4.2. Socio-economic Conditions in the Study Area

4.2.1. Administrative Boundaries

The Study Area covers parts of five emirates, namely, Sharjah, Umm Al Qaiwain, Ras Al Khaimah, Ajman and Fujairah. Sharjah emirate occupies the largest area of the Study Area (Figure 4.2.1.).

Each town in the Study Area exists independently because there are usually large stretches of wasteland between towns. This means that there is no need to decide administrative borders because official services are normally for the people living in the town in question, and not for land.

There are 12 towns included in the Study Area, Falaj Al Mualla (Umm Al Qaiwain Emirate), Nasim (Ajman Emirate), Suhelah, Dhaid, Wishah, Hamdah, Khuderah, Mileiha, Ikhedir, Bahayis and Fili (Sharjah Emirate) and Kadrah (Ras Al Khaimah Emirate). The main towns are: Dhaid, Mileiha in SHJ; Falaj Al Mualla in UAQ. Fujairah Emirate does not have any towns in the Study Area, and occupies only a little waste land in the North-east part of the Study Area. Dhaid is the most important town in terms of regional economy.

4.2.2. People and Population

In the Study Area, from around 300 BC, there was already a settlement at Mileiha that was heavily influenced by the ancient Greeks, and where pottery from the island of Rhodes has been found. There are also some old forts and ruins in the Study Area. There is evidence that this area was already settled from prehistoric times.

The population of some major towns in and around the Study Area are as follows:

Town	Population			Relative Percentage (1975=100)		
	1975	1980	1985	1975	1980	1985
Dhaid	5,000	8,160	15,780	100	163	316
Falaj Al Mualla	630	1,680	2,850	100	267	452
Manamah	1,430	900	1980	100	63	138

Note ; Manamah (AJN) is outside the Study Area.

Both Dhaid and Falaj Al Mualla have higher growth rates, as shown in the above table. As compared with the figure in 1975, both towns had more than three times the

population by 1985. In Manamah, the population in 1980 was less than the figure for 1975, but it recovered in 1985. The recent population data, based on the 1990 census has not been published yet [The National Atlas of UAE, The UAE University(1993)].

According to some unofficial estimates made by the Ministry of Planning, the gender ratio and age structure of the population in the Study Area roughly follow the same structure as the one for the country. The male population is greater than the female. The population is concentrated in the 20-35 age bracket.

4.2.3. Economic Conditions

On economic terms, the Sharjah Emirate, which occupies the largest part of the Study Area, ranks third among the seven emirates. Its industrial production value in 1992 was Dh. 2,727,822 (thousand), of which 24% comes from the chemical and chemical products industry. Most of the industrial and commercial establishments are concentrated in coastal and urban areas for the convenience of transportation and marketing [Government of Sharjah; Statistical Yearbook 1994].

Agricultural production value in Sharjah (1992/93) is Dh. 517.4 million, with dates accounting for 33% and alfalfa accounting 30 % of total value. Total cultivated area was 7,848 ha in 1992/93, and the cultivated area in the Study Area was 5,493 ha. This implies that the Study Area occupies about 70 % of the total cultivated area of Sharjah Emirate [Government of Sharjah; Statistical Yearbook 1994, MAF Statistics Section].

The main economic activity in the Study Area is agriculture, utilizing ground-water for irrigation. Apart from agriculture, there are other activities like livestock raising, beekeeping, retail businesses, quarrying and manufacturing of building materials such as bricks. This means that skilled labor may be difficult to find for activities outside the agricultural sector. There are many quarrying yards in the Study Area, particularly along the wadis. Building materials manufactured in the area are mainly sun-dried bricks. There are some garment factories in Dhaid.

Both municipal and federal governments do some public works in the Study Area. At present, low-cost houses are being built at Mileiha (SHJ), Kadrah (RAK) etc. The above-mentioned construction of a dual carriageway between Dhaid and Mileiha is being carried out by the Sharjah Municipality.

Data obtained from Sharjah Chamber of Commerce & Industry shows that there are 479 shops in Dhaid as shown in Table 4.2.1 and 4.2.2. Of these, 100 shops are involved in agriculture, accounting for 20.9% of all business. According to the municipal office, there are about 150 shops in Falaj Al Mualla (UAQ). In Mileiha, there are 22 shops. Other towns and villages have fewer than 10 shops, and people in those towns sometimes have

to go to Dhaid or other big towns for shopping.

Local grocery stores sell local products, but during the summer season, when local production is low, imports substitute for local production. Almost all kinds of flour and other grains are imported.

4.2.4. Social Conditions and Infrastructure

(1) Local Government

In order to understand the daily lives of people in the Study Area from the view point of social aspects, the Study Team roughly made a provisional investigation on social and living conditions of each town or village.

At first, the Study Team collected data on existing social facilities in the Study Area from the concerned authorities. After that, the Study Team conducted a field survey directly to check the collected data for towns/villages that do not have any municipal office. For towns with a municipal office, both interviewing of municipality officers and field surveys were conducted. The Team sometimes interviewed residents in each town or village.

In the Study Area, there are three administrative municipal offices. Two of them belong to Sharjah Municipality, and are at Dhaid and Mileiha. The office at Mileiha is a branch of Dhaid Section, and the services are limited. The other one is at Falaj Al Mualla, which belongs to Umm Al Qaiwain Municipality. Neither Ajman Municipality nor Ras Al Khaimah Municipality has a municipal office in the Study Area (Figure 4.2.2.).

(2) Education

All education from kindergarten to university, is free for UAE people, but in the case of foreign children, only those whose parents work in government offices can receive free education. Basically, boys and girls are educated separately, except in kindergarten.

Based on the data obtained from the Ministry of Education and the field survey, there is a total of 16 public schools in the Study Area at present. Two of them are co-educated kindergartens. In addition to five Secondary schools (which comprise both primary and preparatory schools), there are six primary schools. There are three separate preparatory and secondary schools. There is no university in the Study Area (Table 4.2.3.).

Among the twelve towns and villages in the Study Area, Dhaid, Mileiha, Fili, Falaj Al Mualla and Kadrah have schools, but there are no schools in the other seven towns and villages.

In the Sharjah Emirate, there are ten schools, and six of them in Dhaid, namely one kindergarten (co-education, 4 classes, 108 pupils), three primary schools (2 boys schools, 18 classes, 529 pupils; 1 girls school, 19 classes, 543 pupils) and two preparatory &

secondary schools (1 boys school, 15 classes, 434 pupils; 1 girls school, 390 pupils). In the Study Area, Dhaid has the largest number of pupils, which means that almost half of pupils in the Study Area are educated there. Dhaid is also an important town from the viewpoint of education (Table 4.2.4.).

Town		Boys		Girls	
		Kindergarten & Primary Schools	Number of Pupils	Kindergarten & Primary Schools	Number of Pupils
Dhaid	SHJ	3	51-250X3	3	51-250X3
Falaj Al Mualla	UAQ	1	251-500	1	501-750
Mileiha	SHJ	1	51-250	0	
Fili	SHJ	1	1-50	1	1-50
Madam	SHJ	1	51-250	1	51-250
Kadrah	RAK	1	1-50	1	1-50
Manamah	AJN	0		1	51-250

Note * Madam and Manamah are outside the Study Area

Type and Town		Boys		Girls	
		Nos. of Schools	Nos. of Pupils	Nos. of Schools	Nos. of Pupils
Preparatory Schools					
Dhaid	SHJ 2	2	51 - 250 x 2	1	51 - 250
Falaj Al Mualla	UAQ	1	21 - 250	0	51 - 250
Mileiha	1	1	1 - 50	0	1 - 50
Madam	SHJ 1	1	51 - 250	1	1 - 50
Kadrah	SHJ 1	1	1 - 50	1	
Manamah	RAK 1 AJN 1	1	51 - 250	1	
Secondary Schools					
Dhaid		1	51 - 250	1	51 - 250
Falaj Al Mualla		1	1 - 50	1	1 - 50
Madam		1	51 - 250	1	51 - 250

Note; Madam and Manamah are outside the Study Area.

All students who live in Bahayis usually go to schools in Madam. Preparatory & secondary school students who live in Shuhela and Nasim also usually go to Manamah for their schooling. Most of students go to school by bus, which are provided by The Emirates General Transport & Services Corporation.

There are also some adult schools in Dhaid, Mileiha, Falaj Al Mualla and Madam. Around 330 people who could not get formal education in the past are now studying a curriculum almost as same as the ordinary school curriculum. More than half of the adult students are women, and they account for two-thirds of the student population overall (Table 4.2.5.)

(3)Water Supply

The Ministry of Water and Electricity provides tap water for all parts of the Study Area, except for Falaj Al Mualla. In Falaj Al Mualla, water supply is the responsibility of the municipality. Basically, the source of tap water is field wells, located in individual towns or villages. The pumps lift up well water to an elevated water tank, and is distributed to each house by gravity. Therefore the supply of water is not 24-hour because it depends on the capacity of wells and pumps (Table 4.2.6.).

According to the ministry, the fixed unit price of water is 15 (Dh/1000 gallons), but the actual unit price differs by town or village in the Study Area. Some people receive subsidy for tap water from local government. In UAQ, there are three unit prices. The price of 7.5 (Dh/1000 gallons) applies to UAE nationals, 15 (Dh/1000 gallons) applies to foreigners and 30 (Dh/1000 gallons) applies to the establishments. Neither the ministry nor municipality offers water supply for any farms, so the resident farm laborers can not receive tap water service. Usually, they use well water for their daily needs.

In UAE, there is a quality standard for unbottled drinking water, that is widely used among GCC countries. Some of the chemical element standards are stricter than the standards of WHO. According to the Ministry of Electricity and Water, they sometimes conduct water quality tests, but in some villages in the Study Area, there is some strongly salty water that could not be used for drinking, but only as shower or laundry water.

(4)Sewerage and Sanitation Service

The houses of UAE nationals have underground septic tanks. The waste water in the tank seems to percolate through soil to some extent. When the tank becomes full, municipal vacuum trucks drain them for a fee. At some farm laborers' houses on the farms, there are flush-type latrines.

Each municipality provides garbage and trash collection services for residential areas. Garbage collection cars gather garbage from cans periodically, and burn the garbage outside the town or village. The farm laborers can not receive this service, so they just throw away garbage and trash around and inside the farm.

(5)Electricity

The whole of the Study Area gets electricity from the Ministry of Water and Electricity. The ministry provides electrification for both households and farms. Nevertheless, most houses have air conditioners, the supply is quite stable, and there have been only a few black-outs in 1994 (Table 4.2.7.). The Study Area belongs to Central Area of Electricity Service Block. In this service area, there are five power stations (Table 4.2.8.). Among

them, three are located in the Study Area. Dhaid Power Station is the largest and supplies electricity out of the Study Area, too. Moreover, the reinforcement project for Dhaid Power Station is now in progress. The unit price for electricity is 7.5 (fils/KWh) for farm and UAE national resident people, 10 (fils/KWh) for governmental use and 15 (fils/KWh) for foreigners and industrial use (Table 4.2.9.).

There are about 6,800 consumers in Dhaid and 1,500 in Falaj Al Mualla. Every year, the number of consumers increases by 200 to 300 in Dhaid and 70 in Falaj Al Mualla. In Dhaid, about 29% of all (2,000) consumers are agricultural users. This figure is somewhat greater than the percentage of the whole area 4.3%. (Table 4.2.9.)

(6) Medical Services

According to Dhaid Section, Sharjah Municipality, Dhaid has a public hospital, a malarial clinic, seven private clinics and four veterinary clinics. Mileiha has a public clinic, too. In Falaj Al Mualla, UAQ, there is a clinic center, which is larger than a clinic but smaller than a hospital. In AJM, there is a governmental clinic in Manamah. There are no clinics nor hospitals in Kadrah, RAK. The medical center of the Study Area is Dhaid Hospital, which has 61 members of staff in 1993.

