Hydroxide

Addition of alkalis to untreated seawater which normally contains carbonate ion in the order of 100 ppm allows the dissolved carbonate ion to precipitate in the form of calcium carbonate which, in turn, impairs the purity of magnesium products. To avoide this loss of product purity, seawater must be pre-treated for decarbonation by either of the following two formulae:

$$Ca(HCO_3)_2 + Ca(OH)_2 \longrightarrow 2CaCO_3\downarrow + 2H_2O$$

$$Ca(HCO_3)_2 + 2H_2SO_4 \longrightarrow CaSO_4 + 2CO_2\uparrow + 2H_2O$$

Addition of milk of lime to the decarbonated seawater causes magnesium salt contained in seawater to settle as magnesium hydroxide by the following reaction formulae:

$$MgCl_2 + Ca(OH)_2 \longrightarrow Mg(OH)_2\downarrow + CaCl_2$$

$$MgSO_4 + Ca(OH)_2 \longrightarrow Mg(OH)_2\downarrow + CaSO_4$$

Magnesia clinker is produced by thermal decomposition of magnesium hydroxide usually by feeding magnesium hydroxide to a rotary kiln where it is converted into magnesia clinker through crystallization by sintering at high temperatures.

(3) Recovery of Bromine

The most extensively employed is the Blowing Out Method which oxidizes the dissolved bromine ion by addition of chlorine and expel the bromine as gas. There are two variations, sulphur-dioxide absorption process and soda-absorption process according to the solvents employed in the absorption process, as shown by Figure VI-3 and VI-4.

Major reaction formulae which define the bromine recovery process are as follows:

Oxidation Process: $2Br^- + Cl_2 \longrightarrow Br_2 + 2Cl^-$

Blow-Out Process: $Br_2(aq.) \longrightarrow Br_2(gas)$

Absorption Process:

Sulphur-Dioxide: $Br_2 + SO_2 + 2H_2O \longrightarrow 2HBr + H_2SO_4$

Soda: $6NaOH + 3Br_2 \longrightarrow 5NaBr + NaBrO_3 + 3H_2O$

Distillation Process:

Sulphur-Dioxide: $2HBr + Cl_2 \longrightarrow Br_2 + 2HCl$

Soda: $5NaBr + NaBrO_3 + 3H_2SO_4 \longrightarrow 3Br_2 + 3NaSO_4 + 3H_2O$

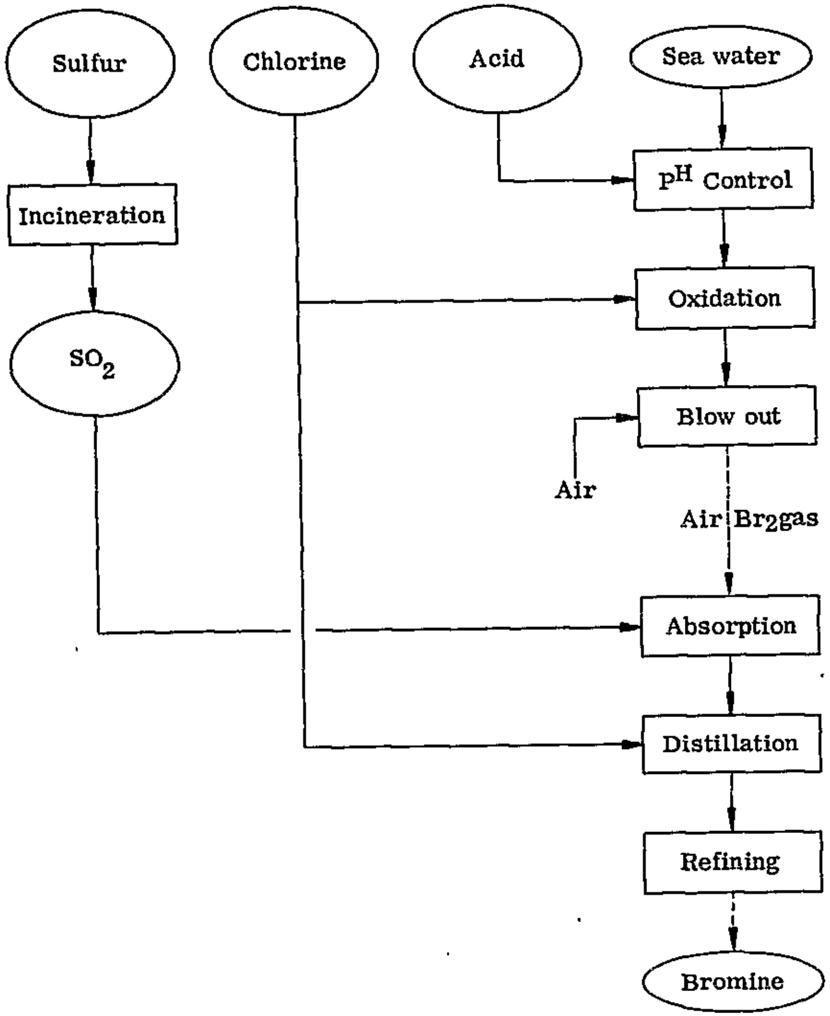

Figure VI-3 Sulphur-Dioxide Absorption Process

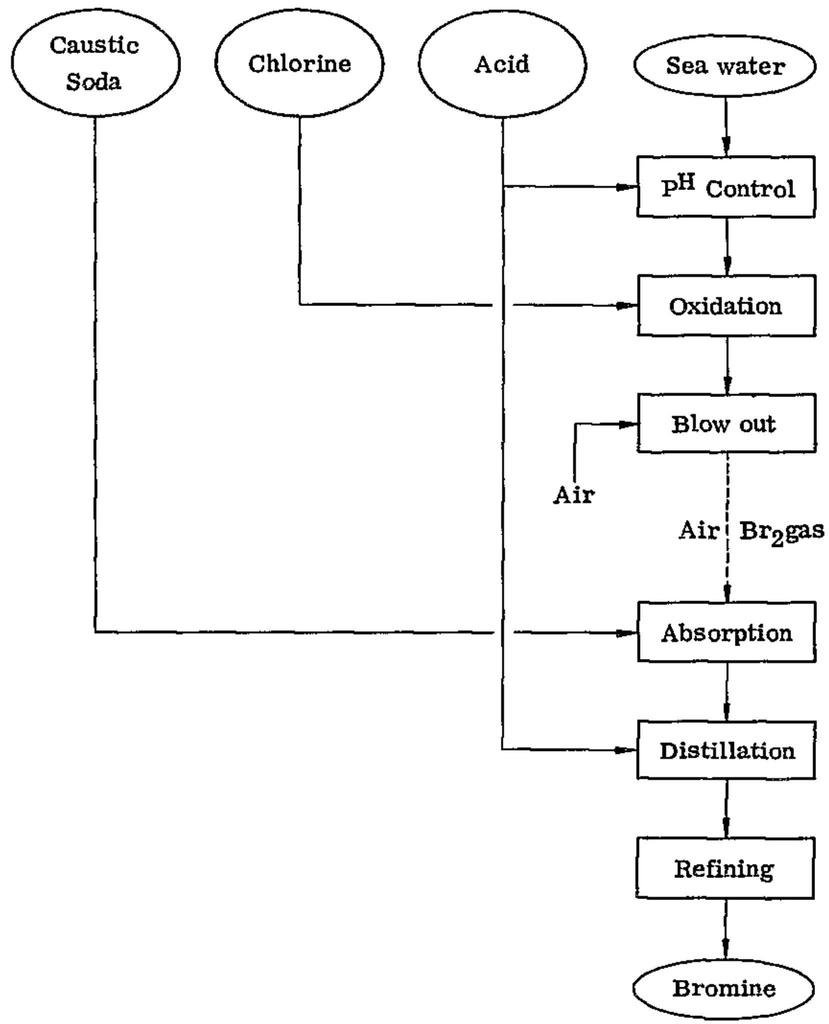

Figure VI-4 Soda-Absorption Process

(4) Manufacturing of Caustic Soda and Chlorine

The Electrolytic separation of common salt to caustic soda and chlorine is accomplished either by mercury process or diaphragm process. Ion exchange process, which is a newly developed modification to the diaphragm process, has received much attention lately. Until several years ago, the mercury process had made a remarkable technological progress, particularly through the use of high electric density and enlargement of one production unit, while the progress of the diaphragm process lagged behind. Quite recently, however, tightor pollution controls on the mercury process have prompted the technological advancement of the diaphragm process. Actual introduction of the diaphragm process is already close at hand.

Commercial caustic soda/chlorine manufacturing processes consist of four main steps; namely, pretreatment of common salt, electrolysis, concentration of caustic soda solution, and treatment of purification of chlorine and hydrogen gases. These steps are all quite similar among different commercial processes except for electrolysis steps.

Sor far methods for the recovery of certain limited substances from brine or sea water have been briefly presented. As a means to accomplish extraction of several valuable substances by one integrated process, a scheme as shown on Figure VI-5 has been conceived since quite a long time ago. This concept may be combined with the established technology to manufacture caustic soda and chlorine by electrolysis. This concept, however, has not been realized to date.

Further, a Japanese research institute made a fairly thorough study on the possibility of combining several proven process in order to simultaneously extract common salt, magnesium, calcium potassium, bromine, caustic soda and chlorine from brine of a sea water desalination plant. This concept, shown schematically on Figure VI-6, also attempt to economize the entire system covering both desalination and extraction portions by sharing required utility facilities.

Spent bittern from common salt recovery is not utilized though it contains magnesium, potassium and bromine. The recovery of these substances from the bittern will be technically complicated and costly.