(7) Telephone and Mail Services

In the Study Area, there is a post office and ETISALAT (The Emirates Telecommunications Corporation) office at Dhaid. ETISALAT is the authority that provides telephone, telex and fax services. Telephone is a more popular communication method than the postal service, because of its convenience and the fact that it is free of charge within local areas, and people cannot receive mail at their own houses, though having a mailbox in the post office incurs a fee. The number of telephones in the Study Area has been increasing in recent years and there is a widening gap between the telephone service and the mail service. The number of workers at Dhaid Post Office has not changes for years. It is not unusual to use mobile telephones in the Study Area. The town of Manamah also has a post office, but does not have a ETISALAT office.

(8) Police and Fire Station

There are two police stations in the Study Area, one at Dhaid and the other at Falaj Al Mualla. In Manamah, Ajman, adjacent to the East of the Study Area, there is also a police station. Regarding the fire station, there is only one in the Study Area, in Dhaid. There is, however, another fire station located at Manamah. Those offices are under the management of the Ministry of the Interior.

(9) Cooking Fuel

Both UAE nationals and foreigners in the Study Area use gas cylinders, mainly butane gas, for cooking. Private companies such as Dubai-based EPPCO (Emirates Petroleum Products Company Ltd.), and Abu Dhabi-based ADNOC,(Abu Dhabi National Oil Company), supply them for all towns and villages. During the field survey, it was discovered that some farmhouses use electrical heaters.

(10) Transportation

There is no public transport system except for school buses. People usually use their own cars or private taxis. There are also some rent-a-car agents in Dhaid. The road that passes through the center of the Study Area east to west is quite well developed and most of the sections are paved dual carriageway. Another main road that runs north to south is also paved and a section of dual carriageway from Dhaid to Mileiha is now under construction. Other roads are mainly gravel roads.

4.3. Farm Survey

4.3.1. Farm Household Inventory Survey

(1) General

A farm inventory survey was conducted in the Study to get more precise information like general farm details, data on crops, orders fertilizer and pesticide, livestock, farm finances, farmers' future intentions, water use and wells. A subcontractor carried out this survey by conducting interviews. The number of interviewed farms were: 15 in Kadrah, RAK, 25 in Falaj Al Mualla, UAQ, 50 in both Dhaid-1 and Dhaid-2, SHJ, and 60 in Mileiha, SHJ. Among them, there were two invalid for supplying false data each in Al Dhaid I, Al Dhaid II, Mileiha and Falaj Al Mualla. Basically, the total available responses number 192.

(2) Farm Size and Land Tenure

The total area of the farms and area owned by farmers completely matches, indicating that there are no tenant farmers in the Study Area. The average total farm area is 55.33 donums and the average area available for cultivation is 49.53 donums, which accounts for 89.5% of the average of total area. The average cultivated area in each sub-area that is actual productive land for agriculture is 40.39 donums, but the average of each sub-area varies from 24 to 52 donums (Table 4.3.1.).

(3) Farm Owners and their Families

Based on the data obtained from general farm details, most owners are from Sharjah Emirate which occupies 34.9% of all interviewed farms. The second largest is Abu Dhabi Emirate, 22.9%, followed by Dubai Emirate, 18.2%, Ras Al Khaimah Emirate, 10.4% and Umm Al Qaiwain Emirate, 7.8%. There are two farms that have foreign owners, namely a Jordanian in Al Dhaid I and a Kuwaiti in Al Dhaid II (Table 4.3.2.).

Most owners are classified as side-job farmers who have another main job as their livelihood. Among 192 farms, there are only 16 full-time farmers, which represents merely 8.3%.

Much data concerning the owner's family is invalid, because most respondents were farm employees, not owners, and it is considered likely that the majority of them do not know much about their owner's family, especially children or babies, who live far from the farm. The average number of people in a farm owner's family, as calculated from 65 valid responses, is 9.5 persons. The figure consists of 4.6 adults and 4.9 children (Table 4.3.3.).

(4) Farm Employees

Usually, the day-to-day farm work is done by expatriates from countries such as Pakistan, Bangladesh, India, Egypt, and Sri Lanka. They usually live on the farm and simply obey their master's instructions.

In the Study Area, most employees are Pakistani, representing around 47.2% of the total surveyed, followed by Bangladeshis (26.6%), Indians (11.6%) and Egyptians (8.7%). In Falaj Al Mualla, Indian employees are predominant, but in the other four areas, Pakistanis predominate.

The mean number of farm employees is 3.5. The largest farm in Falaj Al Mualla, with 4.4 employees, while the smallest one is in Al Dhaid II, with 3.1 employees (Table 4.3.3.).

The average monthly salary for a farm employee is Dh. 830.5. The highest salary is found in Al Dhaid II, Dh. 881.2; on the other hand, the lowest of Dh. 786.5 is found in Mileiha.

Farm employees work 9.7 hr./day on average, but the average of each sub-area varies from 8.5 to 11.2 hr./day. The longest daily working period, 18hr./day, was in Mileiha (Table 4.3.4.).

4.3.2. Supplemental Farm Survey

(1) Survey on Farm Owners and Farm Labors

To collect precise information and reconfirm the results of the farm inventory survey conducted during the Field Survey (I), a supplemental interviewing survey was carried out by the Study Team. The respondents of the survey were farm owners who live or have their own farm in the Study Area. The number of respondents was only 11, which is 5.7% of the total number of the farms surveyed, because most farm owners have other, main jobs and it was hard to contact them. Each interview was conducted through a MAF extension officer, because fluency in the Arabic language is necessary for effective communication. The following issues were clarified through the survey:

- All respondents are merely side-job farmers whose main jobs are predominantly as federal or local government officers.
- The family size of respondents varies from 4 to 14, but there is only one owner who lives with his adult brothers, sisters and parents.
- The average family size is 8.2 persons; that is, 4.2 adults and 4.0 children.
- Except for one respondent, everyone has a domestic maid, and most of them are from Sri-Lanka.
- Most women are housewives, but buying food material is men's work.
- The average farmland area is 41.2 donums, which is almost same as the average

cultivated area of the farm inventory survey, 40.39 donums.

- Irrigation water shortage is the most serious issue or constraint facing modern farming.
- Most respondents are willing to pay irrigation water fees if the public irrigation system were to be established and the unit cost is fair. Behind these responses, there seems to be the most serious issue for them: water shortage.
- Marketing is also a serious issue for commercial farmers, because all of them have experienced wholesalers sometimes sell their products at a discount.
- Only four respondents wish to expand their farms. Others do not want to expand because of water shortages and marketing problems.

(2) Survey on Commercial Farms

As mentioned before, agriculture is the main economic activity in the Study Area; for this reason, it was important to have a deeper understanding of how commercial farms operate. To that effect, during Stage II, private commercial farms were visited; among those farms visited by the Study Team, MIRAK, is the most successful farm. It is worth going into details about this farm due to the insights that can be obtained.

a) Production

MIRAK has three farms in the Al Dhaid vicinity with a cultivation area of 40 ha. In the peak season, the working force is around 200 people, mostly expatriates.

Its annual production is approximately 3,000 tons of vegetables like strawberry, American lettuce, celery, sweet melon, tomatoes, and others. For strawberry alone, a yield of 500 tons is expected in 1995.

There are 22 wells with an average depth of 420 m (1,400 feet). With the exception of the main well, there is no salinity problem. However, it has been noted that the water table is decreasing and in some of the wells the amount of water obtained is half that of five years ago.

MIRAK do not receive any subsidy from the government and its production is characterized by the non-use of chemicals. It has its own nurseries for provision of seeds. Drip irrigation methods are used and the plant bed rows are covered with plastic sheet (mulching) in order to avoid using chemicals to control plagues and diseases.

b) Marketing

20% to 30% of total production is absorbed by the local market and the rest is exported to GCC countries, Southeast Asian countries such as Singapore, Japan, South Africa and some European countries.

It must be noted that recently the exports of strawberries and lettuce to South Africa and California, USA, increased due to bad production conditions in those countries. This has created a good opportunity to open new markets which have excellent potential. On the other hand, the difference in the strawberry production season between the UAE and other countries such as Spain has increased the demand in world markets.

MIRAK has faced two constraints which have had some impact on its growth: one is the increase of freight rates and the other is an increase in the energy cost. These factors decrease the competitiveness of local products vis-à-vis American and local products.

Five refrigerated trucks are used for transportation of the produce. Part of the produce is taken to local markets in Dubai and the remainder, to the port for export.

Concerning problems faced at the moment of opening markets for its products, MIRAK has mentioned that while European countries impose high custom duties ranging from 16% to 18% on some UAE products, the products from those countries are exempted from custom duties when they enter the UAE market. According to MIRAK management, a more balanced and fair international trade policy is required to facilitate the entry of its products in other countries and, at the same time, support the domestic agricultural industry from unequal foreign competition .

c) Comments

MIRAK was able to penetrate domestic and foreign markets due to the following reasons which also explain its commercial success: professional staff in charge of the whole management process (production and marketing); rational use of water resources; application of adequate technologies for planting, irrigation, and harvesting resulting in a good quality product; rational diversification of its production; good storage and transportation facilities; knowledge of the seasonality of competing products in foreign markets so therefore knowing when to introduce its own products; namely, when domestic production was not available in those markets.

4.4. Social Infrastructure Plan

In this Master plan, it is necessary to consider the improvement of the agricultural infrastructures such as embankments for flood control, road networks for agricultural production activities and shipping, and collecting and shipping facilities for the agricultural products, etc.

(1) Embankments for Flood Control

There is flood damage in the farmland near the wadis in the winter season which is one of the peak periods for farming activities. At present, embankments as a prevention against flooding are constructed using materials like surplus soil with high gravel content left over from surrounding farms at the time of land reclamation work. It is thought that flooding will be controlled with toe bund constructions and their maintenance will be the responsibility of each individual farm.

(2) Farm Road Net Work

There are three trunk roads with asphalt pavements that have access to the main consumption areas in the Study Area: Sharjah - Masafi road, Umm al Qaiwain - Mudam road, Manama - Ras Al Khaimah road.

The access road from trunk road to farm in the arid areas and wadi are unpaved. Some parts of these access roads are maintained by the local town office. During rainfall or flooding, these roads become almost impassable, but access is possible with a 4-wheel drive vehicle. As the Study Area is generally flat land with sand and gravel, improvement of the road network for agricultural development is not planned.

4.5. Institutional Plan

4.5.1. Governmental Subsidy

(1) Present Government Subsidy for Agriculture

Farm owners in the Study Area receive various kinds of subsidies from federal and local governments. In particular, the nationals who lived nomadic lives before and settled in the Study Area in accordance with national settlement policy receive more generous subsidies.

In the agriculture sector, MAF provided subsidies for the following:

- Designing farm (free)
- Land preparation (leveling, eliminating gravel, etc.) (free)
- Supervision of daily work (free)
- Fertilizer distribution
- Agro-chemicals distribution
- Distribution of agricultural materials (seeds, plastic cover, nets, pumps, etc.)

(2) Strengthening Governmental Agricultural Promotion

Several low priced vegetables are imported to UAE supported by governmental policies and agriculture in UAE is forced to compete with such imported foods. It is necessary to maintain the present governmental assistance system for agriculture in UAE considering sustainable agriculture is very limited by the natural conditions prevailing in the country. Technical and financial assistance for farmland reclamation and water-saving irrigation systems is also to be maintained and expanded. From the results of the inventory survey, as financial support on the farm for materials such as fertilizer is insufficient, it is necessary to increase the amount of financial support to the farmers.

4.5.2. Commercialization of Agriculture in the Study Area

Commercialization of agricultural products is carried out through the following channels: intermediaries; direct sales to wholesale markets; direct sales to local grocery shops.

Intermediaries

In the case of intermediaries, the farmers pack their products in wood crates, sacks, or cardboard boxes which vary in weight and dimensions depending on the product and specifications of the buyer. Less attention is paid to precise weighting. The farmers

usually transport the goods themselves, even though, in some cases, an intermediary provides the packing material, and sends his own trucks to pick up the produce from the farms. Price for products is fixed by the intermediary.