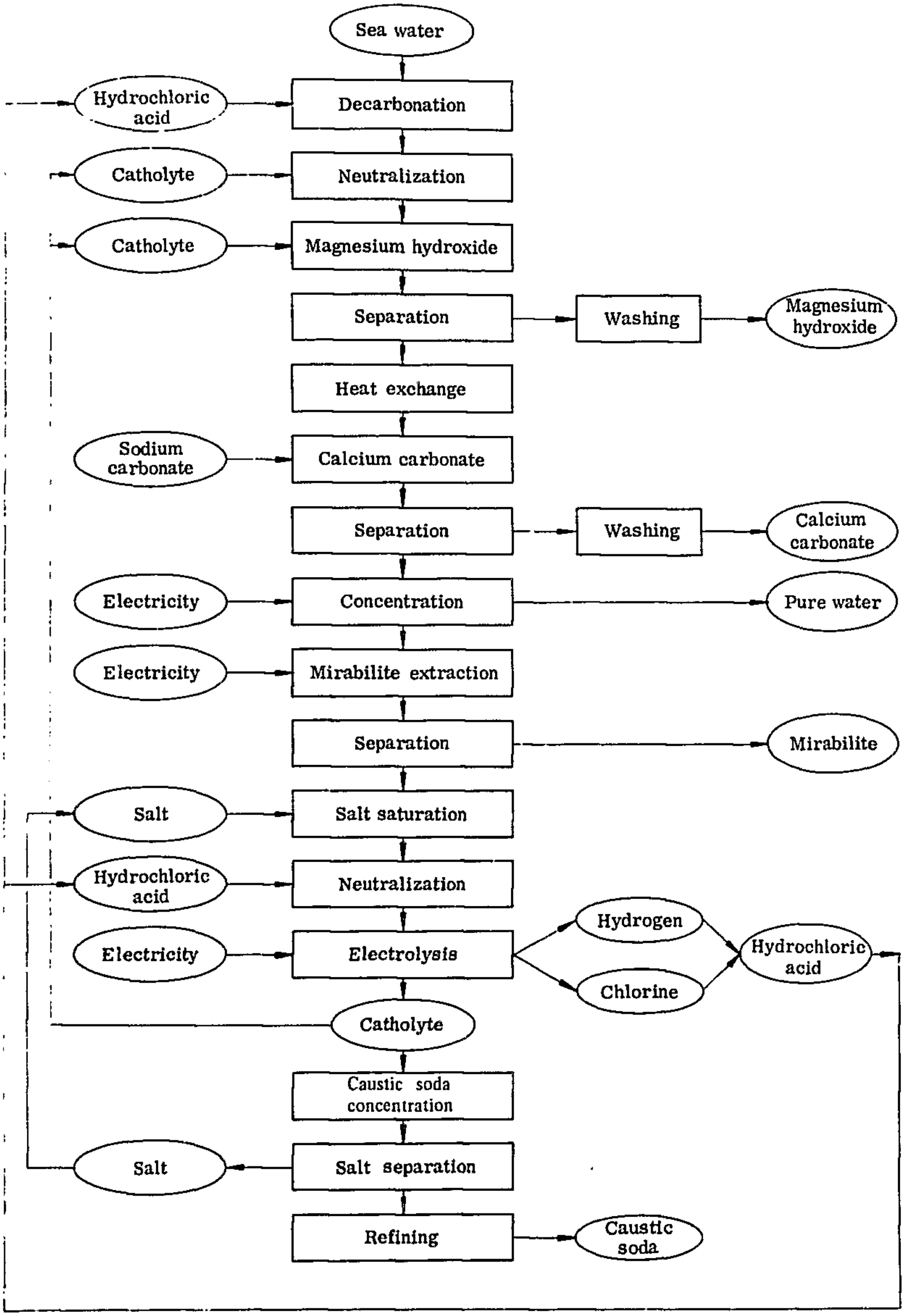

Figure VI-5 Schematic Processes of Comprehensive Seawater Utilization

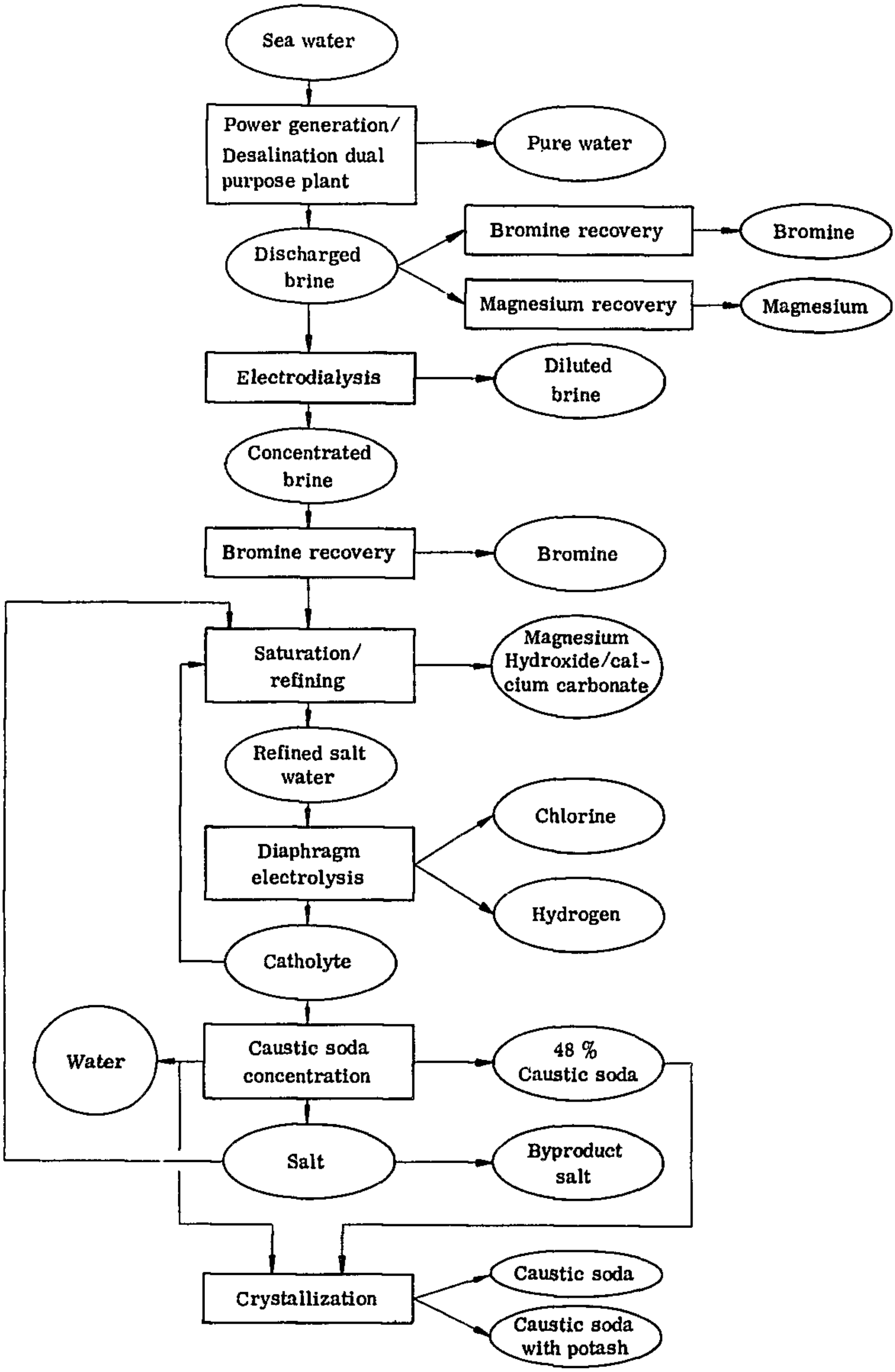

Figure VI-6 System of Desalination and Utilization of Brine

3) Raw Materials and Utilities

Oman's coastline is very long extending some 2,000 kilometres. In this regard Oman would have unlimited sea water as resource if it would be utilized. Exhaust brine from a desalination is more concentrated and hotter than ambient sea water; and therefore, it would be better feed if used for resource recovery. As mentioned previously, pretreatment may be dispensed with which would constitute another advantage.

Conversely, it has disadvantageous sides as well. If recovery of salt and other substances is attempted. The capacity, design, operating conditions and even location would be affected.

The 6.6 million imperial gallons, or 30,000 cubic metres, per day of the brine currently being discharged by the Al Ghubra Desalination Plant has about 1.6 times higher salinity than natural sea water and it contains about 1,300 tons per day of common salt (NaCl), about 100 tons per day of magnesium oxide (MgO), and about three tons per day of bromine (Br_2). Assuming a recovery rate of 50 percent and 300 operation days per year, annual recoveries would be 215,000 tons of common salt, 16,500 tons of magnesium oxide, and 500 tons of bromine.

This amount of common salt could produce by electrolysis about 130,000 tons per year of caustic soda. The facility for electrolysis of this size is not very large by the present standard but could be of economically acceptable size, although there are many larger facilities operating now. On the other hand, the production of these amounts of magnesium oxide and bromine would be too small to be economical by comparison with those operating now in industrialized countries.

4. Assessment of the Feasibility of Brine Utilization Industries

So far sea water utilization industries have been outlined with reference to studies for the utilization of brine from a sea water desalination plant. Oman as site for establishing sea water utilization industry for the recovery of common salt, magnesium, bromine and others is reviewed. The following discussions concern an assessment of the feasibility of these industries, particularly recovery of common salt, magnesium and brine and electrolysis of common salt into caustic soda and chlorine in the light of domestic demand, export environment, technology and manpower, raw materials, and utility, and policy of the Government.

1) Domestic Demand

There are almost no domestic demands for magnesium, bromine, caustic soda and chlorine and their derivatives. Common salt is demanded in the order of several thousand tons per year almost entirely for food use without industrial consumption.

2) Export Environment

Potential export markets for products other than common salt would be more industrialized nations because these nations consume these products in large volumes. These nations, however, produce such products by their own large and highly efficient factories and not only satisfy their own demands but also export some of the excess products. This situation is considered to persist in the future.

Brine-based industries of Oman, if established, would have to compete with the products from these nations in price and quality. This situation is not very easy to overcome in view of the production technology involved, labour available in Oman, and the geographical location of Oman. Business environment appears to be unfabourable for the establishment of export oriented industries of this kind.

Production of common salt by open-pan method are concentrated in areas with little rain and high temperature where abundant supply of inexpensive labour is available. Oman's climatic condition is right but labour situation is not. Competition with salt from the existing open-pan salt farms will be difficult.

3) Production Technology and Manpower

Production of practically all of brine-based products excepting open-pan salt is highly mechanized and technology-intensive requiring advanced technology and skill for operation, control, maintenance, and so forth. Because these industries are also highly automated, the number of required engineers is greatly reduced.

Salt making by open-pan method has been improved by the enlargement of unit salt farm size and the mechanization of process. But this industry still remains to be labour-intensive and, therefore, requires abundant and inexpensive labour.

4) Raw Materials and Utilities

While the supply of sea water is unlimited, the volume of raw material available to industries based on brine discharged by a desalination plant is governed by the capacity of the plant. The 30,000 cubic metres per day of concentrated brine currently being discharged by the desalination plant in Al Ghubra contains about 1,300 tons of common salt, the recovery of one-half of which and the electrolytic separation of common salt thus obtained would produce about 130,000 tons of caustic soda per year. A capacity of this magnitude is adequate for commercial production. Thus, the availability of raw material brine may be considered adequate for a common salt electrolysis plant.

But the above volume of concentrated brine does not contain sufficient amounts of bromine and magnesium to warrant establishment of a plant large enough to enjoy economy of size.

Brine-based industries, except common salt electrolysis plant, will require relatively small amounts of electric power. Electrolysis of common salt with a production scale of 130,000 tons per year of caustic soda, requires about 400 million kilowatt hour or, in terms of natural gas, about 3,500 MMSCF. A pipeline has been completed for the transportation of natural gas from gas fields in the interior to the Metropolitan area, and power generation using this natural gas would offer an opportunity for the supply of electric power for a relatively low price, unless the price of natural gas is priced very high.

As for industrial water, Oman lacks cheap water. These industries would inevitably have to use expensive water.

5) Government Industrialization Policy

Development of industries, particularly those industries which could generate revenue of foreign currency, is one of the important policy targets of the Government. Stressed also are promotion of industries which will (1) produce products now being imported, (2) make the best use of domestic resources, and (3) produce exportable products. Particular emphasis is placed on the latter with respect to the expected decline in the oil revenues.

Now, what is the position of brine-based industries in the industrialization programme of Oman? In view of the current absence of domestic demand for the products which the industries will produce, they may not be conceived of as import-substituting industries. Even though the availability of concentrated brine increases in the future as more desalination plants are constructed at various locations in Oman, the brine is not a natural resource peculiar to Oman. Rather, more advantageous utilization of this resource is possible in some other countries.

In view of the foregoing, it may be concluded that there is little advantage in establishing in Oman industries for the recovery of salt and other various substances from concentrated brine generated by a desalination plant or for the utilization of salt thus recovered.

VII. FISH-BASED INDUSTRIES PROJECT

1. Summary of Fisheries

The fishing industry in Oman was introduced under PART ONE, Chapter II. 2. After current situation of fisheries in Oman is summarized, development projects commensurate with the features of the Omani fisheries will be suggested in this Chapter.

First of all, abundant fishery resources have been identified for Oman. This is because the potential productivity of the resource is high in the Omani waters and also because the resource has not been overly exploited. Most abundant are sardines; while their annual production ranges from a half to 2.5 million tons, only 0.18 million tons are landed each year at the most. Other rich resources are kingfish, tuna, skipjack, mackerel, and snapper, whose landing is from 20 to 30 thousand tons. Production of demersal fishes is fairly high at 0.75 million tons. However, the production of large pelagic fishes is unknown, and the identification of the accurate production volume of this type of fish, which would offer high value added, will be a precondition to the development of the Omani fisheries.

As for fishermen, the present fishing population is estimated to be less than 10,000 and the trend is that of yearly decrease. Outside the government project, there is practically no incorporated fishing activities and fishermen operate on a small scale. Their monthly income is from 30 to 50 RO for those who operate motorized crafts and about half that for those who operate shashas. Because fishermen's income is lower than the 66 or 67 RO per month of unskilled construction labourers, which is the lowest wage of all industrial (except agricultural) workers, the improvement of fishing productivity is an important subject to the Government.

The productivity of traditional fishing method of Oman is low, and the government is planning to provide loans to assist purchase of fishing gear and technical training in the use of such new gear in order to bring up the fishing productivity. The Government has granted a fishing right to the Japanese and the Korean fishing companies to fish demersal fishes and in return had them train Omani fishermen in modern fishing technology aboard their trawlers. (In the case of Japanese Taiyo Fishing Company, however, the selection of Omani trainees was left up to the Japanese Company, and the Omani side had not come up with an adequate training programme.)

While traditional wooden boats such as shashas and huris have been used by the Omani fishermen, the government has recently started to encourage the use of aluminium boats and glassfibre reinforced plastic (FRP) boats, and to motorize those wooden boats, in order to improve the fishing productivity. Traditional wooden shipbuilding is in practice at Sur and Sohar with a stubborn adhesion to the traditional art of shipbuilding, and there appears no room for modern shipbuilding technology to be introduced.

The total fishery catches are estimated at about 210,000 tons per year. The 180,000 tons of sardines are chiefly used for livestock feedstuff while about 20,000 tons of them are consumed as food. Presently the importation of canned and frozen fish is rapidly increasing. Stable supply of fishery products is an important task to be performed by the Government. In this regard, cold stores, freezers, ice plants, and refrigerated vans are being constructed or introduced in order to check the fish price inflation previously caused by the inadequate storage and distribution facilities.

No full fledged fishing port exists in Oman. Small fishing boats are beached at many villages, and relatively large fishing crafts are moored to coastal land by ropes. The lack of fish landing facilities is a hindrance to the introduction of large fishing ships and the improvement of fishing productivity. With this view, the feasibility of fishing port construction at Salalah and Sofar has been reviewed.

2. Fishery Development Objectives

Taking off the oil-dependent economic structure is a national goal of Oman. And fishery promotion is an important item of the Five-Year Plan in view that fishery products are important resource of the nation, along with the agricultural and mining products.

Oman's fishery development objectives can be summarized into the following three, in view of the current situation observed above and the said national goal.

1) Domestic Demand

Domestic food production is far from satisfying the needs of the people and much food is imported, taking the advantage of the low import tariffs. As for fish, frozen and canned fish products are imported. Domestic fish catches consumed as food is about 20,000 tons per year. Assuming a population 850,000, this comes to a per capita average of 24 kilogrammes per year, or 64.6 grammes per day. Further assuming net intake rate of 50%, it is estimated that the daily average per capita fish consumption by the Omanis is about 35 grammes. Although this average is lower than the daily average per capita fish meat consumption by the Japanese of more than 90 grammes, fish and poultry meats are much liked by the Omani people. Their preference is deep-rooted in the culture and the customs. In this situation, productivity improvement under the development programme will not only increase the domestic fish meat production but also contribute to the substitution of imported fish and fish products.

2) Fishermen

The commencement of oil production in Oman and other Gulf nations resulted in rapid national development investments and the creation of new demand for labourers in the construction service sectors, and a large number of fishermen have moved out of fishing into other industries. But the vast majority of them who are not equipped with any practical skills (other than fishing) are compelled to take jobs as unskilled labourers in the construction sector, where wage level is the lowest among the secondary and tertiary industries. These people may also take such personal service jobs as waiters and janitors, or other odd jobs. Even these jobs, however, offer a wage somewhat higher than fishermen's revenue, and it is believed that more fishermen will leave their villages in the future. Fishing productivity enhancement through fishery development will fill the income gap between fishing and other industries and will facilitate the settlement of fishermen in their villages. In addition to such an effect on industrial structure, the fishery development to take place over the long extension of Oman's coastline for about 2,000 kilometres will also have a special effect i.e. the dispersion of population from the Metropolitan area and the promotion of rural development.

3) Exportation

Oman's abundant fishery resources should be considered not only as the source of satisfying domestic demands but also as an important source of export enhancement. Sardine exportation to the neighbouring countries as livestock feed has been discontinued since the appearance of more competitive fish meal. At present, petroleum is by far the biggest (99%) export item of Oman, and the rest is limited to only such agricultural products as dates and limes. When fishery products are successfully exported, the trade structure of the country will be significantly improved.

3. Points of Consideration

Thus, the three major fishery development objectives are (1) domestic demand expansion, (2) fishermen's income increase, and (3) export promotion. Among them, domestic demand and fishermen's income should be given the first priority and export promotion the second. These objectives can be achieved by various ways and means, each of which can have cross impacts (desirable and otherwise) on the achievement of other objectives. Therefore, their mutual relationships should be fully evaluated and coordinated.

The Mission's survey resulted in a rough understanding of the government's basic policy, but not of specific measures for the accomplishment of fishery development. Therefore, no discussion of such measures will be made here, but a number of points for more careful consideration will be suggested for the development of a well balanced set of fishery policies and measures.

The first point pertains to resources. Fishing activities should be carried out under an appropriate production programme in order that resources will not be degraded. Fishing of one kind of fish can have effects on the ecology of other kinds (for instance, catching of sardines in an excessive volume will not only degrade sardine resource itself but also can result in reduced population of more important pelagic fishes in the fishing ground). Large pelagic fish resource is believed to be rather small although not ascertained, and mass catching of those fishes by large fishing boats with modern fishing gear can result in the exhaustion of this resource. Accurate inventory of fish resources and continual up-dating of such statistics will be essential in order to guarantee perpetual prosperity of the Omani fishing industry.

The second point for consideration pertains to consumer-producer problem. Rephrased, this is a question of preference or balance between consumer protection and producer protection. If priority is given to the fish price stabilization, fish and fish products importation should be promoted together with the improvement of delivery and distribution facilities. If, on the other hand, priority is to be given to fishermen's income increase, the government should direct its primary efforts to the development of fishing port(s), modernization of fishing gear, and consider granting of subsidy to fishermen. Actual policy measures should be determined at a midpoint, striking a balance between the two.

The third point pertains to the structure of the fishing population. That is, although productivity improvement and exportation promotion will require that economies of scale be realized in fishing operations, large scale fishing operation will soon deprive petty fishermen of their market as the source of their income. The government has commenced on large companies and is planning fish canning and fish meal plants. Development of these activities is certainly desirable for the Omani fishing industry as a whole, but it should be kept in mind that such activities should not compete against the individually operating fishermen in general in their markets and fishing grounds. For these average fishermen, scale expansion, productivity improvement, and business stability should be accomplished through the establishment of cooperative type organizations. Semi-government large scale fishing activities should be carried out in such a manner as to contribute to the benefit of the average fishermen.

4. Fish-Based Industrialization Project

Proposed items for industrialization among fishing and related activities would be fishery products processing (fish canning, fish meal, etc.) and fishing boat building and repairing, in view of the current situation of the fishing industry and presumed future policy measures of the government. Now, these industries will be reviewed to determine whether or not a further feasibility study is recommended.

1) Fishery Processing Industry

Fish canning and fish meal production have been considered by the government, but the present market and technological situations, which will be discussed below, determine the establishment of such industries. To secure profitability, production cost must be kept minimum by large enough scale of operation, and, in order to export the products, price must be competitive. Canned sardine of Oman, when produced, will have to compete with products from Japan and the Republic of South Africa. In Japan, the minimum cost of sardine is about 20 yen per kilogramme (30 baiza per kilogramme) and the production cost of canned sardine is from 25 to 30 yen per can (37 - 40 baiza per can) by most typical medium size canning factory, whose production scale is about 250 tons per day. The factory envisaged for Raysut is to have a scale of about 25 tons per day, which is not large enough to achieve production cost per day, which is not large enough to achieve production cost per can low enough to make the product internationally competitive. If all the products are to be sold in the domestic market, protection must be provided against the imports.

Canned tuna offers higher value added and, therefore, higher profitability than canned sardine. Production of about 10,000 tons of canned tuna per year will guarantee a profit, but even on this scale, some of it will have to be exported because the size of the domestic market is even smaller. On the other hand, a number of factors (the situation of infrastructure, technology) work against the establishment of internationally competitive price of canned tuna. Besides, the rise of such a canning industry will most likely absorb all the available tuna landing, and leave insufficient supply of fresh tuna for the general consumer in Oman.

For canning of fishing products, cans must be secured. The cost of can usually represents about one-third of the total production cost of canned mackerel and canned sardine, and about 20% of canned tuna. If a can manufacturing plant is to be established along with the canning factory, can manufacturing must have a scale of about 20,000 tons per year. But, production of 10,000 tons of canned tuna will not support such a can manufacturing, and can will have to be imported.

As we have seen above, first priority can not be given to canning project unless the government strongly supports it by various means.

This is also true with fish meal industry, which will have difficulty in the domestic market, not to speak of export. In Japan, an average 350 tons per day fish meal is the minimum scale of production to maintain a profit. If such a plant is operated, the total annual production will be as much as 84,000 tons. This will largely compete with the coastal fishermen who currently supply 180,000 tons of sardines for livestock feed, unless there is a significant expansion of the market. Then, it would be advisable to limit the fish meal production, instead of a full scale fish meal plant, to an effective utilization of scrap fish meat generated by other fishery product processing.

2) Fishing Boat Building and Maintenance

The feasibility evaluation of small fishing craft building and repair industry must start with an inventory of the existing fishing crafts. According to Marine Resources Development Programme, Sultanate of Oman (Final Report) by Mardela International Ltd. and FMC International, April 1975, there were a total of 954 fishing crafts, and their sampling survey revealed the following composition: diesel craft, 4% (39 in number); huri with an out-board engine, 23%; non-motorized huri, 39%; and shasha 34%. Taking into consideration uncounted ships of Masira Islands and those of surveyed villages, a sampling ratio of about 40% was assumed and the total number of various fishing crafts are estimated at 2,500 as shown by Table VII-1.

Table VII-1 Estimated Number of Fishing Boats by Type

Equiped with a diesel engine	100
Shasha	850
Huri without an engine	975
Huri with an outboard engine	575
Total	2,500

(Source) JICA MISSION

(1) Feasibility of Shipbuilding

As estimated above, the total number of fishing boats operating in the waters of Oman is only about 2,500.

The Government is encouraging fishermen to purchase aluminum or FRP boats or at least to motorize their boats. The Five-Year Plan has set up a fund for purchase of 500 engines and 1,000 aluminium boats to provide for the fisherman with the Government subsidy. The aluminium boats will replace shasha and non-motorized huri, and the engines will be attached to presently non-motorized huris. This will result in a qualitative change in shipbuilding market.

However, such modernization of fishing crafts will not help but will bring some negative impact upon the traditional wooden shipbuilding activities at Sur and Sohar. Therefore, Government will need to make a proper adjustment between the fishing crafts modernization policy and the traditional shipbuilding industry protection policy.

Unit price of various types of fishing crafts are presented on Table VII-2.

Table VII-2 Purchasing Price of Fishing Boats

Wooden		Aluminium		Fiberglass Reinforced Plastic	
12-15 feet	200 R.O.	12-16 feet	300-400 R.O.	13 feet	175 R.O.*
25 feet	1,000 R.O.	15 feet, 25 HP	700 R.O.	13 feet, 8 HP	381 R.O.*
8 t	1,500 R.O.			18 feet	312 R.O.*
With an engine (40 HP)	3,000 R.O.			18 feet, 15 HP	692 R.O.*
				20 feet	3,000 R.O.

(Note) * ex-factory price in Japan (conversion rate: 1 R.O. = ¥673)
(Source) JICA MISSION

Although the number of samples taken were not large, wooden boat is generally the cheapest of all of the same size. In the case of 13-feet FRP boat, the above price is based on the Japanese production price, and the actual market price in Oman would be higher than that of a wooden boat due to the shipping cost, insurance etc. Aluminium boats are generally small and tend to be more expensive than others. Although FRP boats are cheaper than aluminium boats, they are not strong enough against the heat of the beach sand when beached. For this reason, aluminium boats are currently being preferred. But, if the cracking problem is overcome, FRP boats will have an increased competitiveness with aluminium boats.

Shipbuilding industry is believed to have little potentiality in Oman for the reasons that (1) The replacement market of shashas and huris by aluminium boats is expected to grow for the coming 5 - 10 years. However, after the existing 1,825 shashas and non-motorized huris have been replaced the market will shrink to a very small one, (2) neither the government, which plans to procure modern ships from abroad, nor the craftsman now engaged in the traditional wooden shipbuilding, intends to promote the domestic production of aluminium and/or FRP boats, and (3) the welding of aluminium boats and the adhesion of FRP parts require fairly high level of technology and the FRP adhesion process must be conducted under a range of temperature (around 15° - 20°C), which means that the airconditioning cost will increase the production cost to a great extent. Unless the Government make positive efforts in solving these problems, shipbuilding industry will have very limited chance of survival, if established.

(2) Potentiality of Ship Repairing Industry

Under the above-mentioned fishing boat modernization programme of the Government, the durability of fishing boats themselves will be improved, but, at the same time, as the number of motorized boats increases, markets of repairing and replacement of engines grow. The number of boats equipped with an out-board engine will increase to 1,000 by 1980. Assuming that the life of an engine is three years under severe climatic condition of Oman, there will be a replacement market of 333 engines per year. Also assuming the breakdown ratio of once every year, these fishing boats will offer 1,000 engine repairs each year. The Government has also recognized these demands, and is planning to build engine maintenance shops at several locations (one at Salalah has already been in operation).

a) Development Investment

Several small engine repair shops in major fishing villages should be preferred to one big plant, from the convenience of service coverage. In that case, each shop will be required to cover a rather small geographical area and need not to be a very large repairing plant. (The repair shop now operating in Salalah has a floor area of about 150 square metres and the number of repairmen is less than 10.) Major part of the investment will go to the workshop building and repair tools and apparatus. The Government plan estimates the investment cost at 250,000 dollars for a shop in Mutrah and from 75,000 to 150,000 dollars for each of shops in other locations. Personnel expense and the actual cost of maintenance are considered to be about all the operation expenses needed for the running of the shop.

b) Site Location

Engine maintenance shops should be located in areas where a large number of motorized boats are used. Because the Government has different financing programmes for fishing boat motorization in different areas, shop location should be determined in accordance with these programmes. Most likely sites are Salalah, Musandam, Sohar, Sur, and Mutrah.

c) Development Effects

The development effect which can be expected from the engine maintenance industry are productivity enhancement and result fish meat production increase, as well as employment opportunity expansion.

Motorization of fishing boats improves fishing productivity by 30%, according to the Fisheries Department. According to the data of Table II-6 in PART ONE, a motorized huri offers 75% higher productivity than does a non-motorized huri in terms of volume of catch. But the greater difference in value of catch per landing of 20.6 RO for a motorized huri against only 8.3 RO for a non-motorized one shows that motorized crafts have a greater radius of operation and, therefore, able to catch fishes of higher price. Thus, the engine maintenance will enhance the productivity of fishermen more in terms of value than volume.

Increase in the number of operation days secured by rare engine breakdowns will also have an important effect on increased fish meat production. Assuming a down time about equal to operation period due to an engine trouble, each fisherman will fish for 120 days every year, one-half of the total yearly average of 240. Difference in average volume of catch per landing between the 85 kilogrammes of a motorized huri and 49 kilogrammes of a non-motorized huri is 36 kilogrammes, which, for 120 days, comes to 4,320 kilogrammes. When the number of motorized ship has increased to 1,000 under the modernization programme, difference in the production between 100% trouble-free operations and 50% trouble time will be (4,320 kilogrammes times 1,000 boats) about 4,000 tons per year. Likewise, a complete breakdown of the 1,000 motorized boat throughout a year will result in a production loss of nearly 10,000 tons--a magnitude which will have serious impacts on the fish meat supply and the consumer price level.

As for employment opportunity creating effect, the total number of opportunities to be directly created by this industry will not be so large, but will be only several tens. However, the reduction of non-operative time of fishermen will have the effect of reducing "unemployment". In this respect, also, the industry will play an important role.

As seen above, an engine maintenance shop will play an important role in supporting the fishing activities, although the shop itself will turn out no tangible product. The Government has recognized the importance of these shops and plans to expand this operation regardless of its profitability, in order to furnish the necessary service to fishermen. As these shops will have great effects compared to the small investment they require, it is expected that these shops be established one after another.

(3) Conclusion

The foregoing discussions can be summarized as follows. (i) Despite the expected increase in the demand of aluminium and FRP boats under the Government's fishing boat modernization programme, shipbuilding (other than wooden ships) will not be feasible. (ii) However, the demand for the maintenance of fishing boats and their engines will continue in the future. The Government is establishing such shops regardless of their profitability since such shops are considered as necessary government service to be offered to fishermen. However, if such shops are to be carried out by private business firms in the future, profitability would be an important question.

Fishermen's technology and productivity enhancement will be important from the standpoint of securing fish meat supply and developing local provinces, and priority should be placed on the technical guidance on the use of highly productive new fishing equipment. The provision of trawler vessels and the operational knowledge of them is an example. Furthermore, technical guidance on prawn and oyster culture, may be of some importance. In order to accomplish technological development, systematic and long-term efforts are required. Although a large sum of money has been invested in the consultation and other services rendered by foreign firms, not a few of them turned out to be insufficient due to the lack of exact recognition and understanding of the situation in Oman.

VIII. RECOMMENDATIONS ON THE FUTURE FEASIBILITY STUDIES

1. Selection and Promotion of Industrial Projects

1) Comprehensive Assessment of Projects

In this PART TWO, selected strategic industrial projects have been subjected to prefeasibility studies, chiefly from the viewpoints of market and raw material/ resources. The prefeasibility study findings are summarized on Table VIII-1.

These proejcts can be classified into the following five different market/resources characteristics:

(1) Domestic resources are available, and domestic market exists.

(2) Domestic resources are available, but domestic market is yet to be developed.

(3) Domestic resources are yet to be confirmed, but domestic market already exists.

(4) Domestic resources are yet to be confirmed, and domestic market is yet to be developed.

(5) Raw materials must be imported, but domestic market already exists.

Then, strategic industrial projects can be classified into the above five, as shown on Table VIII-2.

These falling under category (4) above are believed to have a low priority, unless some new reason for attention will arise in the future. Glassware manufacturing under (3) will be omitted from the feasibility study, because an Omani private company has made a fair progress on the study of this industry. "Recovery of chemicals from salt" industry under (2) is considered to have a low priority because the market has a very limited potentialities with much technological difficulty in production.