Direct sale to wholesale markets

Some farmers take their products to the wholesale market in Dubai. The farmer exhibits his products and sell them through an auction system. This helps to attract a large number of buyers who wish to purchase goods at a competitive price. The farmer will sell the products to the buyer who has offered the highest price. Therefore, price is determined by actual demand.

Direct sale to local grocery shops or direct commercialization

This implies a private contract between the farmer and a local grocery shop. In this case, the price is determined by mutual agreement. The farmer and the buyer establish a delivery schedule and the farmer takes care of transporting the produce to the shop.

In some cases, the farmers directly sell their produce to the public using the back of a truck or pick-up in which they brought their products. Price is set by demand and supply conditions at the moment of the sale.

The farmers in the Study Area showed interest in the idea of having a wholesale market where they could sell their products. So far, they feel that due to the lack of both formal and informal farmers associations, prices for their products are not as good as they would be if a wholesale market was available.

4.5.3. Collecting and Shipping Facilities for Agricultural Products

(1) Establishment of Marketing System and Organization

A lot of vegetables, fruit and food are imported without any tax to UAE from all over the world. Vegetables and fruit produced in UAE is forced to compete with those imported foods in price and quality. Regarding the price, present financial support from MAF should be continued. Concerning the quality, it is necessary to improve the marketing system for keeping the freshness.

In the present traditional agriculture in the Study Area, agricultural production is mainly self-consumption and the establishment of a marketing system and organization are indispensable for agricultural development. According to the production plan, as 50 tons/day of each vegetable is expected to be produced, and a maximum of 6 kinds of vegetables are harvested during the same period (see **Table 5.3.6**), a maximum of around 300 tons/day of vegetables will be shipped (80% of production will be shipped). Therefore, the organization, facilities and equipment such as trucks for collecting and

shipping will be required. As a maximum amount of 150 kg/day of vegetable shipping is expected from each farmer, , the notion of group shipping using 1 small truck for 5 or so farmers makes good sense.

(2) Vegetable Center (Collecting and Shipping Facilities for Agricultural Products)

At present, the average farm gate price is 70% of wholesale price. It will be more profitable for vegetable production to ship directly to market even after paying the necessary 10% commission. On the other hand, alfalfa is sold on a contract production system and present practice is expected to continue in the future. From the results of the farmers inventory survey, some farmers indicate that there is an unjust benefit enjoyed by brokers and the necessity for establishing a fair marketing system.

Considering the secured advantage on selling price, it is necessary to establish marketing facilities. The construction of a collecting center with collecting, selecting, cooling, storage and shipping facilities is planned at Al Dhaid. This center will be constructed by MAF and maintained by farmers as a cooperative organization under the supervision of MAF. The operating fee will be collected from the farmers in the form of a shipping commission.

(3) Manufacturing of Agricultural Products

Given the idea to increase value and to prevent over-production, the manufacturing of agricultural products is to be promoted. Cucumber is the second-highest profitable crop next to melon among the planned vegetables. As farmers fully intend to continue to cultivate cucumber, it is worthwhile considering that some cucumber be processed as pickles. The technology for the bottling and processing of cucumber is not difficult, and the costs of facilities are not high. Cucumber pickles is one of the main processed foods in UAE and is very popular in June to September, which is the fallow season. For tomato (juice, pure) and dates (drying, packing), as it is possible to add value without high technology and high costs for facilities, so again, the pickling and processing of agricultural products should be promoted.

4.5.4. Farmers' Organization

For the smooth and effective production and sale of large quantities of agricultural produce, it is necessary to establish a farmers' organization under the supervision of MAF and with the support of the extension officers. The main activities of such an organization would include the collaborative purchasing of agricultural equipment and merchandise (garden tractors, equipment for disease and pest control, materials for greenhouses and

irrigation, fertilizers, pesticides, etc.), installation of collecting and shipping facilities, group shipping, construction and operation of agricultural processing facilities, adjustment of cultivation plans, and supplying information on marketing and agricultural technology.

4.6. Project Economic Evaluation

4.6.1. Objective of Project Economic Evaluation

The objective of the present project evaluation is to assess the viability for implementation of the project from a financial point of view. It must be noted that due to the free-market policies applied by the UAE Government, it can be assumed that the price markets reflect the true scarcity of resources. In other words, market distortions can be assumed to be absent for relevant production and costs items. Therefore, an economic evaluation of the project shall not be carried out due to the reasons mentioned above.

It must be emphasized that the Project has great importance for the Study Area and for the country itself. From the point of view of the policy of "food security", it is necessary to create favorable conditions to alleviate the agricultural problems caused by a decrease in the amount of irrigation water in the Study Area. If agricultural production is affected in the future, under the present conditions of decreasing irrigation water levels, the food security of the country may be compromised. That is why the project could be said to be justified on a "priority" basis from the economic point of view.

4.6.2. Basic Concepts and Assumption of the Project Economic Evaluation

(1) General Concepts

a) The "With" and "Without-Project" Principle

A project impact can be defined as the difference between the "with" and "without-project" situations. This allows to see if the "net benefits" (understood as the difference of benefits and costs between those two situations) justify the project. The techniques to evaluate the worth of the net benefits will be discussed below:

b) Financial and Economic Efficiency Analyses

Financial analysis refers to the one concerned only with actual monetary flows from (cost) and to (return) specific individuals or groups of individuals within society (farmers, private firms, public organizations or institutions, and others). It deals only with those goods and services for people involved in the project. In other words, it deals with actual monetary payments incurred for labor, capital, and land. The analysis is performed from the point of a government agency, private firm, or individual, cooperative, etc.

Economic efficiency analysis is concerned with the costs and benefits to society as a whole, regardless of who pays and who gains. It deals with benefits measured in terms of what a society is actually willing to pay for goods and services, and costs in terms of the opportunity costs involved, that is, the values of the opportunities forgone when a

resource is used for one purpose rather than its next best use that actually would have occurred.

The economic efficiency analysis, as well as the financial analysis, seeks profitability, but it is profitability from society's point of view, which is related to the return society as a whole and can look at what can be obtained from given limited resources.

In economic analysis, market prices often are adjusted to more accurately reflect social or economic values. In other words, due to the existence of subsidies, taxes, tariffs, etc. or transfer payments in general among other causes, the markets prices do not necessarily reflect the demand and supply conditions which would prevail if there were not those factors mentioned above which distort market prices.

The adjustment of market prices into economic prices is usually denoted by shadow or accounting prices. When carrying out an economic evaluation, at the moment of valuing inputs and outputs, the shadow prices must be applied.

It must be noted that in the case of the UAE, the commitment of the government to a "free market" economy makes it possible to say that the divergence between the accounting or shadow prices and market prices is minimal.

(2) Basic Assessment Steps

There are four basic steps to be adopted:

- Step 1 : Identification and quantifying inputs and outputs

Physical inputs and outputs are identified; this means, what goods and services go into the project and what goods and services are produced by the project? This identification will be done for each separate component of the project; for example, construction work (dams, irrigation and marketing facilities), agricultural inputs and outputs, etc.

- Step 2: Valuing inputs and outputs

Unit value tables for inputs and outputs will be developed giving due consideration to trends in prices and forecasts or projections of future prices. Most of the inputs and outputs included in the financial analysis will also be represented by similar ones in the economic accounts.

However, as explained above, market prices do not necessarily reflect the social costs or benefits of the project. Therefore, it is necessary to transform the market prices into economic prices by means of the "shadow prices".

- **Step 3: Performing the Analysis**

Comparison of costs and benefits will be made in various ways to assess the profitability of the project from the financial and economic points of view. Two common measures for looking at financial and economic efficiency are the net present value (NPV) and the Internal Rate of Return (IRR). These measures are used for both economic and financial analyses.

- **Step 4: Sensitivity Analysis**

As the project is carried out over an usually long period, uncertainty about inputs and outputs is inherent to any project. In order to see how the sensitivity analysis evaluates how sensitive are the NPV and IRR to changes in assumptions concerning inputs and outputs and the values attached to them. A decision maker, taking into consideration the results of the sensitivity analysis, can decide then to take or not the risk of implementing the project.

(3) Discounting Formula

In order to be able to compare costs and benefits (net benefit or cost) taking place in different years, it is necessary to apply an adjustment factor to future net costs/benefits values that reflect their present value. The adjustment factor is derived from the accepted time value of money; and is commonly called the discount rate. The adjustment process is called discounting. Present value is the resulting adjusted value.

For financial analysis, the going rate of interest is the one use for the disuniting process.

For economic efficiency analysis, the discount rate is provided by a central planning unit, i.e., a national planning office; in case that is not available, a rate between 8 or 10 percent is recommended.

(4) Measures of Financial and Economic Efficiency

Two indicators of project worth will be used at the moment of performing the financial and economic evaluation: the net present value (NPV) and internal rate of return (IRR). These measures are interrelated since all are derived from the same basic data, namely, the project's costs and benefits. These measures are neutral in value, and can be calculated for both financial and economic analyses.

In general, it can be said that in financial and economic efficiency terms any project that provides a positive NPV is an efficient use of the resources involved, assuming that each separable component of the project also has a NPV > 0 and the project is the least cost means of achieving the particular benefits. Implementation depends on the total budget

available, however, and the NPV associated with other projects on which the budget could be spent.

A project for which the estimated NPV is negative is not economically acceptable. The negative NPV indicates that there are better uses for the resources involved in the project.

(5) Internal Rate of Return

The internal rate of return is that rate which makes the NPV equal to zero; it is the implied discount rate that would make the present value of project benefits equal the present value of project costs. It is essentially a break-even discount rate in the sense that the present value of benefits equals the present value of costs.

More specifically, it is the average rate of return on the invested funds outstanding per period while they are invested in the project, or that rate of interest which makes the NPV equal to zero.

It must be noted that when NPV = zero, then the IRR = i.

(6) Project Economic Evaluation in the Study

For the present project, the methodology applied for evaluation consists in identifying and valuing the project costs and benefits that will arise with the project, under the two Development Options mentioned in previous chapters, and to compare them with the situation as it would be without the project. Once financial pricing, or pricing carried out at market prices has been established for both project costs and benefits, cash flow consisting of these costs and benefits will be prepared to cover the whole project life and on the basis of this cash flow the internal rate of return (IRR) that set the discounted net benefit stream (discounted benefits minus discounted costs) equal to zero. This project is considered acceptable if the IRR exceeds the opportunity cost of capital in the UAE. For practical purposes, the cost is considered to be 5% as this rate is the rate charged by commercial banks for their loans.

After determining the total project cost, a financial analysis will be made taking into consideration financing sources, that is, foreign loan and governments budget, and the implications at the moment of contracting the loan.

Since costs and benefits of the project at the implementation phase are subject to increase/decrease due to fluctuation in yield, prices and other parameters due to the change of project circumstances from the time of project evaluation for the feasibility study to actual commissioning, a sensitivity test is conducted to find out what parameters

have the strongest effect on the project for a given percentage variation (increase in construction and O/M cost, decrease in yield, and extension of construction period).

4.6.3. Costs and Benefits of the Project

(1) Costs of the Project

The costs of the project, which are subject to project evaluation, shall consist of the initial investment, operation and maintenance costs and replacement costs.

a) Initial investment Costs

Initial investment costs of the Project are composed of the following items:

- Construction works for recharge dam and trench, irrigation facilities
- Construction works for water source facilities, such as wells and pumping system at farm level
- Construction of irrigation facilities
- Installation of greenhouses
- General administration costs (Considered to be 2% of the cost of construction work)
- Consulting services
- Physical Contingencies (Considered to be 10% of maximum construction works cost plus administration cost)
- Price Contingencies (Considered to be 9% of maximum construction works plus administration cost plus consulting services)

The project total costs are shown in Tables 4.6.1. and 4.6.2. The disbursement schedule of the Project cost is shown in Tables 4.6.3. and 4.6.4.

b) Operation and maintenance costs

Annual operation and maintenance costs of the Project include the operation and maintenance costs of irrigation facilities and groundwater strengthening facilities.

In Option-2, US$ 1.27/m^3, which is UAE government official unit price for desalinated sea water was applied as the purchasing unit price.

c) Replacement Costs

Replacement costs of the Project include costs of replacement of facilities, structures and machinery in accordance with their lifespan.

(2) Benefits of the Project

Increase of agricultural production and profits with irrigation improvement and introduction of the highly profitable crops are all considered to be benefits of the project. In the evaluation, 85% of market price is considered as the farm gate price, considering transportation costs and administrative commission. The annual net benefits of the project for Option 1 is estimated to be US$ 61.3 million and US$ 125.1 million for Option 2. Decrease in agricultural production caused by reduction of irrigation water in quantity and quality without the project have also been considered, as has balance of the net return for the whole development area between With project situation and Without project situation.

4.6.4. Financial Evaluation

Tables 4.6.5. and 4.6.6 show the calculations for the income resulting under the Without-Project scenario. The following assumptions have been adopted:

Available water volume for agricultural purposes decreases following the pattern shown in the simulation model. It is supposed that water decrease from the year 1997 to 2014 will be in a constant and linear manner; therefore, cultivated areas will also decrease, as will income levels. From the year 2015 it is assumed that the water level available for agricultural purposes will stabilize and, as a consequence, income levels will also do so.
Considering the lifespan of the recharge dam, the project is deemed to have 50 years of life after commencement of service.
The project is expected to yield benefits within 5 years of completion of the recharge dam and trench constructions.
The calculation was done based on US$ currency (exchange rate US$ 1 = Dh. 3.6)

Given the conditions mentioned above, the financial internal rate of return was calculated as below:

Option	Internal rate of return
Option-1	6.50 %
Option-2	0.44 %

Judging from this result, IRR for Option 1 is cleared by the evaluation criteria set out before but IRR for Option 2 is less than 5 %. By comparing the two IRRs, it is possible to say that Option 1 is the more attractive.

4.6.5 Sensitive Analysis

Based on the results of the evaluation mentioned above, sensitive analysis was carried out as shown in Table 4.6.7.,4.6.8. And 4.6.9. The results are summarized below:

Case	Condition	Internal Ratio of Return
1	Project cost is escalated by 10%	5.02 %
2	Completion of construction works is delayed by 1 years	6.45 %
3	Production declined by 10%	5.06 %

4.6.6. Financing Plan

It is assumed that from the point of view of financial sources, two-thirds (2/3) of the initial investment costs will be financed by a loan and one-third by the government. (The government also will cover the O/M costs and replacement costs under the heading of government subsidy).

- Interest : 3% per annum
- Repayment term: 20 years (grace period: 10 years)

the maximum amount to be repaid shall be US$ 161 million by year 2005, which amount is equivalent to 5 times of annual budget of MAF(Table 4.6.10.).

4.6.7. Conclusions

The project is attractive not only because of to the profitability shown above, but also for the impact on water resources availability and their rationalization. It must be mentioned that this rational use of water comes accompanied by an expected increase in income levels which in turn could be a dynamic factor for the study area economy, increasing the possibilities of employment and the potential for post-harvest processing.

As economic conditions improve, the absentee landowner could be motivated to pay more attention to the farm, not only as a weekend place of leisure but also as a potential hotbed of economic activity.

Table 4.1.1. Economic Variables

(Unit : Dh X10⁶ at current prices)

ECONOMIC VARIABLES	Years					Growth Rates			
	1990	1991	1992	1993	1994	1990 91	1991 92	1992 93	1993 94
- Population (X10³)	1,844	1,909	2,011	2,083	2,230	3%	5%	4%	7%
-Workers (X10³)	694	738	799	856	907	6%	8%	7%	6%
-Gross Domestic Product	125,266	126,261	131,676	130,972	134,813	1%	4%	-1%	3%
-National Income	105,984	105,660	108,329	105,734	129,663	0%	3%	-2%	23%
- Disposable Income	98,822	88,079	105,974	102,781	108,343	-11%	20%	-3%	5%
- National Saving	31,985	15,572	25,261	15,441	9,450	-51%	62%	-39%	-39%
- Final Consumption Expenditure	66,837	72,507	80,713	87,343	95,793	8%	11%	8%	10%
a) Government Final Consumption	20,120	21,131	22,792	23,550	24,520	5%	8%	3%	4%
b) Private Final Consumption	46,717	51,376	57,921	63,793	71,273	10%	13%	10%	12%
- Gross Fixed Capital Formation (GFCF)	24,064	25,790	29,802	33,219	33,760	7%	16%	11%	2%
a) GFCF Government Sector	5,139	6,378	9,511	12,631	12,700	24%	49%	33%	1%
b) GFCF Private Sector	18,925	19,412	20,291	20,588	21,060	3%	5%	1%	2%
- Total Imports	42,510	51,104	64,328	72,495	80,400	20%	26%	13%	11%
- Total Exports	79,678	81,806	88,940	86,267	89,050	3%	9%	-3%	3%
- Surplus of Merchandise Trade	37,168	30,702	24,612	13,772	8,650	-17%	-20%	-44%	-37%
- Imports (Excluding Re-exports)	29,760	25,773	43,328	48,572	52,400	-13%	68%	12%	8%
- Current Surplus of Payments Balance	22,926	6,021	12,980	762	-4,690	-74%	116%	-94%	-715%
- Wages and Salaries	28,019	29,883	31,907	34,183	35,258	7%	7%	7%	3%
- General Consumer Price Index Numbers (1985=100)	109.4	115.4	123.6	127.8	135.0	6.0	8.2	4.2	7.2

Source : 1990-1993 :National Accounts for U.A.E. 1988-1993, Ministry of Planning
1994 : Annual Economic Report 1994, Ministry of Planning

Table 4.1.2. Economic Indicators per Capita

(Unit : Dh X10³ at current prices)

ECONOMIC VARIABLES	Year					Growth Rates			
	1990	1991	1992	1993	1994	1990 91	1991/92	1992/93	1993 94
-Gross Domestic Product	67.9	66.1	65.5	62.9	60.5	-2.7%	-0.9%	-4.0%	-3.8%
-National Income	57.5	55.4	53.9	50.7	48.6	-3.7%	-2.7%	-5.9%	-4.1%
- Disposable Income	53.6	46.1	52.7	49.3	47.2	-14.0%	14.3%	-6.5%	-4.3%
- Final Consumption Expenditure	36.2	38.0	40.1	41.9	43.0	5.0%	5.5%	4.5%	2.6%
a) Government Final Consumption	10.9	11.1	11.3	11.3	11.0	1.8%	1.8%	0.0%	-2.7%
b) Private Final Consumption	25.3	26.9	28.8	30.6	32.0	6.3%	7.1%	6.3%	4.6%
- National Saving	17.4	8.1	12.6	7.4	4.2	-53.4%	55.6%	-41.3%	-43.2%
- Gross Fixed Capital Formation (GFCF)	13.1	13.5	14.8	16.0	15.1	3.1%	9.6%	8.1%	-5.6%
a) GFCF Government Sector	2.8	3.3	4.7	6.1	5.7	17.9%	42.4%	29.8%	-6.6%
b) GFCF Private Sector	10.3	10.2	10.1	9.9	9.4	-1.0%	-1.0%	-2.0%	-5.1%
- Total Imports (Excluding Re-exports)	16.1	18.7	21.5	23.3	23.5	16.1%	15.0%	8.4%	0.9%
- Total Exports	43.2	42.9	44.2	41.4	40.0	-0.7%	3.0%	-6.3%	-3.4%
- General Average of Wages	35.0	34.8	34.7	35.0	34.7	-0.6%	-0.3%	0.9%	-0.9%
- General Average of Labour Productivity	84.2	84.4	84.5	84.9	85.7	0.2%	0.1%	0.5%	0.9%

Source : 1990-1993 :National Accounts for U.A.E. 1988-1993, Ministry of Planning
1994 : Annual Economic Report 1994, Ministry of Planning

Table 4.1.3. Gross Domestic Product at Factor Cost by Economic Sectors

(Unit : Dh.X10⁶ at current prices)

SECTORS	Year					Growth Rates				Share in Total				
	1990	1991	1992	1993	1994	1990/91	1991/92	1992/93	1993/94	1990	1991	1992	1993	1994
- Agriculture, Livestock and Fishing	2,056	2,563	2,865	3,156	3,404	24.66%	11.78%	10.16%	7.86%	1.64%	2.03%	2.18%	2.41%	2.52%
- Mining and Quarrying														
a) Crude Oil	57,632	54,260	53,753	47,104	45,038	-5.85%	-0.93%	-12.37%	-4.39%	46.01%	42.97%	40.82%	35.96%	33.41%
b) Others	307	332	355	389	420	8.14%	6.93%	9.58%	7.97%	0.25%	0.26%	0.27%	0.30%	0.31%
- Manufacturing	9,701	9,770	10,502	10,600	11,158	0.71%	7.49%	0.93%	5.26%	7.74%	7.74%	7.98%	8.09%	8.28%
- Electricity and Water	2,461	2,700	2,888	2,966	3,100	9.71%	6.96%	2.70%	4.52%	1.96%	2.14%	2.19%	2.26%	2.30%
- Construction	9,687	10,365	11,085	12,200	13,210	7.00%	6.95%	10.06%	8.28%	7.73%	8.21%	8.42%	9.31%	9.80%
- Wholesale, Retail Trade, Restaurants, and Hotels	11,237	11,943	13,310	14,005	14,866	6.28%	11.45%	5.22%	6.15%	8.97%	9.46%	10.11%	10.69%	11.03%
-Transports, Storage and Communication	6,211	6,711	7,263	7,923	8,532	8.05%	8.23%	9.09%	7.69%	4.96%	5.32%	5.52%	6.05%	6.33%
- Finance, Insurance and Real Estate														
a) Finance and Insurance	5,126	5,488	5,604	6,335	6,851	7.06%	2.11%	13.04%	8.15%	4.09%	4.35%	4.26%	4.84%	5.08%
b) Real Estate	6,864	7,440	8,180	9,088	9,980	8.39%	9.95%	11.10%	9.82%	5.48%	5.89%	6.21%	6.94%	7.40%
- Other Services	2,467	2,689	2,953	3,280	3,535	9.00%	9.82%	11.07%	7.77%	1.97%	2.13%	2.24%	2.50%	2.62%
Less - Imputed Bank Services	-1,950	-2,182	-2,200	-2,304	-2,491	11.90%	0.82%	4.73%	8.12%					
- Producers of Government Services	12,968	13,634	14,418	15,385	16,280	5.14%	5.75%	6.71%	5.82%	10.35%	10.80%	10.95%	11.75%	12.08%
- Domestic Services of Households	499	551	700	845	930	10.42%	27.04%	20.71%	10.06%	0.40%	0.44%	0.53%	0.65%	0.69%
Total	125,266	126,264	131,676	130,972	134,813	0.80%	4.29%	-0.53%	2.93%	100.00%	100.00%	100.00%	100.00%	100.00%
Oil Sector	57,632	54,260	53,753	47,104	45,038	-6%	-1%	-12%	-4.39%	46.01%	42.97%	40.82%	35.96%	33.41%
Non-oil Sector	67,634	72,004	77,923	83,868	89,775	6%	8%	8%	7.04%	53.99%	57.03%	59.18%	64.04%	66.59%

Source : 1990-1993 :National Accounts for U.A.E. 1988-1993, Ministry of Planning
1994 : Annual Economic Report 1994, Ministry of Planning

Table 4.1.4. Public Revenues and Expenditures

(Unit : Dh.X10⁶ at current prices)

Items	Year			Growth Rate	
	1991	1992	1993	1991/92	1992/93
Crude Oil Revenues	38,919	36,507	31,314	-6%	-14%
Other Revenues	8,886	10,895	7,856	23%	-28%
Total Public Revenues	47,805	47,402	39,170	-1%	-17%
Total Public Expenditure	56,509	45,735	45,206	-19%	-1%
Final Surplus or Deficit	-8,704	1,667	-6,036		