The remaining projects have been grouped into project packages based on raw materials, resources required, and their industrial features as presented on

Table VIII-1 Summary of Prefeasibility Study Findings

Group	Project	Product	Scale	Facility/ Technology	Employment	Raw Materials	Market/Demand Scale	Problems
Building Materials	Secondary Cement Products	Concrete Panels and Slabs	Small, $5 Mill. U.S.	Medium/Small Simple Tech.	50 - 90	Currently imported; 1 mil. ton/yr cement plant will start operating in about 1983.	Small, Prelim. plan; 10 to 20 5-story, 30-unit apartment houses to be built per year.	Competition with products of existing Co. (Amiantit)
		ALC Products	50 Thous. m^3/Yr	Medium/Small; Med. Level Tech.		Abundant (silica sand, cement, quick lime); need good quality water	30-40 thous. m^3/Yr (1985)	
	Marble	To be decided by discovered deposit grade	Small 10 thous. ton/Yr. $1 Mill. U.S.	Simple Fac., High Tech.	30 - 40	Domestic; at least several 100 thous. tons of reserve	Small, 2 thous. ton/Yr.; Competitive export market	Size of deposit is yet to be proved.
	Limestone	Lime	18 Thous. Ton/Yr $6 Mill. U.S.	Fair level of Tech.	50 - 60	Abundant	Small, 1976 import 123 Thous. RO	
		Calcium Carbonate Powder	3 Thous. Ton/Yr $1 - 1.2 Mill. U.S.	ditto	15 - 20	Abundant	Almost none	Market in the Gulf area small
	Dolomitic	Dolomite Plaster	10 - 20 Thous. Ton/Yr.; $5-6 Mill. U.S.	Small, Simple Tech.	50	Abundant	1976 import 3.2 Thous. R.O.; Depend on building demand, 5,000 t/y	Need of market development
		Dolomite Fertilizer					Small	
Ceramics, Glass, Brick and Refractory	Glass	Glass Containers	Medium/Small 10 Thous Ton/Yr	Relatively easy		Suspected if volume adequate	Middle size market in Gulf area	A private firm is starting
		Sheet Glass	Large	High & complicated facility and tech		ditto	Small; 11,000m^2/Yr.	No inter'l competitiveness
	Porcelain	Ceramic Tiles	Small; several 100 thous. m^2/Yr. $3-4 Mill. U.S.	Relatively easy	50 - 100	Clay reserve unproven (limited by use)	$5 mill./Yr for all ceramics; for tiles, 500 Thous. m^2/Yr. or less.	Competition with imports
	Bricks	Refractory bricks		Complicated; Large Scale			Almost none	No domestic demand until cement plant operation start

(To be cont'd)

(Continned)

Group	Project	Product	Scale	Facility/ Technology	Employment	Raw Materials	Market/Demand Scale	Problems
		Ordinary Bricks		Simple; Small Scale		Clay Reserve unproven	50 Thous. m^3/Yr. or less	Competition with concrete blocks
		Other Porcelain (Tableware, etc.)		Varied		Unproven		
Metal/ Plastic Fabrication	Copper Smelting/Fabrication	Cathode Copper	20 Thous. Ton/ Yr.; $8 Mill. U.S.	Simple; Medium Size	30	Abundant	Domest. and Export; Domest, 2 Thous. Ton/ Yr. Cables, 200 Ton/ Yr rolled copper	Inter'l Compet.; Electric wires to compete with Gulf countries.
		Wire Rod	20 Thous. Ton/ Yr; $10 Mill. U.S	Complicated; Medium Scale	20			
		Copper Cables (Vinyl Insulated)	1,200 Ton/Yr. $3.5 Mill. U.S.	Complicated; Small Scale	20			
	Plastic	Containers	3,000 pcs/Day; $200 Thous. U.S.	Easy	5	Import	Demand estimated fairly high for water containers	Compete with Imports
Petroleum/ Natural Gas	Petroleum-Based	Petroleum Products	50 Thous. bbl/ day; $80-120 Mill. U.S.	Big Plant; High Tech.		Abundant	30,000 bbl/day (domestic; 1985)	Internat'l Compet. still questionable
	Gas-Based	Ethylene and Derivatives		Big Plant; High Tech.		Insufficient	Over-supplied in the Gulf area	Compt. with Saudi Arabian products
		Ammonia/Urea	1,000 Ton/Day	ditto		Abundant	Small	Compt. with Gulf area proejcts
Seawater	Brine-Based	Recovery of common salt, magnesium, bromides; Mfg. of caustic soda and chlorine	130 Thous. Ton/ Yr Caustic Soda; 17 Thous. Ton/ Yr. Magnesium Oxide	Big Plant; High Tech.		Abundant	Almost no domestic market	Low export compet.
Fisheries	Small fishing boat manufacturing	FRP Boats, Aluminium Boats	Small	Some Tech. needed		Import	Small, 2,000 - 3,000 in all	Domestic market oppressed by imports
	Repairing	Repairing	Small (Several shop at fishing villages)	Simple, Easy	10/shop	Imported parts	Large; 1,000 boats/Yr.	Need techn. train. guidance

(Source) JICA MISSION

Table VIII-3. It should be desirable that feasibility studies be undertaken for each package.

Table VIII-2 Categorization of the Selected Strategic Industrial Projects

Characteristics	Projects
1. Resources are available and market is already existing.	Secondary Products of Cement, Petroleum Products
2. Resources are available and market is yet to be developed.	Marble, Lime, Calcium Carbonate, Dolomite Plasters, Electrolytic Copper Wires, Insulated Copper Wires and Cables, Nitrogenous Fertilizers, Chemicals from Salt
3. Resources are yet to be confirmed but market is already existing.	Glass Containers, Ceramic Tiles, Clay Bricks, (Porcelain Products)
4. Resources are yet to be confirmed and market is yet to be developed.	Sheet Glass, Refractory Bricks, Petrochemical Products
5. Raw materials are to be imported and market is existing.	Plastic Containers, Small Fishing Boats

(Source) JICA MISSION

Table VIII-3 Packaging of the Finally Selected Industrial Projects

Priority	Project Packages	Projects
High	1. Products from Carbonate Rocks	Marble, Lime, Calcium Carbonate, Dolomite Plasters, (Secondary Products of Cement)
High	2. Copper Products	Electrolytic Copper (Wire Bar), Copper Wire, Insulated Copper Wires
High	3. Petroleum Products	Petroleum Products
Medium	4. Ceramics and Related Products	Ceramic Tiles, Clay Bricks, (Porcelain Products)
Medium	5. Nitrogenous Fertilizers	Nitrogenous Fertilizers
Medium	6. Others	Plastic Containers, Repair of Small Fishing Boats

(Source) JICA MISSION

Table VIII-4 Problems and Possible Solutions of the Industrial Projects

Projects	Problems	Possible Solution
Lime	°Small market size	°Domestic and export marketing
Calcium Carbonate	°Availability of pure lime stone	°Careful geological survey
	°Small market size	°Exploitation of the use
		°Export marketing in the Gulf countries
Dolomite Plaster	°Small market size	°Demonstration of effective use of plasters
		°Export marketing in the Gulf countries
Electrolytic Copper and Copper Wires	°Small market size	°Export marketing in the Gulf countries especially those which have established manufacturing of electric copper wires and cables
Insulated Copper Wires	°Small market size	°Electrification in Oman
		°Simplification of sizes of electric wires to be produced
		°Export marketing
Petroleum Products	°Small domestic markets for residual oils	°Export marketing including bunker oil market
Ceramic Tiles	°Availability of clay of good quality	°Geological survey designed for locating clay deposit
	°Small market size	°Export marketing in the Gulf countries
Clay Bricks	°Availability of clay in quantity	°Geological survey designed for locating clay deposit
(Porcelain Products)	°Availability of high-quality clay, feld-spar, kaolin, quartz and so on	°Extensive geological survey
Netrogenous Fertilizers	°Small market size	°Export marketing, preferably on the Government to Government purchase aggreement
Secondary Products of Cement	°Small domestic markets	°Promotion of use of preeast and/or pre-fabricated concrete products in the Government-financed projects such as water supply and housing
Plastic Containers	°Small market size	°Export marketing in the Gulf countries

(Source) JICA MISSION

2) Project Implementation

Some of the finally selected projects, listed on Table VIII-3, accompanies certain difficulties (see Table VIII-4). Of them, particularly bricks, ceramic tiles, and nitrogenous fertilizer projects will require the saisfaction of the following as prerequisite to their implementation:

(a) Confirmation of the needed volume of resource by advance geological survey (bricks and tiles), and

(b) Government-to-government sales agreement (nitrogenous fertilizer).

The smallness of domestic market and difficulties involved by product exportation to neighbouring countries are constituting a bottleneck to hinder the implementation of a number of projects finally selected. The bottleneck can be removed by:

(1) "Buy Omani" campaign to encourage the use of Omani products in government projects,

(2) Implementation of construction and other government projects under which ALC products and other new products will be used,

(3) The arrangement under which a foreign government will make an investment in the project and also buy the products of the project, as seen in the case of cement project,

(4) Dispatch of export promotion missions to the Gulf countries for the survey of trade situation in each country with emphasis on specific merchandise, such as copper, tiles and marbles,

(5) Inducing investment by a multi-national enterprise operating in Gulf or Middle East countries and exporting products through the marketing network of the enterprise, as being done by Amiantit, and

(6) Fosteration of exporters under an export subsidy system (Oman has importers but no exporters).

2. Needs for Resources Assessment for Future Development

Also, the minimum volume of reserves necessary for economic exploitation of resource is not known for many resources, and this is constituting one of the greatest obstacles to the implementation of projects for industrial utilization of domestic resources. Accurate information in this regard will facilitate not only the implementation but also the future development of various mining and manufacturing industries. Agricultural, fishery, and mineral sources survey should include the following.

1) Survey of Agricultural Potentials

Water resources and soil in Oman have been quite well known, and the next stage of survey is to determine areas suited to various crops. In order for the agricultural industry of Oman to depart from the traditional self-sustaining phase, cash crops or crops that yield much income must be selected which may increase the farmers' income, and consequently reduce the population outflow from farms to urban areas.

It follows that "the selection of most growable cash crop for the development region" must be introduced into the philosophy of crop selection through agricultural survey in addition to the conventional "increase of self-sufficiency." Combination of such cash crops and their processing will expand agricultural value added and offer a base for the development of agro-industry.

The fosteration of such a plantation-type farming in Oman may be subject to further consideration, but should certainly be tried out in a suitable area where water is available. Examples of such attempts are listed on Table VIII-5.

2) Survey of Fishery Potentials

The potentials of Omani fisheries have been surveyed in Mardela International Report or by University of Bergen, as well as by FAO. And the development feasibility of deep sea trawl fishing has been surveyed under joint agreement between the Omani Government and the Japanese and the Korean fishing companies.

As far as the Mission could find, stable and substantial landing of the "saleable" kind of fish which may be frozen or canned has not yet been confirmed. In other words, as abundant as the Omani fishery resources may be, adequate survey needed for the fosteration of large scale fishery processing industry has not been taken. Fishery landings should be classified into (1) those which can be supplied to domestic food market, (2) those which Omani people would not eat but which can be exported, and (3) those which can be used as animal feed, and the landing volume of each of exportable fishes, namely, cuttlefish, lobster, clam, oyster, and so forth should be determined and their storage methods, such as freezing, canning, smoking, and other preservative processing should be reviewed. Even though the Omani fishing industry is to be looked at as the source of protein for domestic consumption at least for the time being, it should be conceived of as an advantageous source of income, particularly of foreign exchange income, in the long run.

Table VIII-5 Possible Agricultural Development Directed at Fostering Agro-based Industry

Crop	Industry
Citrus Tree	Canned Juice
Other Fruit Trees	Canned Fruits, Dried Fruits
Tomato	Canned Juice, Canned Tomato Paste
Oil Seed Crops	Vegetable Oil
Coconut Palm	Coconut Oil, Soap

(Source) JICA MISSION

3) Systematic Geological Survey

What is most important of geological survey in Oman is the accurate inventory-taking of the mineral resources. The future discovery of new economically exploitable metal ore deposits is highly possible. The results of exploratory surveys substantially influence development policies and investment programmes; therefore, such surveys should be started immediately. Of the reports of geological surveys so far undertaken, few of them clearly indicate the volumes and qualities of the mineral resources which could be economically exploited. This can be explained by (1) vastly wide area to be covered by such surveys, (2) the lack of experts in Oman, (3) only several years since the nation's "open-door," (4) difficulty of travel, (5) steep topography, (6) stern climate, and (7) inadequate water supply.

On the other hand, high possibility of exploratory surveys resulting in the discovery of new exploitable deposits is claimed based on (1) the wide 50,000 square kilometre spread of ophiolite in which mineral ore deposits occur (the ore bodies discovered so far was only 10 square kilometres), (2) that mineralization has been found not in a restricted locality but all over the ophiolite deposits, (3) that oxide ores (copper, iron) had been already mined in ancient times, and (4) that new discoveries have been recently reported in the vicinity of such ancient mines. In addition, the possibility is particularly high of discovering high grade sulfide at the deep base of oxide zones, where exploration has never been conducted.

Mineralized (for instance, copper or chrome) zones are usually found in area where such geological structures as fault, shear zone, and complex distribution of igneous rocks are mixed with each other or where mineralized metamorphism has taken place in a wide area. Therefore, exploratory survey must be undertaken in sufficient detail, which, first of all, requires the preparation of topographical maps with a high degree of precision.

Practical guideline on points to look for in exploratory surveys is offered as follows:

(1) Copper Exploration

a. Ophiolite, particularly the distribution of diabase and margin of pillow lava
b. Zones where rocks and geological structures are mixed with each other,
c. Area of mineralization, and
d. The need of vertical mining rather than horizontal.

(2) Chrome Exploration:

a. Peridotite at the point of contact with gabbro,
b. Fault, shear zone, and other complicated geological structure,

c. Detection of anomalies of chrome by geochemical survey, and

d. The need of vertical mining rather than horizontal.

In Oman the most important mineralization is the network-dissemination type of copper seen in the igneous rocks of ophiolite. There is also high possibility of rewarding results from exploring the deep part as stated before. While deep part can be explored by drilling, it should be more desirable from the standpoint of time and economy that a geophysical exploration is carried out first and that anomalous values (or zone) be geologically examined before the execution of test drilling. For geophysical survey, the benefits of different exploration methods should be fully compared between magnetic exploration, IP method, and gravity method. In the case of Oman, IP method is assumed most effective in view of the mineralization zone of disseminated type, ore depth, and geological structure.

NOTE : IP Method - Induced Polarisation Method.

ANNEX

I. FIELD SURVEY REPORT, MARCH, 1978

II. SUMMARY OF DISCUSSIONS, OCTOBER, 1978

III. TERMS OF REFERENCE FOR THE JICA STUDY

ANNEX I

FIELD SURVEY REPORT

OF

THE PREFEASIBILITY STUDY FOR INDUSTRIAL DEVELOPMENT

SULTANATE OF OMAN

March, 1978

JAPANESE SURVEY TEAM

JAPAN INTERNATIONAL COOPERATION AGENCY

CONTENTS

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Your Excellency
Mr. Mohammed Zubair
The Minister of Commerce and Industry
Sultanate of Oman

Your Excellency:

We have the pleasure of submitting our interim report at the end of our survey programme in the Sultanate of Oman.

During the limited period of our stay, we tried to do our best in looking into the socio-economy of your country in order to delineate a basis of your industrialization programme. Through analysis of information and data collected by this mission, we hope to come to a conclusion which will eventually lead to continuation of the present study, namely, a feasibility study of one or two selected industrial projects in future.

It is the sincerest hope of the Japan International Cooperation Agency as well as the Japanese Government that the technical cooperation with your Government as represented by the present study will further solidify the relationship already in existence between the two countries.