Source : Annual Economic Report 1994, Ministry of Planning

Table 4.1.5. Trade Balance Statistics

(Unit : Dh.X10⁶ at current prices)

EXPORT ITEMS	Year				Growth Rate			Share of Items			
	1990	1991	1992	1993	1990/91	1991/92	1992/93	1990	1991	1992	1993
0 - Crude oil	54,455	52,762	52,309	46,016	-3.1%	-0.9%	-12.0%	68.3%	64.5%	58.8%	53.3%
1 - Gas	4,403	4,513	4,976	4,800	2.5%	10.3%	-3.5%	5.5%	5.5%	5.6%	5.6%
2 - Oil products	4,400	4,086	4,425	4,387	-7.1%	8.3%	-0.9%	5.5%	5.0%	5.0%	5.1%
3 - Other exports	3,670	5,114	6,231	7,141	39.3%	21.8%	14.6%	4.6%	6.3%	7.0%	8.3%
4 - Re-export	12,750	15,331	21,000	23,923	20.2%	37.0%	13.9%	16.0%	18.7%	23.6%	27.7%
Total Commodity Exports (FOB)	79,678	81,806	88,941	86,267	2.7%	8.7%	-3.0%	100.0%	100.0%	100.0%	100.0%
IMPORT ITEMS	Year				Growth Rate			Share of Items			
	1990	1991	1992	1993	1990/91	1991/92	1992/93	1990	1991	1992	1993
0 - Food and Livestock	5,530	5,569	6,422	7,060	0.7%	15.3%	9.9%	13.0%	10.9%	10.0%	9.7%
1 - Beverages and Tobacco	447	479	588	702	7.2%	22.8%	19.4%	1.1%	0.9%	0.9%	1.0%
2 - Crude materials except fuels	960	1,180	1,077	1,146	22.9%	-8.7%	6.4%	2.3%	2.3%	1.7%	1.6%
3 - Mineral's fuel lubricants and related materials	1,347	1,056	945	1,005	-21.6%	-10.5%	6.3%	3.2%	2.1%	1.5%	1.4%
4 - Animal and vegetable oils and fats	132	245	214	220	85.6%	-12.7%	2.8%	0.3%	0.5%	0.3%	0.3%
5 - Chemicals	3,055	3,463	4,067	4,404	13.4%	17.4%	8.3%	7.2%	6.8%	6.3%	6.1%
6 - Manufactured goods	10,388	12,629	15,946	18,012	21.6%	26.3%	13.0%	24.4%	24.7%	24.8%	24.8%
7 - Machinery and transport equipments	13,563	17,658	24,284	27,860	30.2%	37.5%	14.7%	31.9%	34.6%	37.8%	38.4%
8 - Miscellaneous manufactured goods	6,803	8,587	10,558	11,851	26.2%	23.0%	12.2%	16.0%	16.8%	16.4%	16.3%
9 - Non-classified transactions	285	238	227	235	-16.5%	-4.6%	3.5%	0.7%	0.5%	0.4%	0.3%
Total Commodity Imports (CIF)	42,510	51,104	64,328	72,495	20.2%	25.9%	12.7%	100.0%	100.0%	100.0%	100.0%
TRADE BALANCE	37,168	30,702	24,613	13,772							

Source : Annual Economic Report 1994, Ministry of Planning

Table 4.1.6. Workers by Emirates

Emirates	Year					Growth Rates				Participation in Total				
	1990	1991	1992	1993	1994	1990/91	1991/92	1992/93	1993/94	1990	1991	1992	1993	1994
Abu Dhabi	289,171	311,680	333,666	355,944	n.a	7.78%	7.05%	6.68%	--	41.65%	42.25%	41.74%	41.58%	--
Dubai	205,558	215,102	233,103	252,505	n.a	4.64%	8.37%	8.32%	--	29.61%	29.16%	29.16%	29.49%	--
Sharjah	101,055	105,602	118,556	127,092	n.a	4.50%	12.27%	7.20%	--	14.56%	14.32%	14.83%	14.85%	--
Ajman	18,690	20,125	22,471	24,163	n.a	7.68%	11.66%	7.53%	--	2.69%	2.73%	2.81%	2.82%	--
Umm Al-Quwain	9,618	10,502	11,288	12,201	n.a	9.19%	7.48%	8.09%	--	1.39%	1.42%	1.41%	1.43%	--
Ras Al-Khaimah	47,483	49,753	53,653	56,045	n.a	4.78%	7.84%	4.46%	--	6.84%	6.74%	6.71%	6.55%	--
Fujeirah	22,681	24,926	26,690	28,154	n.a	9.90%	7.08%	5.49%	--	3.27%	3.38%	3.34%	3.29%	--
Total	694,256	737,690	799,427	856,104	906,580	6.26%	8.37%	7.09%	5.90%	100.00%	100.00%	100.00%	100.00%	100.00%

Source : 1990-1993 :National Accounts for UAE, 1988-1993, Ministry of Planning
1994 : Annual Economic Report 1994, Ministry of Planning

Table 4.1.7. Workers by Economic Sectors

SECTORS	Year					Growth Rates				Share in Total				
	1990	1991	1992	1993	1994	1990/91	1991/92	1992/93	1993/94	1990	1991	1992	1993	1994
- Agriculture, Livestock and Fishery	43,296	57,733	59,627	63,964	66,850	33.34%	3.28%	7.27%	4.51%	6.24%	7.83%	7.46%	7.47%	7.37%
- Mining and Quarrying														
a) Crude Oil	7,880	8,280	8,420	8,870	9,390	5.08%	1.69%	5.34%	5.86%	1.14%	1.12%	1.05%	1.04%	1.04%
b) Others	2,150	2,400	2,624	2,800	3,008	11.63%	9.33%	6.71%	7.43%	0.31%	0.33%	0.33%	0.33%	0.33%
- Manufacturing	66,530	67,250	81,160	85,590	89,972	1.08%	20.68%	5.46%	5.12%	9.58%	9.12%	10.15%	10.00%	9.92%
- Electricity and Water	20,678	20,762	21,078	22,130	22,915	0.41%	1.52%	4.99%	3.55%	2.98%	2.81%	2.64%	2.58%	2.53%
- Construction	119,230	126,245	133,350	140,100	147,150	5.88%	5.63%	5.06%	5.03%	17.18%	17.11%	16.68%	16.36%	16.23%
- Wholesale, Retail Trade, Restaurants, and Hotels	101,370	104,817	110,921	116,946	122,878	3.40%	5.82%	5.43%	5.07%	0.00% 14.60%	0.00% 14.21%	0.00% 13.88%	0.00% 13.66%	0.00% 13.55%
-Transports, Storage and Communication	72,047	75,223	78,145	82,323	86,610	4.41%	3.88%	5.35%	5.21%	10.38%	10.20%	9.78%	9.62%	9.55%
- Finance, Insurance and Real Estate										0.00%	0.00%	0.00%	0.00%	0.00%
a) Finance and Insurance	16,061	16,699	16,609	16,488	16,998	3.97%	-0.54%	-0.73%	3.09%	2.31%	2.26%	2.08%	1.93%	1.87%
b) Real Estate	3,100	3,325	3,470	3,610	4,013	7.26%	4.36%	4.03%	11.16%	0.45%	0.45%	0.43%	0.42%	0.44%
- Other Services	78,141	85,166	93,683	103,050	111,100	8.99%	10.00%	10.00%	7.81%	11.26%	11.54%	11.72%	12.04%	12.25%
- Producers of Government Services	114,161	115,688	122,370	129,149	135,436	1.34%	5.78%	5.54%	4.87%	16.44%	15.68%	15.31%	15.09%	14.94%
- Domestic Services of Households	49,557	54,122	67,970	81,084	90,260	9.21%	25.59%	19.29%	11.32%	7.14%	7.34%	8.50%	9.47%	9.96%
Total	694,201	737,710	799,427	856,104	906,580	6.27%	8.37%	7.09%	5.90%	100.00%	100.00%	100.00%	100.00%	100.00%

Source : 1990-1993 :National Accounts for U.A.E. 1988-1993, Ministry of Planning
1994 : Annual Economic Report 1994, Ministry of Planning

Table 4.2.1. Number of Shops in Dhaid, Wishah, Mileiha and Fili

Kind of Shops	Al Dhaid	Wishah	Mileiha	Fili	Total
Agriculture Related Shops (a)	100	2	4	2	108
Agri. Materials TR.	12	0	0	0	12
Agri. Products	1	0	0	0	1
Agri. Tools & Equip. TR.	7	0	0	0	7
Cotton	1	0	0	0	1
Sugar & Nuts TR.	1	0	0	0	1
Fooders & Grains TR.	34	1	1	1	37
Fruits & Vegetables TR.	25	0	2	1	28
Honey & Bee Hives TR.	5	0	0	0	5
Livestock TR.	1	1	1	0	3
Poultry	0	0	0	0	0
Poultry Cleaning & Selling	1	0	0	0	1
Nurseries & Flowers	2	0	0	0	2
Veterinary & Tools TR.	3	0	0	0	3
Irrigation Cont.	1	0	0	0	1
Water Pumps TR.	4	0	0	0	4
Water Well Drilling	2	0	0	0	2
Car & Spare Parts TR.	24	0	2	0	26
Motorcycle & Bicycle	3	0	0	0	3
Bldg. Cont. G	11	0	2	1	14
House Holds TR.	50	0	1	0	51
Domestic Pets TR.	2	0	0	0	2
Electronics TR.	22	0	1	0	23
Grocery	93	5	9	0	107
Fuel & Gas TR.	14	0	2	2	18
Garment	58	0	0	0	58
Jewel & Watch TR.	7	0	0	0	7
Pharmacy	5	0	0	1	6
Supermarket	40	0	1	4	45
Masonry Cont.	4	0	0	0	4
Textile TR.	12	0	0	0	12
Others	34	0	0	0	34
Total	479	7	22	10	518
Percentage of (a)	20.9%	28.6%	18.2%	20.0%	20.8%

Source : Sharjah Chamber of Commerce & Industry

Table 4.2.2. List of Non-Agricultural Farms

NAME	ACTIVITY	PROD. VALUE (Dh.)	Nr.WORKERS	TOTAL SALARIES (Dh.)
Dafco Concrete Production	Concrete manufacturers	2,970,128	54	350,519
Sowidy Crusher Co.	Crusher	n.d	26	348,000
Zaraoni Block Manufacture	Concrecte blocks manufacturer	150,000	5	60,000
Airport Block Manuf.	Concrecte blocks manufacturer	30,000	2	24,000
Stiglal Block	Concrecte blocks manufacturer	273,000	4	48,000
Shereen Decoration	Decoration	New	New	New
Shariff Agricultural Engineering	Agricultural equipment and servic	241,338	3	24,000
New Ramlah Bakery	Bakery products	260,000	5	120,000
Al Dhaid Water and Refreshment	Water and refreshement	8,000,000	30	700,000
International Clothes Manufacturer	Ready-to-wear clothes	17,738,019	345	3,173,648
Al Dhaid Tee-shirts	T-shirts	3,177,652	65	476,213
Salem Shaid Steel works	Steel works	40,000	3	28,000
Wadi Al Dhaid Steel works	Steel works	48,000	1	18,000
New Safa Steel works	Steel works	300,000	2	36,000
Al Woodian Steel work	Steel works	36,000	2	12,000
Baghad Steel work	Steel works	24,000	3	30,000
Al Wofak Steel work	Steel works	36,000	2	13,200
Al Sharif Carpenter	Carpentry	180,000	5	60,000
Al Sari Carpenter	Carpentry	120,000	4	60,000

Data source: Economic Department of Sharja

Table 4.2.3. Present Public Schools in the Study Area

Type		SHJ			UAQ	RAK	Total	Share(%)
		Dhaid	Mileiha	Fili	Falaj Al Mualla	Kadrah		
Kindergarten	(Co-ed.)	1	0	0	1	0	2	12.5%
Primary school	(Male)	2	0	1	1	0	4	25.0%
	(Female)	1	0	1	0	0	2	12.5%
Primary + Preparatory	(Male)	0	1	0	0	1	2	12.5%
& Secondary school	(Female)	0	1	0	1	1	3	18.8%
Preparatory	(Male)	1	0	0	1	0	2	12.5%
& Secondary school	(Female)	1	0	0	0	0	1	6.3%
Total		6	2	2	4	2	16	100.0%
Share(%)		37.5%	12.5%	12.5%	25.0%	12.5%	100.0%	

Source : Ministry of Education

Table 4.2.4. Number of Classes and Students in the Study Area (1993/94)(1/3)

Sex	Type	Nationality	Kindergarten 1 Nos.of class	Kindergarten 1 Nos.of studen	Kindergarten 2 Nos.of class	Kindergarten 2 Nos.of studen	Kindergarten Total Nos.of class	Kindergarten Total Nos.of studen	Primary 1 Nos.of class	Primary 1 Nos.of studen	Primary 2 Nos.of class	Primary 2 Nos.of studen	Primary 3 Nos.of class	Primary 3 Nos.of studen	Primary 4 Nos.of class	Primary 4 Nos.of studen	Primary 5 Nos.of class	Primary 5 Nos.of studen	Primary 6 Nos.of class	Primary 6 Nos.of studen	Primary Total Nos.of class	Primary Total Nos.of studen
Dhaid																						
Male	Kindergarten	U.A.E.national		16		28		44														
		Foreigners																				
		Total	2	16	2	28	4	44														
Female	Kindergarten	U.A.E.national		21		43		64														
		Foreigners																				
		Total		21		43		64														
Male	Prim.	U.A.E.national								65		75		73								213
		Foreigners								17		32		23								72
		Total							3	82	3	107	3	96							9	285
Male	Prim.	U.A.E.national														50		74		56		180
		Foreigners														23		26		15		64
		Total													3	73	3	100	3	71	9	244
Female	Prim.	U.A.E.national								67		58		68		70		67		50		380
		Foreigners								21		29		25		39		19		30		163
		Total							3	88	3	87	3	93	4	109	3	86	3	80	19	543
Male	Pre.+Sec.	U.A.E.national																				
		Foreigners																				-
		Total																				
Female	Pre.+Sec.	U.A.E.national																				
		Foreigners																				
		Total																				
Total		U.A.E.national		37		71		108		132		133		141		120		141		106		773
		Foreigners								38		61		48		62		45		45		299
		Total	2	37	2	71	4	108	6	170	6	194	6	189	7	182	6	186	6	151	37	1072
Eili																						
Male	Prim.	U.A.E.national								7		10		14		9		8		8		56
		Foreigners								2				1				1		1		5
		Total							1	9	1	10	1	15	1	9	1	9	1	9	6	61
Female	Prim.(Pre.)	U.A.E.national								12		8		10		15		12		9		66
		Foreigners														1						1
		Total								12		8		10		16		12		9		67
Total		U.A.E.national								19		18		24		24		20		17		122
		Foreigners								2				1		1		1		1		6
		Total							1	21	1	18	1	25	1	25	1	21	1	18	6	128

Sex	Type	Nationality	Preparatory 1 Nos.of class	Preparatory 1 Nos.of studen	Preparatory 2 Nos.of class	Preparatory 2 Nos.of studen	Preparatory 3 Nos.of class	Preparatory 3 Nos.of studen	Preparatory Total Nos.of class	Preparatory Total Nos.of studen	Secondary 1 Nos.of class	Secondary 1 Nos.of studen	Secondary 2 Lite. Nos.of class	Secondary 2 Lite. Nos.of studen	Secondary 2 Sci. Nos.of class	Secondary 2 Sci. Nos.of studen	Secondary 3 Lite. Nos.of class	Secondary 3 Lite. Nos.of studen	Secondary 3 Sci. Nos.of class	Secondary 3 Sci. Nos.of studen	Secondary Total Nos.of class	Secondary Total Nos.of studen	Grand Total Nos.of class	Grand Total Nos.of studen
Dhaid																								
Male	Kindergarten	U.A.E.national																						44
		Foreigners																						
		Total																					4	44
Female	Kindergarten	U.A.E.national																						64
		Foreigners																						
		Total																						64
Male	Prim.	U.A.E.national																						213
		Foreigners																						72
		Total																					9	285
Male	Prim.	U.A.E.national																						180
		Foreigners																						64
		Total																					9	244
Female	Prim.	U.A.E.national																						380
		Foreigners																						163
		Total																					19	543
Male	Pre.+Sec.	U.A.E.national		72		63		42		177		44		24		14		28		7		117		294
		Foreigners		25		37		17		79		29		3		9		3		17		61		140
		Total	3	97	3	100	2	59	8	256	3	73	1	27	1	23	1	31	1	24	7	178	15	434
Female	Pre.+Sec.	U.A.E.national		70		44		47		161		49		30		6		17		7		109		270
		Foreigners		31		20		23		74		13		9		10		3		11		46		120
		Total	3	101	3	64	3	70	9	235	2	62	2	39	1	16	1	20	1	18	7	155	16	390
Total		U.A.E.national		142		107		89		338		93		54		20		45		14		226		1445
		Foreigners		56		57		40		153		42		12		19		6		28		107		559
		Total	6	198	6	164	5	129	17	491	5	135	3	66	2	39	2	51	2	42	14	333	72	2004
Eili																								
Male	Prim.	U.A.E.national																						56
		Foreigners																						5
		Total																					6	61
Female	Prim.(Pre.)	U.A.E.national		6						6														72
		Foreigners																						1
		Total	1	6					1	6													1	73
Total		U.A.E.national		6						6														128
		Foreigners																						6
		Total	1	6					1	6													7	134

Source : Ministry of Education

Table 4.2.4: Number of Classes and Students in the Study Area (1993/94)(2/3)

Sex	Type	Nationality	Kindergarten						Primary school																Preparatory school										Secondary school												Grand Total	
			1		2		Total		1		2		3		4		5		6		Total		1		2		3		Total		1		2				3				Total					
																																	Lite.		Sci.		Lite.		Sci.							
			Nos of class	Nos of studen	Nos of class	Nos of studen	Nos of class	Nos of studen	Nos of class	Nos of studen	Nos of class	Nos of studen	Nos of class	Nos of studen	Nos of class	Nos of studen	Nos of class	Nos of studen	Nos of class	Nos of studen	Nos of class	Nos of studen	Nos of class	Nos of studen	Nos of class	Nos of studen	Nos of class	Nos of studen	Nos of class	Nos of studen	Nos of class	Nos of studen	Nos of class	Nos of studen	Nos of class	Nos of studen	Nos of class	Nos of studen	Nos of class	Nos of studen	Nos of class	Nos of studen	Nos of class	Nos of studen	Nos of class	Nos of studen	Nos of class	Nos of studen
Milriha																																																
Male	Prim.+Prp.+Sec.	U.A.E.national								42		33		32		30		33		21		191		31		24		18		73		14								14				278
		Foreigners								3		9				8		1		2		23				1		2		3														26
		Total							2	45	2	42	1	32	2	38	1	34	1	23	9	214	1	31	1	25	1	20	3	76	1	14								1	14	13	304
Female	Prim.+Prp.+Sec.	U.A.E.national								27		24		32		35		24		31		173		26		40		21		87		23		14		7				44				304
		Foreigners								3		4		2		4		4		2		19		3		1				4		1		1		2				4				27
		Total							1	30	1	28	1	34	2	39	1	28	1	33	7	192	1	29	1	41	1	21	3	91	1	24	1	15		1	9			3	48	13	331
Total		U.A.E.national								69		57		64		65		57		52		364		57		64		39		160		37		14		7				58				582
		Foreigners								6		13		2		12		5		4		42		3		2		2		7		1		1		2				4				53
		Total							3	75	3	70	2	66	4	77	2	62	2	56	16	406	2	60	2	66	2	41	6	167	2	38	1	15		1	9			4	62	26	635
Falaj Al Mualla																																															
Male	Kindergarten	U.A.E.national		12		35		47																																								47
		Foreigners																																														
		Total	2	12	2	35	4	47																																						4	47
Female	Kindergarten	U.A.E.national		17		25		42																																								42
		Foreigners																																														
		Total		17		25		42																																								42
Male	Prim	U.A.E.national								37		38		41		54		36		32		238																											238
		Foreigners								12		17		14		16		13		10		82																											82
		Total							2	49	2	55	2	55	3	70	2	49	2	42	13	320																											13	320
Female	Prim.+Prp.+Sec.	U.A.E.national								35		47		35		46		43		32		238		41		33		30		104		29		16		4		16		2		67				409
		Foreigners								22		15		16		14		12		15		94		9		8		8		25		7		1		2				4		14				133
		Total							2	57	3	62	2	51	2	60	2	55	2	47	13	332	2	50	2	41	2	38	6	129	2	36	1	17	1	6	1	16	1	6	6	81	25	542
Male	Prp.+Sec.	U.A.E.national																						38		36		29		103		25		10		5		8		2		50				153
		Foreigners																						10		7		9		26		8		1		6				3		18				44
		Total																					2	48	2	43	2	38	6	129	2	33	1	11	1	11	1	8	1	5	6	68	12	197
Total		U.A.E.national		29		60		89		72		85		76		100		79		64		476		79		69		59		207		54		26		9		24		4		117				889
		Foreigners								34		32		30		30		25		25		176		19		15		17		51		15		2		8				7		32				259
		Total	2	29	2	60	4	89	4	106	5	117	4	106	5	130	4	104	4	89	26	652	4	98	4	84	4	76	12	258	4	69	2	28	2	17	2	24	2	11	12	149	54	1148
Kadrah																																															
Male	Prim.+Prp.+Sec.	U.A.E.national								18		13		9		14		12		14		80		17		7		3		27		5				6				5		16		123
		Foreigners								2		1		1				1				5																								5
		Total							1	20	1	14	1	10	1	14	1	13	1	14	6	85	1	17	1	7	1	3	3	27	1	5			1	6			1	5	3	16	12	128
Female	Prim.+Prp.+Sec.	U.A.E.national								10		11		10		6		13		11		61		14		5		6		25		6		5				3				14		100
		Foreigners								4		1		1		1		1				8																								8
		Total							1	14	1	12	1	11	1	7	1	14	1	11	6	69	1	14	1	5	1	6	3	25	1	6	1	5		1	3			3	14	12	108
Total		U.A.E.national								28		24		19		20		25		25		141		31		12		9		52		11		5		6		3		5		30		223
		Foreigners								6		2		2		1		2				13																								13
		Total							2	34	2	26	2	21	2	21	2	27	2	25	12	154	2	31	2	12	2	9	6	52	2	11	1	5	1	6	1	3	1	5	6	30	24	236

Source : Ministry of Education

Table 4.2.4. Number of Classes and Students in the Study Area (1993/94)(3/3)

Sex	Type	Nationality	Kindergarten 1		Kindergarten 2		Kindergarten Total		Primary school 1		Primary school 2		Primary school 3		Primary school 4		Primary school 5		Primary school 6		Primary school Total	
			Nos.of class	Nos.of studen	Nos.of class	Nos.of studen	Nos.of class	Nos.of studen	Nos.of class	Nos.of studen	Nos.of class	Nos.of studen	Nos.of class	Nos.of studen	Nos.of class	Nos.of studen	Nos.of class	Nos.of studen	Nos.of class	Nos.of studen	Nos.of class	Nos.of studen
Madam																						
Male	Prim.+Pre.+Sec.	U.A.E.national								52		40		60		58		51		44		305
		Foreigners								4		4		5		5		8		4		30
		Total							2	56	2	44	2	65	2	63	2	59	2	48	12	335
Female	Prim.+Pre.+Sec.	U.A.E.national								47		53		47		39		47		39		272
		Foreigners								3		3		5		2		3		3		19
		Total							2	50	2	56	2	52	2	41	2	50	2	42	12	291
Total		U.A.E.national								99		93		107		97		98		83		577
		Foreigners								7		7		10		7		11		7		49
		Total							4	106	4	100	4	117	4	104	4	109	4	90	24	626