Yours faithfully,

Tan Hashida

Head of the Survey Team
for Industrial Development
in Oman

TH:hk

I INTRODUCTION

During the stay of the mission in Oman, we have often been told that most development has been achieved since 1970. This is a real surprise for everyone who knows what man can achieve within a limited period of eight years.

In view of declining trend of oil production, Oman will have to exert every possible power to limit outflow of foreign currency as well as to exploit other sources of foreign currency inflow to keep the development going.

Oman, if compared with the neighbouring countries, is gifted with variety of natural resources. So we believe that it will be particularly important for Oman to achieve a balanced growth of every economic sector. Development of manufacturing industry is, by no means, to be achieved independently of development of other sectors of economy, in particular agriculture, fishery and mining.

Bearing this in mind, we tried to look into the following objectives;

1. To grasp bases of industrialization in Oman, and
2. To evaluate prerequisites for development of selected industrial projects.

The terms of reference of the present study proposal by the Japan International Cooperation Agency (JICA) are summarized in Annex 1.

On returning Japan, the mission will continue analysis of information and data collected, and hopefully come to recommendation on the next stage of this study, feasibility study, primarily according to the terms of reference mentioned before. The estimated time schedule of the remaining part of this study is as follows:

April to May, 1978	--- Analysis of information and data
June, 1978	--- Draft report preparation
July, 1978	--- Modification of the draft report and printing
August, 1978	--- Final oral presentation in Muscat.
September, 1978	--- Final report submission

The survey mission member consists of nine experts as shown below:

1. Tan Hashida, Senior Industrial Economist,
   Head of the Survey Team (Administration and Industrialization Programme)

2. Hidetomi Asoh, Senior Economist,
   Deputy Head of the Team (Investment Analysis)

3. Shusaku Ikeda, Senior Geologist
   (Evaluation of Metallic Mineral Resources)

4. Koji Tanaka, Senior Chemical Engineer
   (Industrial Project Analysis)

5. Yoshihisa Hirose, Senior Geologist
   (Evaluation of Non-Metallic Mineral Resources)

6. Tetsuo Wakui, Development Economist
   (Analysis of Development Plan, Infrastructure and National Economy)

7. Toshio Kurokawa, Chemical Engineer
   (Industrial Project Analysis)

8. Masaki Kobayashi, Regional Planner
   (Analysis of Regional and Urban Plan, and Industrial Location)

9. Eiichi Seki, Coordinator
   Official of Industry Division, Mining and Industrial Planning and
   Survey Department, JICA

A list of visits made by the mission during the stay in Oman is shown in Annex 2.

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II GENERAL OBSERVATION ON DEVELOPMENT

1. Economy

Since 1970, the economic policy in Oman so far adopted has been oriented towards more laying foundations for economic and social development rather than embarking on large-scale economic developments from the outset. This policy has met with success as is evidently seen today.

The large revenues brought about by the rises of oil prices which took place after 1973 plus loans and grants have enabled the Government to implement large-scale national projects most of which aimed at improvement of infrastructure.

The growth of economy is well illustrated by a rapid increase in GDP which registered 107 million O.R. in 1970 and 827 million O.R. in 1976 indicating an average annual growth of 40.6 percent.

By far the most important source of revenue is export of oil. The Government revenue recorded 45.4 million O.R. in 1970 and 505.3 million O.R. in 1976 in which contribution by oil always accounted for almost 90% or above. Expenditure for defence has the largest share in the national budget and is instrumental to generate of domestic demands. At the same time a large expenditure for defence services as a constraint to increasing development expenditures.

There is uneasiness in the prospect of oil revenue which is expected to decline unless substantial discoveries of oil reserves are made. In view of the predominant portion of oil in the national revenue, this problem can very serious if means to cope with the problem are not found.

According to the statistics of Central Bank, the scale of foreign trade has boomed from the level of 56.8 million O.R. in 1970 to 836.6 million O.R. in 1976. Balance of trade has shown surplus since 1974. Regarding export, statistics show the level of 44.8 million O.R. in 1970 and 456.1 million O.R. in 1976. By commodity, oil represents over 99% every year. Japan is the biggest importer with a share of more than 50% in 1977.

In 1975, capital goods, consumers goods, and intermediate goods accounted for about 50, 30 and 20 per cent of import respectively. The United Kingdom and United Arab Emirates are the major sources of supply with about 20% and 18% of the total import respectively.

2. Development Plan

Since 1976, the Five Year Plan (FYP) has been brought into implementation. Although the progress report for the year of 1976 has been prepared, it still waits for the official approval. For this reason, the mission is not informed of achievement made in 1976 in detail. The indicated growth of GDP by 14.2% in 1976 in current price seems better than expected by some other outside experts, although no estimation of deflator value is available. The plan is based on assumptions that the contribution of the oil and construction sectors to GDP will decline, whereas agriculture, fisheries, manufacturing and other industries are expected to grow at annual rate of 10.8%. Income generating industries such as agriculture (including fisheries) and manufacturing are assumed to grow at 13.7% and 71.5% p.a. respectively. Since only three years are left for further development before 1980 and implementation of some important projects are lagging behind, it seems that achievement of the goals is not so easy. Slower glowth of these income generating industries than expected may contribute negatively to the overall economic growth in the coming next three years.

As for investment plan, we foresee gradual decrease of public spending, whereas private investment will become active at the later stage of FYP period. Despite of inherent problems of setting up commercial projects, private sector is gaining confidence in dealing with these problems. Our projection of average growth of public and private investment is - 5.0% p.a. and 5.0% p.a. respectively for the plan period in contrast to - 19.0% and 14.0% projected in the FYP. We have noticed that private investment sometimes proceeds quickly, once feasibility of the project is established. So it will be desirable for the government to ensure minimum profit of industrial projects by introducing various forms of incentives to encourage private investment as much as possible.

Importance of geographically balanced growth of national economy has been emphasized in the EYP and the government investments are being distributed evenly. Since population tends to concentrate in the metropolitan area in which most industrialization has taken place, a part of the government spending is preferably directed to regional industrialization programme in line with infrastructure development.

3. Infrastructure and Manpower

Though Oman's infrastructure was extremely limited before 1970, roads, ports, power facilities and telecommunication equipment have been greatly developed by the immense efforts of the new government, and as a result, it may be considered that a minimum infrastructure required to sustain Oman's economic development is now available. This amazing speed of infrastructural development, however, caused a significant strain in Oman's financial position. From now on, it is important to carry out development projects with due consideration given to economic justification and consistency with the industrial development projects.

1) Road

Up to now, total length of asphalt surfaced road and that of gravel road reached about 1,500 km and 8,500 km respectively and the intercity highway network may be regarded as almost completed. Hereafter, feeder service, or branch roads, should be increased connecting trunk lines and scattered towns and villages. In case economic scales of local towns and villages are very small, road construction is apt to cause population outflow from villages and towns to bigger cities with substantial adverse impacts on local economy. This question deserves full attention by the planners.

The old roads in Muscat and Mutrah are mostly inadequate for transportation by vehicles and have began to suffer from congestion and shortage of parking spaces. Roundabouts in the newly developed area as well as in the old cities function fairly well. Their capacity, however, are limited upto about 250 to 300 vehicles per hour for each one lane, so that this rotary system will cause traffic congestion and should be improved sooner or later as traffic volume increases. In case the industrial area is developed in the capital region, another access road to the Port of Mina Qaboos would be necessary and at the same time, full attention must be paid to measures to avoid congestion due to commuting.

2) Port

In Oman there are a number of natural harbours, but she has no port with deepwater berths except Port Qaboos and Raysut Port now under construction. Reflecting the general import boom in the Middle East, Port Qaboos with the capacity of 1.5 million tons was slightly congested in 1974 to 1976, but the congection is expected to lessen as a result of levelling-off of import and of the vast investment to the port development all through the Gulf countries.

Coastal shipping had, historically, played an important role, but nowadays it has been largely replaced by land transportation. So, the present expansion of Port Raysut would provide excess capacity in the immediate future.

3) Power

Electric power supply in the capital area depends on the Riyam and Al Ghubra power stations, the capacities being 37 MW and 77 MW, respectively, and 114 MW in total. The peak load registered 65 MW in 1977. In 1978, the peak load is anticipated to reach 85 MW. The recent rapid development of the capital area has remarkably increased the demand for power and the peak load is forecast to surpass the installed capacity during 1979, though installation of gas turbine generating units is in progress.

The above projection do not take into account possible establishment of energy consuming industries in the capital area. In case these industries are set up in the capital area they will have to possess own generators; otherwise, serious shortage of power supply would result.

A recent development worthy of note is completion of a natural gas pipeline from Yibal to the capital area which will very soon make a cheap and stable supply of fuel available to power generation in the capital area.

4) Water

Consumption of water in the capital area recorded 365 million imperial gallons in 1976. In the first half of 1977, the capital area consumed 362 million imperial gallons of which about three quarters was supplied by the Al Ghubra desalination plant and the balance by underground sources of Wadi Samail and Wadi Rusayl located west of Seeb International Airport.

With the existing sources alone, shortage of supply is expected from 1979. There is a plan to add in the Al Ghubra plant two units of desalination plant each capable of producing 2.5 million imperial gallons per day. It is urgently needed to develop new sources of water supply to cope with increasing demand for household and industrial uses of water.

5) Telecommunication

The number of telephone lines has been rapidly increasing and it exceeded 7,000 lines in the beginning of 1978. However, the supply cannot catch up with the busting demand so that aobut 7,000 applications are waiting for installation of telephone. Communication is often difficult especially in the morning time and during the week-end because of busy lines, and also after rainfalls because the system are apt to be out of order. The Cable and Wireless Company (CWC) has no particular priority policy for installation by purpose of use, under the principle of "First come, first served". But it might be advisable that public uses and business uses should be given priority to private uses until when telephone came into wide use to some extent. Demand for telex is also very high and there are 250 applications waiting for installation, while 275 units are now in use. CWC intends to increase another 1,200 lines by introducing a new automatic exchange.

6) Manpower

The population of Oman is considered to be around one million. The rapid change in economic activity and administrative reform in recent years have required a large inflow of experienced, semi-skilled and unskilled manpower from abroad, namely, professional and qualified mainly from Europe, Egypt and Jordan and semi-skilled and unskilled from India and Pakistan.

Until the time when a sufficient number of experienced Omanis become available, this trend will continue with a significant financial burden on the economy of Oman. As a step to cope with this situation, the Government has established a vocational training center for Omanis in Muscat and is planning to establish such training centers in various parts of the country. In the private sectors of industry, efforts have been made to train the

Omanis and to transfer, though gradually, jobs of greater responsibility from the expatriates to the Omanis. In spite of these efforts, however, expansion of industrial activities are likely to rely heavily on expatriates for several years to come.

One of the statistics indicates that the total number of employees excluding those engaged in agriculture, fisheries and public sector was 53,385 of which 24 percent are Omanis and the rest expatriates.

4. Industrialization

1) Present Status of Manufacturing in Oman

According to the updated industrial project list dated January 15, 1978, issued by the Ministry of Commerce and Industry there are not many manufacturing firms in operation except for small-scale workshops. These include flour mill, asbestos-cement products, PVC pipes, furniture, aluminum products, soft drinks, date processing, paint and some other industries. Total investment cost of these projects is estimated at less than 5 million R.O.

The industrial project list includes 54 projects, out of which 19 projects are already completed or in operation, 15 projects are in the stage of feasibility study or completed, and the rest are in such preliminary stages that little information is available.

Several visits to private firms made by the mission revealed that most of them are small- to medium-sized in terms of capital, production, and sales still in an infant stage of development, with a few exceptions in which the government sector prticipates. This appears only natural when the short period of eight years of modernization in Oman is taken into account.

2) Advantages and Disadvantages of Industrialization in Oman

Oman, as one of late comers for industrialization, should properly recognize her advantages and disadvantages at this initial stage of industrial development. The advantages may include:

(1) considerable potential of exploiting hydrocarbon and mineral resources

(2) relatively high potential of exploiting water resources--potential for agricultural and agroindustrial development

(3) high cost effectiveness of industrial development on national economy due to her small scale of economy

(4) political stability

The disadvantages may includes:

(1) shortage of manpower, in particular highly skilled workers and qualified people

(2) small domestic market size

(3) competition with industrialization of neighbouring countries

(4) traditional inclination of Omani people to commercial activity rather than to manufacturing

(5) hot climate in summer

While retaining her free economic activity on one side, the government is requested to assist development of certain important industries whose economic feasibility remains uncertain for the time being. Various incentives for private industrial investment including tax exemption, financing with preference and specially designed infrastructural development are needed, since protection of domestic products by means of tariff barrier is not entirely applicable to Oman. It is also important that, in some capital intensive industrial sectors the government takes the initiatives of development, typically represented by the gas pipeline, cement and copper projects currently in progress.

The government should also try to provide as much infrastructure for industrialization as possible. Stabilized supply of electricity and water to industry at reasonable cost is essential. In view of rapid industrialization in the gulf area, promotion of industrial siting by establishing the industrial areas is urgently needed. The planned Rusayl Industrial Area with proposed development area of 300 ha, though water supply seems guaranteed, may have topographical restriction for the future expansion. Flat lands are better to be allocated in Seeb district for future exploitation as industrial areas.

3) Selection of Industry

Identification of projects for industrialization of Oman is preferably to be conducted in the following manner:

Step 1 Preparation of list of industries possibly located in Oman

Step 2 Preliminary screening based on such fundamental criteria as;

a) the government's priority

b) elimination of existing and already planned projects

Step 3 Primary screening based on such criteria as;

a) availability of natural resources

b) marketability of products

Step 4 Secondary screening based on such criteria as

a) technological competance

b) price and non-price competitiveness

c) industrial linkage

Industries selected through this process may be regarded as "appropriate industries" for location in Oman, and the list will form a basis of acceleration of licensing industrial projects and/or future invitation of investment.

III COMMENTS ON MAJOR INDUSTRIAL SECTORS

1. Petroleum and Natural Gas

1) Overview on Reserves and Development

The proven recoverable oil reserves of the Sultanate of Oman were estimated at 5.8 billion barrels as of the end of 1976. This figure takes into account the recovery by secondary and tertiary recovery methods.

Except for Dhofar area, the oil being produced and found in Oman is light in API gravity, around 35, and low in sulfur content, approximately 1% by weight. In the Dhofar area a heavy oil of about 20° API gravity has been found.

Commercial production of oil started in August 1967 by Petroleum Development (Oman) Ltd. (PDO) which is now owned 60% by the Government and 40% by private companies with Shell as the largest shareholder. The production of oil unitl the end of 1977 is as shown below:

1967	20.9 Million Barrels
1968	87.9
1969	119.7
1970	121.3
1971	107.4
1972	102.8
1973	107.0
1974	105.8
1975	124.6
1976	133.8
1977	124.2

At present PDO is the sole producer of petoleum in Oman. Oman Sun Oil Company (Sunoco), Elf Aquitaine Oman/Sumitomo, and Quintana International Ltd., have been searching for oil in Oman for the past few years; however, none of them has been successful. Recently BP Petroleum Development Ltd. has signed a production sharing agreement with the Government and BP is expected to start drilling very soon.

The five-year plan of the Government forecasts the production of oil until 1980 as given below:

1976	135.0 Million Barrels
1977	132.0
1978	128.0
1979	125.0
1980	122.0

The projection foresees decline in the production. The heavy oil found in the Dhofar area would give a production of about 10 million barrels in 1980 and onwards. As indicated by the decline in the projected production, the most experts agree that the producing fields have already passed the peak; and therefore, new discoveries of substantial size will be needed to stablize oil production.

Natural gas in Oman exists in association with crude oil and also in the state of dry gas of which the main reservoir is located around Yibal. The reserve of gas is considered to be of such magnitude that would permit production at the rate of 140 million SCFD for a period of about 80 years.

A 20 inch pipeline has been laid from Yibal to al-Ghubra which is near commissioning at present. The pipeline is designed to deliner 140 million SCFD of gas without compression or 320 million SCFD of gas if compression is applied. Concurrently with the construction of the pipeline, a gas processing plant has been installed in Yibal to extract Liquefied Petroleum Gas (LPG) and Natural Gas Liquid (NGL) from natural gas. Productions of LPG and NGL will vary depending upon the throughout of natural gas to the plant and also on the composition of gas. Presently, the production of LPG and NGL are estimated at about 150 and 5,000 barrels per day, respectively.

2) Utilization of Petroleum and Gas

Petroleum is the mainstay of the economy of Oman. Export of petroleum generates a revenue which now accounts for more than 80% of the earnings of foreign currencies. At home there is no industry to utilize crude oil. All the petroleum products Oman needs -- aviation gasoline, premium and regular grades motor gasolines, kerosene, Jet-A-1, deisel fuel, LPG, bunker fuel and lubricating oils -- are imported. Of these products, substantial portion of Jet-A-1 and almost all bunker fuel are re-exported. Shell Markets (Middle East) Ltd. and BP Arabian Agencies Ltd. share the marketing of these products between themselves.

The demands for petroleum products in 1977 including and excluding bunker grade fuel oil were 9.4 and 25.4 thousand barrels per day (TBD), respectively. The demands are forecast to grow by 1985 to around 20 TBD or 30 TBD whether the bunker grade fuel is included or not.

The demands thus forecast do not appear large enough to justify construction of a refinery or a topping plant, the former being more sophisticated and equipped with all facilities for produce gasolines, gas oil, Jet-A-1, kerosene and fuel oil while the latter being equipped with a crude oil pipestill and a minimum number of facilities to produce gas oil, Jet-A-1, kerosene and fuel oil but not to produce gasolines.

A question of whether or not a refinery or a topping plant is justifiable should consider forecast demands for petroleum products and relevant economic and technical problems which we will look into later.

Generation of electricity presents a concrete program for utilization of natural gas. The Muscat power station (37 MW) and the Al Ghubra power station (78 MW) will use natural gas from 1978. Both power plants with a combined capacity of 115 MW will burn less than 30 million SCFD of gas, or about 21% of the 140 million SCFD pipeline capacity.

Other industries which have been considered for Oman and would consume natural gas are manufacture of ammonia/urea, manufacture of cement, smelting of copper, production of sponge iron, etc. The refinery, if installed, could burn gas instead of fuel oil. If these projects materialize before

1985, the consumption of natural gas by industries may be estimated as shown below:

Industry	Capacity	Natural Gas Demand (MMSCFD)
Refinery	30,000 BPSD	5
Ammonia (Urea)	1,000 T/D (1,700 T/D)	40
Electricity	200 MW	52
Cement	1 MMT/Y	15
Sponge Iron	400,000 T/Y	22
Copper Smelter	20,000 T/Y	5

Since the pipeline could deliver 320 million SCFD if compressors are employed, there would be a sufficient supply of gas to these industries.

We will study the adequancy of establishing an ammonia plant, a cement factory and a copper smelter. We will, however, not investigate the iron reduction project, since our expertise does not cover this field. The technology for construction and operation of a 1,000 T/D ammonia plant and a 1,700 T/D urea plant has already been established. Therefore, the study will be concentrated on the forecast of supply and demand pictures of nitrogenous fertilizers in the region surrounding Oman.

Another possibility of gas utilization which we have considered but abandoned is establishment of ethane cracking to produce ethylene and derivatives of ethylene. It is questionable whether the delivered gas will contain ethane in sufficient quantity to feed a commercial scale cracking unit. In addition, there are a number of problems before the petrochemical project can be justified; namely, a large capital outlay to be required, difficulties associated with the operation of the facilities and marketing of the products, negligible domestic demands for the intermediate and finished end products, inflexible nature of operation inherent to a highly integrated complex of a number of facilities, and so forth.

2. Agriculture & Fisheries

1) Agriculture

The cultivated land in Oman amounts roughly to 37,000 ha which is only 0.12% of the total land of 100,000 km^2. The agricultural areas are limited to where water supply is easily available or there are the traditional water system "falaj" through the area. Batinah coastal plan, interior of norther Oman, Musandam peninsula, Dhofar province are the major agricultural area.

Principal crops are dates, alfalfa, onions, citrus, wheat, banana, mangoes, etc. and various kinds of vegetables are harvested. Camels, sheep, cattles, goats are also abundant as livestock resources.

The Omani government has established a number of agricultural extension centres throughout the country and is giving seeds, fertilizers, insecticides, tractor services as well as technical instructions to local farmers in order to improve the agricultural activities in the country. A total of 23 such centers were in operation as of the end of 1976.

Major agriculture-related industries are yet to be developed, however, some of them are in operation on small scales. They are:

(1) date-processing plants in two places (mostly for export),
(2) dairy farms in Salalah and Sohar, and
(3) a flour mill of a capacity of 4,800 tons in Muscat (wheat is imported from Australia).

The overall production capacity of agriculture in Oman is still insufficient to sustain full-scale agro-industries in the country. Effective use of water resource is the key to the agricultural development in Oman. With the severe natural environment it would be necessary to introduce large-scale mechanization to every aspect of the agricultural activities as well as to the system of irrigation. In order to realize the mechanization, the first step to be taken would be to intensify education, training and to promote organization and cooperation of farmers. In spite of the efforts of the extension centers, only a small protion of the total farmers are now under the influence of these centers. As for the water resources, evaluation of the underground water potential and further measures to secure the reserve (reservoir dam in Dhofar) must be undertaken.

2) Fisheries

It has already been recognized that Oman is quite rich in fisheries resources. For example, the annual yield of sardines is estimated at about 1.5 million tons, and tuna 10-60,000 tons. For demersal fish, a catch of about 300,000 tons is expected.

Although the exact number of fishermen in Oman is not know, it is estimated to be several thousands. The number is supposed to be decreasing with the expansion of employment in other industries in urban areas. The majority of the Omani fishermen are still equipped with very small, one-man fishing boats, and their activities are irregular due to the change of weather. This makes the daily catch fluctuate greatly.

Fish is important food, for the Omanis, and the demand for fish is enormous. Fish is sold fresh, frozen, dried or salted. In Dhofar area, sardines are also consumed as fishmeal for feeding cattle. The prices of fresh fish are relatively high and fluctuate according to the seasons of the year. Improvement of the distribution system and the construction of cold storages throughout the country will contribute greatly to the price stablization and therefore increase the total demand for fish.

Ice plants, cold stores are in existence in Mutrah, Salalah, Sur, Sohar, etc. and new constructions and improvements are now being undertaken in other places including the interior districts. In addition to offshore fish catching by trawlers in progress jointly with foreign firms, the government is now granting financial aids to local fishermen in purchasing modern fishing boats and outboard engines, and furthermore provides repair services for them free of charge in the established workshops. Although the government is planning to replace small wooden fishing boats with samll aluminum or FRP (fibreglass-reinforced plastics) boats, the local fishermen tend to use wooden boats which they are accustomed to and are manufactured locally. The construction of aluminum or RFP fishing boats is not contemplated.

Although some canning factories of sardines are now under consideration, the operation will be difficult if the sale is confined to the limited domestic market. We foresee that overseas marketing of these products will be decisive of performance of the finalized project.

To make the best of the vast fisheries resources and to make the fish supply stable, the Omani fishermen must improve the quality of their fishing activity as well as to expand the scale of it. It will be fundamental to organize independent local fishermen since large scale fishing in which many fishermen work in cooperation is absolutely necessary for yielding a constant catch. In addition, the facilities for storage and transportation must be provided sufficiently.

3. Construction Materials

There are four major types of building materials, namely;

(1) metallic - iron and steel, aluminium, brass

(2) inorganic - cement, aggregates, blocks, bricks, ceramics, glass

(3) organic - wood, plastics, paints

Except for aggregates, blocks, paints and plastics products domestic production of these are almost non-existing.

In 1980s, it is expected that production of rolled steel, cement and some other minor construction materials will start, leaving only aluminium extrusions, ceramics, glass and wood to be imported. Recent development of several projects in which manufacture of asbestos cement pipes and limestone/silica blocks will enhance self-sufficiency of construction materials in Oman.

Besides rolled steels and cement, we presume that the following projects may be worthwhile to be looked into in detail;

(1) clay brick production

(2) ceramic tile production

(3) production of plasters and mortars

(4) manufacture of marble blocks

(5) aluminum profile extrusion

(6) sheet glass manufacturing

(7) FRP (Fibre Reinforced Plastics) manufacturing

(8) manufacture of aerated lightweight concrete

Projects (1) and (2) will be feasible marketwise only if domestic clay deposits of high quality or equivalent resources are located within easy access of transportation. Project (3) will utilize either limestone or dolomite which are found abundant in most parts of Oman.

Though the existing dmeand for these products is limited, competitive pricing and diffusion of application technique may prove the manufacture viable even at small scale production, since it requires relatively small capital investment.

Marble quarrying to produce blocks will be one of promising projects provided sizable deposits of high quality are located in the vicinity of the trunk roads. One or two applications for quarrying marble have been reportedly submitted. Marble blocks will be exported, only if mechnized methods of quarrying and finishing are introduced to cut the high cost of labour.

Extrusion of aluminum profiles may not be a feasible proposition since demand is small and specifications are diversified. Demand for these products in 1976 is estimated as less than 2,000 tons, which will not economically justify introduction of a hydraulic extrusion press.

Demand for sheet glass has not been clearly identified by the mission. Due to its capital intensiveness, manufacture of sheet glass in Oman at this stage seems to be less economical. Moreover, sizable silica sand deposits of high quality have not yet been located and alternative use of quarzite as raw material must push up production cost considerably. Availability of soda ash at reasonable cost in Oman still remains uncertain. Thus production of sheet glass appears as one of long-term objectives of effective exploitation of merals in Oman, provided that sizable amount of high-quality silica sand deposits be located within easy access of transportation.

FRP products are expected to substitute metals and wood only if specific applications are identified and technology of application is established. FRP has its own drawback of high cost of production.

Aerated or autoclaved lightweight concrete (ALC) can be cast into the forms of blocks and slabs. Cost of production of ALC blocks may be higher by 50% than that of conventional concrete blocks and, for this very reason, extensive substitution is not expected to occur (ref. Renardet-I.C.E. report in 1974). Increasing use of reinforced ALC slabs, on the other hand, appears possible, once standardization of building modules is carried out and technology of its application is established among contractors. The penetration process of ALC slabs, however, may take some more time than expected elsewhere.

Estimated annual investment on building in public sector gradually decline and level off at certain level, whereas private investment increases steadily according to the Five Year Plan. Total investment in building including housing is, therefore, estimated to increase gradually. Demand for bulky construction materials will increase from the estimated current level of approximately 160,000 m^3 per year by the rate of 3 to 4% p.a.

4. Mineral Resources

The territories of the Sultanate of Oman, especially the northern Oman mountains represented by Jabal Akhdar, Jabal Nakhl, Jabal Bani Jabir, etc. have ample potentiality of various mineral resources, which can be classified as follows:

(1) Metallic minerals as represented by copper,
(2) Non-metallic minerals as represented by asbestos,
(3) Industrial rock as represented by limestone,
(4) Sand and gravel as aggregate resources, and
(5) Seawater as source of salt.

Though our itinerary was too short to make a full-scale reconnaisance survey covering all the above items, our findings or comments are summarized below.

1) Metallic Minerals

The most extensive research so far made for metallic minerals, especially for copper, would be the one by Prospection (Oman) Ltd., which confirmed presence of 3 ore bodies having 12 million tons in total of minable ore reserves with the average grade of 2.1% cu.

It should be noted that the said 3 ore bodies occur in a limited area of only 20 km^2 and that the similar geologic environment can be found over vast areas on both east and west flanks of the Oman mountains where over 60 occurrences of copper mineralization were reported.

It is emphasised, therefore, the Sultanate is highly potential to have new ore deposits of copper, especially, and other minerals such as zinc, silver, etc. It should be pointed out that the depths of exploration made so far still remain insufficient to cover all the potential depths of the ore bodies.

Kinds and quantities of so far confirmed or estimated researves of the metallic minerals are summarized in the following:

Mineral	Ore reserves (1,000 T)
Copper	12,000
Chromium	abundant but of lower grade
Iron	- ditto -
Nickel	-
Gold	-
Silver	-
Manganese	-
Zinc	-
Lead	-

2) Non-metallic Minerals

As for non-metallic minerals which could be utilized on an industrial scale, asbestos and coal are to be specially mentioned. Amiantit (Oman) Ltd. was awarded a special licence to explore asbestos only, and confirmed, after 18 months of laborious research, presence of asbestos deposits worth considering a more detailed investigation anyhow, though the final decision on the next step to be undertaken has not been made yet mainly due to remoteness of the deposits. Considering many occurences of asbestos in the Sultanate, some measures to promote further exploration and, finally, encourage industrial uses of local asbestos might be recommendable.

Meanwhile, a coal deposit with some 10 million tons of reserves reportedly occurs near Sur. It appears, however, any detailed investigation has not been undertaken so far on possibilities of industrial utilization of the deposit, which, in our opinion, would be difficult to be economically exploited considering the magnitude of the deposit.