Sex	Type	Nationality	Preparatory school 1		Preparatory school 2		Preparatory school 3		Preparatory school Total		Secondary school 1		Secondary school 2 Lite.		Secondary school 2 Sci.		Secondary school 3 Lite.		Secondary school 3 Sci.		Secondary school Total		Grand Total	
			Nos.of class	Nos.of studen	Nos.of class	Nos.of studen	Nos.of class	Nos.of studen	Nos.of class	Nos.of studen	Nos.of class	Nos.of studen	Nos.of class	Nos.of studen	Nos.of class	Nos.of studen	Nos.of class	Nos.of studen	Nos.of class	Nos.of studen	Nos.of class	Nos.of studen	Nos.of class	Nos.of studen
Madam																								
Male	Prim.+Pre.+Sec.	U.A.E.national		33		28		37		98		36		26				20				82		485
		Foreigners		2		2		6		10		2										2		42
		Total	1	35	1	30	2	43	4	108	2	38	1	26			1	20			4	84	20	527
Female	Prim.+Pre.+Sec.	U.A.E.national		37		30		34		101		22		12		5		12		1		52		425
		Foreigners		3		2		2		7						1				1		2		28
		Total	2	40	1	32	2	36	5	108	1	22	1	12	1	6	1	12	1	2	5	54	22	453
Total		U.A.E.national		70		58		71		199		58		38		5		32		1		134		910
		Foreigners		5		4		8		17		2				1				1		4		70
		Total	3	75	2	62	4	79	9	216	3	60	2	38	1	6	2	32	1	2	9	138	42	980

Source : Ministry of Education

Table 4.2.5. Number of Classes and Students of the Adult Education Centers in the Study Area (1993/94)

Sex	Nationality	Literacy				Primary				Preparatory school						Secondary school										Total	
		1(2years)		2(2years)		5		6		1		2		3		1		2				3					
																		Lite.		Sci.		Lite.		Sci.			
		Nos.of class	Nos.of student	Nos.of class	Nos.of student	Nos.of class	Nos.of student	Nos.of class	Nos.of student	Nos.of class	Nos.of student	Nos.of class	Nos.of student	Nos.of class	Nos.of student	Nos.of class	Nos.of student	Nos.of class	Nos.of student	Nos.of class	Nos.of student	Nos.of class	Nos.of student	Nos.of class	Nos.of student	Nos.of class	Nos.of student
Dhaid																											
Male	U.A.E.national										2		6		9		12		10				7				46
	Foreigners										1		1		1												3
	Total									1	3	1	7	1	10	1	12	1	10			1	7			6	49
Female	U.A.E.national		6		1		1		3				11		15		6		9				13				65
	Foreigners		8		5		5						1		2		1		2								24
	Total	1	14	1	6	1	6	1	3			1	12	1	17	1	7	1	11			1	13			9	89
Total	U.A.E.national		6		1		1		3		2		17		24		18		19				20				111
	Foreigners		8		5		5				1		2		3		1		2								27
	Total	1	14	1	6	1	6	1	3	1	3	2	19	2	27	2	19	2	21			2	20			15	138
Mileiha																											
Male	U.A.E.national		3		5		6		6		9		6		11		9		14								69
	Foreigners						1																				1
	Total	1	3	1	5	1	7	1	6	1	9	1	6	1	11	1	9	1	14							9	70
Female	U.A.E.national						4		3		3				2		5		5				3				25
	Foreigners																										
	Total					1	4	1	3	1	3			1	2	1	5	1	5			1	3			7	25
Total	U.A.E.national		3		5		10		9		12		6		13		14		19				3				94
	Foreigners						1																				1
	Total	1	3	1	5	2	11	2	9	2	12	1	6	2	13	2	14	2	19			1	3			16	95
Madam																											
Female	U.A.E.national		8		4		8		3		4		6														33
	Foreigners		2		5								1														8
	Total	1	10	1	9	1	8	1	3	1	4	1	7													6	41
Falaj Al Mualla																											
Female	U.A.E.national		2		3		4				3		2		3		6		5				2				30
	Foreigners		14				3		1		2				2		1										23
	Total	1	16	1	3	1	7	1	1	1	5	1	2	1	5	1	7	1	5			1	2			10	53

Source : Ministry of Education

Table 4.2.6. Existing Water Supply Tanks in the Study Area

Location	Volume (gallons)	Remark	
SHARJAH			
Suhelah	10,000	(Elev.)	(Min. of Electricity and Water)
Al Dhaid	200,000	(Elev. 35M Tower)	(Min. of Electricity and Water)
Hamdah	20,000	(Elev. 12M/40' Tower)	(Min. of Electricity and Water)
Khuderah	10,000	(Elev.)	(Min. of Electricity and Water)
Mileiha	20,000	(Elev. 12M/40' Tower)	(Min. of Electricity and Water)
	20,000	(Elev. 12M/40' Tower)	(Min. of Electricity and Water)
Ikhudir	10,000	(Elev.)	(Min. of Electricity and Water)
Bahayis	10,000	(Elev.)	(Min. of Electricity and Water)
Fili	20,000	(Elev.)	(Min. of Electricity and Water)
	10,000	(Elev.)	(Min. of Electricity and Water)
Wishah	20,000	(Elev.)	(Min. of Electricity and Water)
AJMAN			
Nasim	20,000	(Elev. 15M/50' Tower)	(Min. of Electricity and Water)
R.A.K.			
Kadrah	10,000	(Elevated)	(Min. of Electricity and Water)
U.A.Q.			
Falaj Al Mu'alla	150,000		(U.A.Q. Municipality)
	200,000		(U.A.Q. Municipality)

Source : Ministry of Electricity and Water
Falaj Al Mualla Municipality Office

Table 4.2.7. Power Station Block-outs During 1993 and 1994

Year	Affected area	Occurrence		Duraion of black-out	Remarks
		Date	Time		
1993	Dhaid	1993/1/16	10:45	3 Mts.	M & R station trouble.
	(except Masfut)	1993/1/22	21:15	5 Mts.	Heavy system disturbance caused by fault in Hamdah feeder.
1994	Central Area (ex. Masfut)	1994/1/16	10:20	5 Mts.	G.T. No. 6 tripped on high exhaust temp.

Source : Annual report for the year 1993 - Electricity Affairs, Ministry of Electricity & Water
Annual report for the year 1994 - Electricity Affairs, Ministry of Electricity & Water

Table 4.2.8. Annual Energy Generation and Distribution from 1988 to 1994

(Million KWH)

Location	1988	1989	1990	1991	1992	1993	1994
Dhaid power station	299.778	291.788	335.24	326.503	349.217	394.437	421.112
Masafi power station	0	0	0.158	0.072	0.131	0.015	0.002
Manama power station	0	0	0.153	0.107	0.185	0.001	0.001
Falaj Al Mualla power station	0.547	0.271	2.018	1.446	0.828	0.506	0.333
Masfut power station	6.749	7.912	7.242	4.445	5.703	14.242	9.388
Idhn	0	0	0.076	0.02	(North Area)		
Total	307.074	299.971	344.887	332.593	356.064	409.201	430.836
Growth Rate	100%	97.7%	112.3%	108.3%	116.0%	133.3%	140.3%
Distribution							
Location	1988	1989	1990	1991	1992	1993	1994
Dhaid power station	97.6%	97.3%	97.2%	98.2%	98.1%	96.4%	97.7%
Masafi power station	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Manama power station	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%
Falaj Al Mualla power station	0.2%	0.1%	0.6%	0.4%	0.2%	0.1%	0.1%
Masfut power station	2.2%	2.6%	2.1%	1.3%	1.6%	3.5%	2.2%
Idhn	0.0%	0.0%	0.0%	0.0%	(North Area)		
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Source : Annual report for the year 1994 - Electricity Affairs, Ministry of Electricity & Water

Table 4.2.9. Classification of Consumers in the Study Area

Type	Whole area				Dhaid Area	
	1993/12/31		1994/12/31		1995/5/21	
	Nos. of consumers	Percentage	Nos. of consumers	Percentage	Nos. of consumers	Percentage
Residential	50,256	51.8%	52,823	50.6%	2,540	37.0%
Commercial	32,512	33.5%	36,124	34.6%	1,943	28.3%
Government	7,554	7.8%	7,808	7.5%	263	3.8%
Industrial	1,906	2.0%	2,667	2.6%	98	1.4%
Agricultural	4,222	4.4%	4,530	4.3%	1,963	28.6%
Others	495	0.5%	519	0.5%	64	0.9%
Total	96,945	100.0%	104,471	100.0%	6,871	100.0%

Source : Annual report for the year 1993 - Electricity Affairs, Ministry of Electricity & Water
Annual report for the year 1994 - Electricity Affairs, Ministry of Electricity & Water

Table 4.3.1. Average Farm Size of Farm Inventory Survey

Sub-Area	Cultivated Area (a)	Area Available for Cultivation (b)	Total Area (c)	Area Owned (d)	Cultivated Area Ratio (a/b)
Dhaid I	41.37	44.29	50.14	50.14	93.4%
Dhaid II	47.63	48.03	51.43	51.43	99.2%
Mileiha	33.18	53.33	56.23	56.23	62.2%
F.A.M.	51.52	62.35	75.46	75.46	82.6%
Kadrah	23.86	35.93	49.54	49.54	66.4%
Average	40.39	49.53	55.33	55.33	81.6%

Note: Invalid data are excluded.

Table 4.3.2. Farm Owners by Emirates

Sub-Area	Sharjah	Abu Dhabi	Dubai	Ras Al Khaimah	Umm Al Qaiwain	Ajman	Fujairah	Foreigner	No Answer	*Total
Actual Figures										
Dhaid I SHJ	15	10	17	1		3		1	1	48
Dhaid II SHJ	10	17	15	1	1	1	1	1	1	48
Mileiha SHJ	42	14	2							58
F.A.M. UAQ		2	1	3	14	1			2	23
Kadrah RAK				15						15
Total	67	43	35	20	15	5	1	2	4	192
Distribution (%)										
Dhaid I SHJ	31.3%	20.8%	35.4%	2.1%	0.0%	6.3%	0.0%	2.1%	2.1%	100.0%
Dhaid II SHJ	20.8%	35.4%	31.3%	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%	100.0%
Mileiha SHJ	72.4%	24.1%	3.4%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%
F.A.M. UAQ	0.0%	8.7%	4.3%	13.0%	60.9%	4.3%	0.0%	0.0%	8.7%	100.0%
Kadrah RAK	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%
Total	34.9%	22.4%	18.2%	10.4%	7.8%	2.6%	0.5%	1.0%	2.1%	100.0%

Note: *Total figures are excluded the numbers of farmers which data could not get obtained.