3) Industrial Rocks

As for industrial rocks available in the Sultanate, the followings could be mentioned:

- Carbonate rocks--limestone, marble and dolomite
- Siliceous rocks--quartzite, schist and sandstone
- Argillaceous rocks--shale, phyllite and clay

a) Carbonate rocks

Carbonate rocks are very abundant in the Sultanate, and potentially, they can be utilized for varieties of industrial uses.

At present, their actual utilization is negligible as compared with their widespread distribution, but there are at least two carbonate-based projects now under investigation or in progress, namely, a cement plant project and lime-silica brick manufacturing project, both of which we expect would be worth undertaking a detailed study since they could be based entirely on the locally available resources, not only carbonates but also siliceous and argillaceous rocks as well as natural gas.

In addition to the above, however, attention should be drawn to the possibilities of further utilization of carbonate rocks such as follows:

- Marble manufacturing
- Quick lime burning and subsequent slaked (hydrated) lime production
- Dolomite buring for producing refractories and/or plasters
- Production of pulverized calcium carbonates for various industrial uses

From the geologic viewpoint, it appears that there is ample possibility to locate suitable deposits for any of the above purposes, though it would require a laborious intensive research for each specific project.

For example, a short-time survey was made by our geologists on a couple of marble occurrences, where they found marbles of acceptable or even attractive quality, though the quantities of minable reserves did not appear to be very substantial.

It should be noted that not a few occurrences of 'exotic' limestones, most of which would expectedly have been more or less metamorphosed into a kind of marble, are reported in many localities covering a considerable area of the Sultanate. Though it might not be easy to obtain slabs or blocks of larger dimensions from any of the marble deposits, production of marble chips for terrazzo manufacturing purpose or high-quality aggregate uses would be practicable in some of the favourably located deposits.

b) Siliceous rocks

It should be pointed out that no important silica sand deposit has been reported in the Sultanate and that in our geologists' opinion, such deposit cannot be expected in such geologic environment where igneous rocks and carbonates predominate as in the case of the Sultanate.

Instead, however, siliceous rocks as represented by quartzite or quarts sandstone are considerably widespread in certain areas, especially in and around the Sayh Hatat Basin, where such rocks develop widely along the Wadis forming thick beds or masses locally intercalated with phyllite or reddish dolomite beds.

In the Sultanate, therefore, silicate industries such as sheet-glass or bottle manufacturing plants would have a disadvantage of being forced to utilize such siliceous rocks instead of silica sand, which means that processes of drilling, blasting, crushing and grinding of the hard rock are required beforehand in addition to the normal processes to follow them.

c) Argillaceous rocks

Deposits of clay to be utilized as raw materials of ceramic industries such as manufacturing of bricks, roof/wall/floor tiles etc. are limited to a few localities that have been reported to date, though further exploration efforts are strongly desired here.

As a countermeasure to cope with the rising potential demand of clays, it is recommended to investigate possibilities of utlizaing argillaceous rocks such as shale, clayslate, marl, shists and phyllites, etc.

It is usual in Japan to exploit weathered part of such rocks as a source of clay for cement industry as well as for brick manufacturing.

4) Sand and Gravel

Sand and gravel for road surfacing or aggregate use are obtainable from any of Wadis developing throughout the Sultanate. They are, in fact, one of the most abundant resources, but it appears that, from the very reason that they are abundant, no particular study has been made on their chemical compositions and physical properties except for limited number of geochemical sampling programmes undertaken from certain Wadi sediments.

Should such investigation be proceeded continuously, the results would be much more fruitful than one might think, in not only that it might lead to discovery of new mineral occurrences but also it would introduce proper and wider uses of each Wadi sediment.

5) Sea Water

Sea water contains approximately four percent of salt. The desalination plant at Al Ghubra discharges brine, or concentrated sea water, which contains about twice as much salt. We have briefly looked into the possibility of utilizing the brine from the Al Ghubra plant to set up salt-based industries.

Use of brine instead of sea water certainly represents an advantage when producing salt from sea water either as an end product or as a raw material for the production of caustic soda and chlorine. The brine from the Al Ghubra plant could therefore be a basis for salt related industries.

All the more important is, however, the presence of demands for these products. The domestic demand for salt is expected to be negligibly small to justify production of salt in commercial scale; and therefore, the industry would have to look for export markets.

Production of caustic soda and chlorine needs more rigid condition to be met; that is, industries to consume chlorine must exist in the vicinity of the plant since transportation by boat of chlorine is technically prohibitive at the present state of technology. In other words, the feasibility of producing caustic soda and chlorine depends to a great extent on the feasibility of other industries which consume chlorine.

We will continue to look into the utilization of brine although the study we have so far conducted indicates that the presence of brine would not necessarily constitute as favourable a condition as one might think.

ANNEX II

SUMMARY OF DISCUSSIONS

ON

DRAFT REPORT OF THE PREFEASIBILITY STUDY

FOR INDUSTRIAL DEVELOPMENT

SULTANATE OF OMAN

November, 1978

JAPAN INTERNATIONAL COOPERATION AGENCY

I. INTRODUCTION

"The Prefeasibility Study for Industrial Development in Sultanate of Oman" has been conducted by JICA since February, 1978. JICA sent a team of nine experts to Oman from 24th February to 21st March, 1978 for gathering data and information. After returning to Japan, these experts tried to do their best to finalize a draft report. The draft report was completed by the end of August, 1978 and mailed to the Government of Oman for review in advance. The final presentation and discussion on the draft report took place in Muscat from 25th to 29th October, 1978. It was understood that the Government of Oman had thoroughly reviewed the report and prepared many questionnaires and comments. The discussion and exchange of views on the study are believed to be most fruitful for planning industrialization of Oman.

This report is designed to summarize the results of the discussions on the draft report, particularly in response to a request by His Excellency Minister of Commerce and Industry that this summary be attached to this final report for reference.

For the final presentation and discussion the following two experts were despatched by JICA:

Mr. Tan Hashida, Head of the Team

Mr. Koji Tanaka, Team Member

II. MEETING SCHEDULE

Date	Time	Meeting
25th Oct.	9:00	Discussion with Ministry of Commerce and Industry • Mr. Barakat Al-Lamki • Mr. Saxena • Dr. Faizal M. Elamir • Mr. Malek Adawi • Mr. Moosa Baqer • Mr. Erayet H. Mallik • Mr. Khalid Kayer
26th Oct.	9:00	Discussion with the Development Council • H.E. Dr. Sharif Lotfy
28th Oct.	9:00	Discussion with Division of Petroleum and Minerals, Ministry of Agriculture, Fisheries, Petroleum and Minerals • Mr. Ali Battasi • Mr. Ken Bodine
	10:30	Discussion with Division of Petroleum and Minerals, Ministry of Agriculture, Fisheries, Petroleum and Minerals • Mr. Mohammed Qasim • Dr. I.M. El-Boushi • Mr. Omer Al-Amin • Mr. Mohammed-Rugrehm
	11:30	Discussion with Division of Fisheries, Ministry of Agriculture, Fisheries, Petroleum and Minerals • Mr. Ahmed S.S. Al-Sharfari • Mr. Abdul G.Y. Saad
	13:30	Meeting with H.E. Mohammed Zubair, Minister of Commerce and Industry • H.E. Ali Dawood • Mr. Barakat Al-Lamki • Mr. Saxena • Dr. Faisal M. Elamir • Mr. Enayet M. Mallik • Mr. Khalid Kayer

Date	Time	Meeting
29th Oct.	11:00	Discussion with Oman Development Bank · Mr. Mohammed B.B. Othman · Mr. Storch (An Expert from International Finance Corporation)
	12:30	Discussion with the Development Council · Dr. Mohammed Shazli

III SUMMARY OF DISCUSSION

Major items of the discussions were classified into two categories as shown below:

a. Projection of Oman's economy, industrialization and so on

b. Evaluation of prefeasibility of selected industrial projects

The following is summary of discussions expressed in the form of question and answer, and comments.

Note: The following abbreviation is used.

Q. : Question
A. : Answer
C. : Comment
O. : Omani Government
J. : JICA Mission

1. Projection of Oman's Economy and Industrialization

Q.O. : We are interested to know that how the JICA Mission projected GDP, Gross Industrial Output and other macro-economic indicators of Oman. We would also like to have the JICA Missions's comment on discrepancies of projected figures between the Five Year Plan and the JICA report.

A.J. : The GDP figures were estimated based on long-term trends of petroleum production and price and also past trends and present status of each economic sector other than petroleum. Industrial sector was, in particular, looked into in detail on project-by-project basis. The method of estimation used was fundamentally judgemental. The discrepancy may be partially explained by the difference of figures of 1976 which is the base year. Instead of low GDP for 1976 assumed in the Five Year Plan, the JICA Mission used up-to-date figures suggested by the Development Council. On the other hand, our projection of overall GDP growth rate from 1976 to 1980 was lower than that assumed in the Five Year Plan. We expected slowdown of economy in Oman after 1978.

Q.O. : There are some obviously overestimated figures projected for the year of 1980 in the JICA report. For example, Gross Industrial Output and Industrial Employment in 1980 will reach 38 million RO and 11,540 respectively according to the JICA report. We believe this is by far larger figures than we expected. We want to know the reason behind this.

A.J. : We must admit that projection for the year of 1980 may be on the optimistic side because only two and half years are left to reach that level. However, by encouraging private investment in industry, it would be possible to achieve figures close to these targets.

Q.O. : Total investment required to achieve industrialization for 15 years from 1976 to 1990 amounted to 420 million RO in 1976 price according to the report. The estimated investment in industry for 5 years from 1976 to 1980, 166 million RO, seemed considerably large in comparison with 137 million RO stated in the Five Year Plan.

A.J. : At the early stage of industrialization much investment is usually needed for construction of infrastructure and other auxiliary facilities. This could be explained in terms of large indirect investment.

Direct investment is also inefficient in view of slow startup of various industrial projects.

C.O. : Omani economy, unlike UAE's or Saudi Arabian ones, has already entered into a stabilized growth or readjustment stage, although economic growth of 1976 and 1977 exceeded our expectation. The existing recession in Oman is due to reduction of growth rate but not due to reduction of economic activity as a whole, which is easily explained by the fact that very few bankruptsy has taken place in Oman. In order to stimulate Omani economy, it is necessary to speed up the Government spending, in particular, expenditure on projects. In 1980s it will be possible to accomplish a stable and upward economic growth. Private industrial sector has been active as represented by the following investment in industry. We regard this as encouraging.

1976	10 million RO
1977	20 million RO

C.J. : We would like to emphasize importance of private sector in industrial development. The role of the Development Bank of Oman, an industrial financier, could be fully utilized to foster the private sector in industry.

C.O. : The Government of Oman is now preparing various measures to accelerate industrialization. We would welcome any advice in this regard which might be obtained in the course of the succeeding study.

Q.J. : We would like to ask about protection tariff for industrial goods manufactured in Oman.

A.O. : The system is under consideration. The proposed tariff rates, however, would be moderate only to warrant appropriate margin for domestic manufacturers. We essentially believe in free market economy to which Oman belongs.

2. Results of Evaluation of Selected Industrial Projects

1) Marble

C.O. : There are two past studies on development marble resources in Oman conducted by Arab League and a U.S. consultant. A new feasibility study is already under way and therefore this item can be excluded from further consideration.

2) Ceramic Tiles

C.O. : In connection with the preliminary study conducted by the Whitehead group, another in-depth study is now being implemented. This item could be also dismissed. According to the JICA report, commercial scale production of ceramic tiles could be started at the scale of 300,000 m^2 per year but we believe the production scale be better reduced to somewhat 50,000 m^2 per year since the preliminary study warranted production of only floor tiles due to clay quality so far examined.

C.J. : Production scale of 300,000 m^2 per year is large even in Japan. We agree with your view that initial production starts at smaller capacity.

3. Glass Products

Q.O. : We would like to ask you how you evaluated possibility of establishing glass industry in Oman.

A.J. : As for sheet glass production, minimum economic size of production is a few million square metres per year depending upon various conditions. Demand for sheet glass in Oman is approximately 11,000 m^2 per year, which is minute compared with the minimum production scale. Capital outlay for sheet glass manufacturing will exceed ten million RO and technology required is high and sophisticated. There is also problem of packaging sheet glass for shipment, because Oman must import wood and other materials for this purpose. Demand for glass containers (bottles) is relatively large if markets in the Gulf countries are brought together. Quartzite reserves have been located in Oman and these will warrant supply of silicate raw material. We have been informed, however, that one private company is promoting this glass container project and has completed a feasibility study. For this very reason, we decided to leave the whole matter to the private sector. Manufacture of glass tableware seems also possible in Oman, since it requires less capital and raw materials supply. In this case, however, a careful marketing study should be made before selecting types of products.

A.O. : Total investment needed to produce 10,000 tons per year glass bottles is 5 million RO according to the JICA report, whereas a private source indicated that investment of 1.1 million RO is enough to start manufacturing 20,000 tons per year of glass bottles.

A.J. : The latter figure seems to be too optimistic. We would like to confirm the validity of the figure. To sum up, glass projects other than glass bottle manufacturing could be reconsidered later when markets are developed or abundant cheap raw materials becomes available.

4. Clay (Red) Bricks

Q.O. : Our questions include markets for bricks, inter-material competition in building industry and availability of clay.

A.J. : Hollow clay bricks could be extensively used if they can be made cheap and more high-rise buildings are erected. The trend is conspicuous in some parts of the Gulf area including Saudi Arabia and Iran because use of clay bricks usually reduce building cost. Clay bricks compete with concrete blocks and also some precast concrete products including ALC. The key factors which determine result of the inter-material competition will be price and quality. A big clay deposits which could be easily exploited have not been located in Oman and, until cheap clay becomes available in quantity, manufacture of clay bricks may be left untouched.

5. Secondary Concrete Products - Precast Concrete Panels and ALC Products

A.O. : We want to ask about your views on the future of building sector in Oman and also on the markets for the above two products.

A.J. : The Five Year Plan predicts gradual decrease in investment in building sector up to 1980. We think that level of the total investment in building sector will be unchanged or rather slightly increasing due to delayed public investment and also need for new investment in housing by the Government. The two secondary concrete products are suited for constructing standardized houses and buildings which are easily incorporated into Government-sponsored housing development schemes. If this takes place, either precast concrete or ALC products must be selected since markets for these products are limited. It is recommended that initial scale of production of these materials be well below the levels indicated in the report.

C.O. : There exists oversupply of high-cost housing in Oman, whereas shortage of low-cost housing is expected in future. In planning construction of low-cost housing in Oman, such local factors as traditional design, climate and life pattern must be taken into consideration.

6. Nitrogenous Fertilizers

Q.O. : We come across two conflicting views as to prefeasibility of the fertilizer project. We want clarification about marketability of the fertilizer.

A.J. : The fertilizer project will become feasible only if market is secured. In other words, domestic market for the fertilizer is so small that most must be exported to countries which could easily absorb 600 to 1,500 tons per day of the product. In order to stabilize exportation conclusion of a long-term Government-to-Government agreement on purchase is strongly recommended. Projection of regional demand and supply balance in the Middle East and the South West Asia (Pakistan, India and so forth) indicates that in 1980s shortage of supply in the South West Asia could be offset by the excess supply of the Middle East. One typical example is a G-G agreement between Oman and India.

C.O. : Exploitation of natural gas is one of key long-term objectives of industrialization and there is some time left before we reach final decision on this matter. There are two feasibility studies on the gas-fertilizer project already available and we can make full use of the existing studies when Oman wants to arrange the G-G agreement.

Q.O. : We would like to ask you some technical advice to make this project competitive.

A.J. : The minimum production scale of ammonia plant is 600 tons per day and below this level unit cost rises sharply because expensive reciprocating compressors must be employed. A fertilizer plant mounted on a barge could be recommended for gas feed obtained from offshoare gas fields.

7. Copper Products

Q.O. : According to your recommendation, the copper projects is preferably modified to include electrolysis and copper wire manufacturing. Then what is technological and economical indication of this modification?

A.J. : The reasons why we recommend the project to go further downstream are as follows:

a. Markets for the fire refined copper is small--only 10% of total copper market.

b. Higher value added in Oman could be achieved.

c. There exist markets for wire bars and wire rods in the Gulf countries--several factories for manufacturing electric wire and cable are under construction.

Technological and economic impacts of the process modification is expected to be small. Smelting is simplified by removing reduction process and electrolysis and SCR process are added. And, if domestic market justifies, insulated electric wire manufacturing could be added. We foresee little difficulty in introducing these technologies into Oman. The additional investment is estimated at about 20 million U.S. dollars, which is small compared with the proposed investment of 120 to 140 million U.S. dollars to develop the copper mined and the smelter.

C.O. : Extension of the copper project toward downstream processing is now being discussed within the Government of Oman and OMCO. There remains still uncertainty as to copper price in future and, on account of this, there is an opinion that we had better to wait and see for a while before we finally decide to proceed with the downstream processing.

C.J. : We would like to make it clear that as long as copper market remains weak development of the on-going copper project may not be viable and therefore downstream processing will not become feasible as well. Our recommendation is based on a fact that the downstream extension of the project makes marketing of copper products much easier and that it is more efficient to design the upstream and downstream processes at the same time.

Q.J. : We wonder if implementation of the copper project is slightly delayed.

A.O. : It is not true. We have already invited tenders for engineering design of copper mines, a dressing plant,smelter and related infrastructure. The project is certainly on the move.

8. Fish Meal

Q.O. : The JICA report indicates that the minimum economic scale of fish meal production is approximately 350 tons per day and there is lettle possibility for Oman to construct such a processing plant. On the contrary, a small-scale fish meal plant is to be built in Oman by

Korean according to a fishery agreement between the two countries. We regard the 350 tons per year plant as too large to be built in Oman.

A.J. : Fish meal plants could be enlarged to match the amount of fish catch and fish catch should be estimated prior to determining capacity of fish meal plant. It will be wiser to start with smaller capacity of production and gradually to enlarge it in accordance with increase of fish catch.

C.O. : Construction of a small fish meal plant is one of many items included in the agreement and it has not materialized yet. It is our wish to build larger plants in future, because fish meal is in big demand in the world market. There is a plan in Oman that sardine fishing be further encouraged in order to process the catch into;

a. fish meal

b. canned fish

c. frozen fish

and these products be marketed.

9. Repairing Small Fishing Boats

C.O. : Ministry of Agriculture, Fisheries, Petroleum and Minerals has already started to build small workshops for repairing outboard engines and boats in Sur, Salalah, Mutrah and Sohar. And Japanese cooperation may not be needed urgently.

10. Petroleum Refinery

Q.O. : Some people have cast a doubt on the increasing trend of petroleum product demand as explained in the JICA study. In particular the total demand in Oman except for bunker fuel is sometimes projected to remain on the same level as that of the present, namely approximately 10,000 barrels per day (bpd). Refining capacity of 50,000 bpd proposed by JICA seems too large to be economically operated in view of the expected smallness of demand in Oman. To avoid risking heavy investment in large-scale refinery, there is an opinion that Oman is to construct a small- to medium-scale refinery with capacity of 10,000 to 30,000 bpd by 1985 only to meet major parts of the demand and, if necessary, the rest to be met by importation. And after 1985 refining capacity will be increased to 50,000 bpd, for example, so as to meet the incremental demand.

A.J. : We have not looked into possibility of stage construction which would optimize combination of capacity and process in terms of investment and cost. So it is not possible for us to recommend an optimized schedule of building up refining capacity. As the World Bank experts advised, construction of a topping plant with gasoline manufacturing facility could be recommendable as the first step of refining petroleum in Oman.

Q.O. : The Workd Bank report suggested construction of 30,000 bpd topping plant and thereafter American firms including Bechtel and Fluor have proposed construction of a topping plant. Their rough estimate of construction cost is something like 10 million U.S. dollars for a 10,000 bpd plant, which is extremely cheap compared with construction cost of a medium-sized grassroots refinery.

A.J. : The prices the Americans are quoting seem very low in comparison with those internationally accepted. There are a few ways of saving the construction cost, including use of a skid-mounted plant or a plant-barge.

Q.O. : Residual oil from the 50,000 bpd refinery will amount to about 13,000 bpd in 1985 as explained in the JICA report. The abovementioned figure will be net excess excluding sales of bunker oil and it will have to be exported somewhere. We would like to know if you have any idea about disposal of this residual oil including exportation to Japan and also if any Japanese companies are interested in equity participation in this refinery project with the aim of marketing the excess products.

A.J. : There exists a lot of uncertainty regarding estimation of demand for bunker oil and we are not sure if 13,000 bpd residual oil will have to be exported in 1985. We foresee, at least, a stiff competition for marketing residual oil in the Gulf area in future because there will be many petroleum refineries in operation. For the time being, excess residual oil in Oman, if it occurs, will have to be marketed through distribution channels of international oil companies. Exportation of the residual oil to Japan may not be possible on the ground that residual oil is also in surplus in Japan. Construction of a heavy oil cracking apparatus is not recommended due to higher refining cost resulting from additional investment.

C.O. : There is an optimistic view of demand for residual and bunker oils. There will be additional demand for bunker oil from Oman by VLCCs (Very Large Crude Carriers) which barely pass through the Strait of Hormuz after loading fully with crude oil in the Gulf area but not with bunker oil because of insufficient depth of the Strait. In the coming age of petroleum shortage, residual oil will certainly find large market since it will make cheapest sources of energy among hydrocarbon resources. Also it would be possible for oil producing nations to sell residual oil at relatively low price when their export-oriented refineries are competing each other.

C.O. : Decision making on construction of a petroleum refinery in Oman will be based on balancing advantages against disadvantages as shown below:

Advantages: Saving foreign currency to import petroleum products and insuring the national security in case of discontinuation of petroleum products supply through the Strait of Hormuz.

Disadvantages: Reduction in foreign currency earning due to reduced export of Omani crude oil and large investment involved.

The Government of Oman now contemplates stockpiling petroleum products but actual implementation of the plan is withheld since construction of a refinery will make an alternative for stockpiling. In view of the strategic consideration prevailing in Oman, construction of even a small-scale topping plant seems to be justified. The Gas Concil composed of the Ministry of Commerce and Industry and Ministry of

Agriculture, Fisheries, Petroleum and Minerals will have the final responsibility of the refinery project. In making decision on this matter, such factors as follows will be thoroughly reviewed and examined:

a. Future domestic demand for petroleum products
b. Optimal combination of output products and refining capacity
c. Estimated necessory importation of petroleum products if a proposed refinery could not meet all the domestic demand
d. Estimation of refinery investment and operation cost
e. Comparison refinery investment with stockpiling investment

11. Others

A.O. : Production of plastic water tanks has attracted much attention. We wonder if you examined possibility of manufacturing FRP (Fibre Reinforced Plastics) tanks.

A.J. : In the JICA report, we proposed production of polyethylene tanks with steel frame reinforcement which are inexpensive enough to be widely marketed in Oman. FRP tanks will be expensive and therefore will find small market.

Q.O. : There is a steel-rerolling project going in Oman and the project may be expanded so as to incorporate downstream processing such as wire drawing, nail and wire net manufacturing and so forth.

A.J. : We understand that initial production of rolled steels is planned to be 30,000 tons per year and most of the products are to be consumed in construction sector. Markets for other secondary products in Oman are expected to remain small and therefore production of wire rod is not strongly recommended for the time being. The JICA team did not looked into these markets in detail and will not have a plan to reexamine the project in future.

12. Results of Discussion

1) The Government of Oman wishes the Japanese Government to continue its technical cooperation in the following areas of detailed industrial project study:

a. Building materials
b. Petroleum refinery
c. Copper products
d. Plastic tanks

An official request in this regard will be sent to Japan through the normal diplomatic channel. The Government of Japan, on the receipt of the request, will decide which project(s) are to be further studied, considering situations in Oman and its own conditions including budget.

2) The Government of Oman will accept the invitation by JICA that two Omani experts be sent to Japan in order to deepen understanding and exchange views about the present study. Together with the abovementioned two experts, "other two" experts will also be sent to Japan for the same purpose at the expense of the Government of Oman.

ANNEX III

TERMS OF REFERENCE FOR THE JICA (Japan International Cooperation Agency) STUDY -- PREFEASIBILITY STUDY FOR INDUSTRIAL DEVELOPMENT IN OMAN

February, 1977

The general objectives of the study include the following:

1) Formulation of a comprehensive industrialization programme in Oman, in which preliminary identification of industrial projects is included.

2) Preliminary feasibility study of several selected projects, out of which some projects could be selected, after discussion with the Ministry of Commerce and Industry, for detailed feasibility study.

1. <u>Industrialization Programme for Oman</u>

1) Review of Socio-economic Development

(1) Natural Resources

Topography
Geology
Hydrocarbon
Minerals
Water

(2) Social Structure

Demography
Education

(3) Economic Development

Economic growth
Industrial development
Trade balance

(4) Financial Structure

Development finance
Financial organization

(5) Review of Infrastructure

Transportation

Electricity and energy

Water supply and sewage

Housing

2) Existing and Planned Industrialization

(1) Case studies of existing industries

(2) Planned industrial siting in Oman

3) Policies of Industrial Development

(1) Industrialization Policies

Foreign investment

Taxation and trade

Regional development and industrial area

(2) Investment Environment

Financial resources

Man power

Raw materials

Markets

Relationship with neighbouring countries

4) Recommendations on Industrialization Programme

(1) Identification of Targets of Industrialization

(2) Selection of Strategic Industries

(3) Identification of Sizes and Timing of Strategic Industry Development

Location

Production and investment sizes

Timing or time schedule

(4) Impacts of the Industrial Development on Macro-economy of Oman

5) Industrialization Programme

(1) Short-term

(2) Long-term

2. Prefeasibility Study on Selected Strategic Industrialization Projects

1) Bases of Selection

(1) Review of Selected Strategic Industries

(2) Market, Demand and Supply Balances

(3) Necessary Infrastructure

(4) Man Power and Supporting Industries

(5) Government's Incentives

2) Marble and Stone Cutting Industry*

(1) Review of Existing Industry

(2) Review of Conditions for Development

Stone resources

Markets

Technology and related industries

Transportation

(3) Preliminary Assessment of Feasibility

Production scale

Investment scale

(4) Possible Location

(5) Economic Impacts of Development

3) Ceramics Industry*

(1) Review of Existing Industries

(2) Review of Conditions for Development

Raw materials -- lime stone, gypsum, clay

Market evaluation

Technology and manpower

Infrastructure

(3) Preliminary Assessment of Feasibility

Products

Production scale

Investment scale

(4) Possible Location

(5) Economic Impacts of Development

4) Glass Industry*

(1) Review of Existing Industries

(2) Review of Conditions for Development

Raw materials -- silica sand, soda ash, lime stone

Markets

Technology and manpower

Energy and infrastructure

(3) Preliminary Assessment of Feasibility

Products

Production scale

Investment scale

(4) Possible Location

(5) Economic Impacts of Development

5) Copper-related Industries*

(1) Review of Copper Industry

(2) Review of Conditions for Development

Raw materials -- copper ore, refined copper

Markets

Production technology and manpower

(3) Preliminary Assessment of Feasibility

Products

Production scale

Investment scale

(4) Possible Location

(5) Economic Impacts of Development

6) Construction Materials Industry*

(1) Review of Existing Industries

(2) Review of Conditions for Development

Raw materials -- cement, aggregates, lime, clay, asbestos, steel bar

Markets, demand and supply

Technology and manpower

Infrastructure

(3) Preliminary Assessment of Feasibility

Products

Production scale

Investment scale

(4) Possible Location

(5) Economic Impacts of Development

7) Salt-related Industries*

(1) Existing and Future Desalination

(2) Review of Conditions for Development

Markets of salt products

Technology and manpwer

Electricity and other infrastructure

(3) Preliminary Assessment of Feasibility

Products

Production scale

Investment scale

(4) Possible Location

(5) Economic Impacts of Development

8) Modernization of Small Fishing Boats*

(1) Review of Coastal Fishing and Existing Modernization Programme

(2) Review of Conditions for Development

Development program of coastal fishing

Markets for fish and its products

Existing fishing boats

(3) Preliminary Assessment of Feasibility

Products

Production scale

Investment scale

(4) Economic Impacts of Development

9) Hydrocarbon-related Industries*

(1) Review of Existing Hydrocarbon Industries

(2) Review of Conditions for Development

Hydrocarbon resources

Markets for products
- Petroleum products
- Fertilizer
- Gas products

Infrastructure

(3) Preliminary Assessment of Feasibility
    Products
    Production scale
    Investment scale

(4) Possible Location

(5) Economic Impacts of Development

10) Other Selected Strategic Industries*

11) Recommendations on Feasibility Study
    (1) Identification of Projects for Feasibility Study

    (2) Formulation of Terms of Reference for Feasibility Study

NOTE: These industries are tentatively selected as a result of the discussion between the Ministry of Commerce and Industry (MOCI) and a representative of JICA made in October, 1977.