Table 4.3.3. Farm Owners' family and Farm Employees

Item / Area		Owner's Family						Employee								
		Adult			Children			Nationality							Monthly	Working
		Male (Nos.)	Female (Nos.)	Total (Nos.)	Male (Nos.)	Female (Nos.)	Total (Nos.)	Bangladeshi (Nos.)	Pakistani (Nos.)	Indian (Nos.)	Egyptian (Nos.)	Sri-Lankan (Nos.)	Other (Nos.)	Total (Nos.)	salary (Dhs.)	hours (hr./day)
Kadrah	Max.	5	7	12	10	6	13	3	6	0	1	0	0	6	1000	12
No. of interviewed	Min.	1	1	2	3	1	2	1	1	0	1	0	0	1	667	8
Farms:15	Sum.	27	34	61	37	25	62	9	38	0	1	0	0	48	11457	139
	*Num.	11	11	11	11	11	11	14	14	14	14	14	14	14	14	14
	Avg.	2.45	3.09	5.55	3.36	2.27	5.64	0.64	2.71	0.00	0.07	0.00	0.00	3.43	818.36	9.93
Falaj Al Mualla	Max.	5	5	10	4	5	6	7	3	28	1	0	12	30	1500	12
No. of interviewed	Min.	1	1	2	1	2	3	1	1	1	1	0	1	1	600	7
Farms:25	Sum.	22	19	41	9	13	22	25	25	35	1	0	15	101	18579	209
	*Num.	8	8	8	8	8	8	23	23	23	23	23	23	23	23	23
	Avg.	2.75	2.38	5.13	1.13	1.63	2.75	1.09	1.09	1.52	0.04	0.00	0.65	4.39	807.78	9.09
Dhaid I	Max.	7	10	16	4	8	11	7	13	1	2	1	3	14	1500	12
No. of interviewed	Min.	1	1	2	1	1	1	1	1	1	1	1	1	1	600	8
Farms:50	Sum.	108	99	207	21	26	47	54	85	4	16	1	5	169	39186	436
	*Num.	30	30	30	30	30	30	50	50	50	50	50	50	50	50	50
	Avg.	3.60	3.30	6.90	0.70	0.87	1.57	1.08	1.70	0.08	0.32	0.02	0.10	3.38	783.72	8.72
Dhaid II	Max.	10	10	20	5	4	8	4	10	3	4	0	1	10	1600	12
No. of interviewed	Min.	1	1	2	1	1	2	1	1	1	1	0	1	1	400	8
Farms:50	Sum.	95	104	199	26	20	46	36	65	15	28	0	2	146	40614.16	400
	*Num.	32	32	32	32	32	32	46	46	46	46	46	46	46	46	46
	Avg.	2.97	3.25	6.22	0.81	0.63	1.44	0.78	1.41	0.33	0.61	0.00	0.04	3.17	882.92	8.70
Mileiha	Max.	6	9	15	7	7	12	14	12	14	12	2	4	53	1200	18
No. of interviewed	Min.	1	1	2	1	1	1	1	1	1	1	2	1	1	500	7
Farms:60	Sum.	72	91	163	74	68	142	50	95	22	13	2	14	196	45619	649
	*Num.	32	32	32	32	32	32	58	58	58	58	58	58	58	58	58
	Avg.	2.25	2.84	5.09	2.31	2.13	4.44	0.86	1.64	0.38	0.22	0.03	0.24	3.38	786.53	11.19
Total	Sum.	324	347	671	167	152	319	174	308	76	59	3	36	660	155455.2	1833
No. of interviewed	*Num.	113	113	113	113	113	113	191	191	191	191	191	191	191	191	191
Farms:200	Avg.	2.87	3.07	5.94	1.48	1.35	2.82	0.91	1.61	0.40	0.31	0.02	0.19	3.46	813.90	9.60
	(%)	-	-	-	-	-	-	26.4%	46.7%	11.5%	8.9%	0.5%	5.5%	100.0%	-	-

Note: *Num. means number of answered Farms.

Table 4.3.4. Average Salary and Working Hours of Farm Employees

Sub-Area	Average Monthly Salary (Dhs.)	Maximum Monthly Salary (Dhs.)	Minimum Monthly Salary (Dhs.)	Average Working Hours (hr./day)	Maximum Working Hours (hr./day)	Minimum Working Hours (hr./day)	No. of Farms
Dhaid I	848.6	1500	600	9.3	12	8	47
Dhaid II	881.2	1600	400	8.5	12	8	47
Mileiha	786.5	1200	500	11.2	18	7	58
F.A.M.	807.8	1500	600	9.1	12	7	23
Kadrah	818.4	1000	667	9.9	12	8	14
Average	830.5	1360	553	9.7	13.2	8	189

Note: *No. of Farms are excluded the farms which have invalid data.

Table 4.5.1. Vegetable Production (Option-1)

Crop	Total Production (ton)	Vegetable Yield of Each 10 Days (X10 ton)																														
		Aug			Sep			Oct			Nov			Dec			Jan			Feb			Mar			Apr			May			Jun			Jul		
Bean	750																		45	30															
Cabbage	500															50																			
Cabbage	850													50	35																			
Cauliflower	500											50																						
Cucumber	3,600																					30	50	50	50	50	50	50	30					
Cucumber	2,250															15	50	50	50	50	10													
Dwarf Bean	5,850																	35	50	50	50	50	50	50	50	50	50	50	50					
Eggplant	2,000										35	50		50	50	15																		
Green beans	1,250										50	50	25																					
Lettuce	1,000																50	50																
Musk Melon	1,050																5	50	50															
Musk melon	5,500	30																						20	50	50	50	50	50	50	50	50	50	50	50
Parsley	1,500							30	50	50	20																							
Pepper	3,000							50	50	50	50	50	50																					
Pepper(L.C)	9,100								10	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50							
Radish	50										5																							
Spinach	3,700													20	50	50	50	50	50	50	50													
Squash	1,500	40																														10	50	50
Squash	1,500													50	50	50																		
Sweet melon	1,000																					25	50	25										
Sweet Pepper	6,950																		50	50	50	50	50	50	50	50	50	50	50	45				
Sweet Pepper	3,850																										50	50	50	50	50	50	50	50	35
Tomato	4,750																		5	50	50	50	50	50	50	50	50	20							
Tomato	4,000																										50	50	50	50	50	50	50	50	50
Turnip(Laft)	1,000							50	50																									
Water Melon	800																										30	50						
Total	67,800	70						50	50	80	160	235	250	250	255	230	155	285	300	300	290	250	200	230	275	300	295	300	300	300	280	200	195	150	160	200	185

Table 4.6.1. Summary of Project Cost of Option-1

Works	Name	Quantity	Unit	Unit Cost (US$X10³)	Cost (US$X10³)
Recharge Dam & Trench	Siji	1	set	19,486.79	19,486.79
	Kadrah	1	set	9,636.12	9,636.12
	Shokah	1	set	11,295.86	11,295.86
	Subtotal				40,418.76
Irrigation & Farming Facilities	Well & Submarsible Pump	2,018	no.	72.21	145,716.64
	Water Distribution Facilities	2,548	ha	2.22	5,668.70
	Irrigation Facilities	2,548	ha	1.15	2,937.84
	Greenhouses	12,108	set	1.39	16,818.01
	Subtotal				171,141.20
Groundwater Monitoring System		1	L.S.		8,435.00
Vegetable Center		1	L.S.		1,000.00
Subtotal					220,994.96
Administration Expenses			L.S.		5,524.87
Consulting Services					22,099.50
Investment Cost Total					248,619.33
Physical Contingencies			L.S.		22,651.98
Price Escalation (9%)			L.S.		113,811.86
Total Cost for Option-1					385,083.18

Table 4.6.2. Summary of Project Cost of Option-2

Works	Name	Quantity	Unit	Unit Cost (US$X10³)	Cost (US$X10³)
Recharge Dam & Trench	Siji	1	set	19,486.79	19,486.79
	Kadrah	1	set	9,636.12	9,636.12
	Shokah	1	set	11,295.86	11,295.86
	Subtotal				40,418.76
Irrigation & Farming Facilities	Wells, Pumps, Tanks, etc.	2,018	no.	72.97	147,248.33
	Water Distribution Facilities	4,584	ha	1.58	7,250.67
	Irrigation Facilities	4,854	ha	1.16	5,616.08
	Greenhouses	8,072	set	1.39	11,212.01
	Subtotal				171,327.08
Desalinized Water Supply	Pump & Control Facilities	1	set	4,975.00	93,046.68
	Pumping Houses	1	set	4,975.00	4,975.00
	Pipe lines, Tanks etc.	1	L.S.	146,857.77	146,857.77
	Subtotal				244,879.44
Groundwater Monitoring System		1	L.S.		8,435.00
Vegetable Center		1	L.S.		1,500.00
Subtotal					466,560.29
Administration Expenses					11,664.01
Consulting Services					46,656.03
Investment Cost Total					524,880.32
Physical Contingencies		1	L.S.		47,822.43
Price Escalation		1	L.S.		362,608.76
Total Cost for Option-2					935,311.51

Table 4.6.3. Annual Disbursement of Project Costs - Option-1

(Unit : US$X10³)

Works	Name	Total Cost	0 1996	1 1997	2 1998	3 1999	4 2000	5 2001	6 2002	7 2003	8 2004	9 2005	10 2006
Consulting Seivices	Feasibility Study	3,314.9		3,314.9									
	Detailed Design	7,734.8			5,156.5	2,578.3							
	Construction Supervision	11,049.7				1,004.5	2,009.0	2,009.0	2,009.0	2,009.0	2,009.0		
	Sub-total	22,099.5		3,314.9	5,156.5	3,582.8	2,009.0	2,009.0	2,009.0	2,009.0	2,009.0	0.0	0.0
Recharge Dam & Trenchi	Siji	19,486.8					6,495.6	6,495.6	6,495.6				
	Kadrah	9,636.1						3,212.0	3,212.0	3,212.0			
	Shokab	11,295.9							3,765.3	3,765.3	3,765.3		
	Sub-total	40,418.8		0.0	0.0	0.0	6,495.6	9,707.6	13,472.9	6,977.3	3,765.3	0.0	0.0
Irrigation and Farming Facilities	Water Sources Facilities	18,207.3			3,034.5	6,069.1	6,069.1	3,034.5					
	Water Distribution Facilitie	5,668.7			1,417.2	2,834.4	1,417.2						
	Irrigation Facilities	2,937.8			734.5	1,468.9	734.5						
	Green Houses	16,818.0				5,606.0	5,606.0	5,606.0					
	Subtotal	43,631.8		0.0	5,186.2	15,978.4	13,826.7	8,640.6	0.0	0.0	0.0	0.0	0.0
Water Extraction Facilities	Well	71,453.3			11,908.9	23,817.8	23,817.8	11,908.9					
	Submersible Pump	56,056.0			9,342.7	18,685.3	18,685.3	9,342.7					
	Subtotal	127,509.3		0.0	21,251.6	42,503.1	42,503.1	21,251.6	0.0	0.0	0.0	0.0	0.0
Groundwater Monitoring System		8,435.0					4,217.5	4,217.5					
Vegetable Center		1,000.0							1,000.0				
Administration Expenses		5,524.9	0.0	0.0	660.9	1,462.0	1,676.1	1,095.4	361.8	174.4	94.1	0.0	0.0
Investment Cost Total		248,619.3	0.0	3,314.9	32,255.2	63,526.3	70,728.1	46,921.7	16,843.8	9,160.8	5,868.5	0.0	0.0
Physical Contingencies		22,652.0	0.0	0.0	2,709.9	5,994.4	6,871.9	4,491.3	1,483.5	715.2	385.9	0.0	0.0
Price Escalation		113,811.9	0.0	298.3	6,576.9	20,510.6	31,938.7	27,692.3	12,409.4	8,177.7	6,207.9	0.0	0.0
Total		385,083.2	0.0	3,613.3	41,542.0	90,031.3	109,538.7	79,105.3	30,736.7	18,053.7	12,462.3	0.0	0.0

Table 4.6.4. Annual Disbursement of Project Costs - Option-2

(Unit : US$X10³)

Works	Name	Total Cost	0 1996	1 1997	2 1998	3 1999	4 2000	5 2001	6 2002	7 2003	8 2004	9 2005	10 2006
Consulting Seivices	Feasibility Study	6,998.4		4,665.6	2,332.8								
	Detailed Design	16,329.6			4,082.4	8,164.8	4,082.4						
	Construction Supervision	23,328.0					2,120.7	4,241.5	4,241.5	4,241.5	4,241.5	4,241.5	
	Subtotal	46,656.0		4,665.6	6,415.2	8,164.8	6,203.1	4,241.5	4,241.5	4,241.5	4,241.5	4,241.5	0.0
Recharge Dam & Trenchi	Siji	19,486.8					3,247.8	6,495.6	6,495.6	3,247.8			
	Kadrah	9,636.1						1,606.0	3,212.0	3,212.0	1,606.0		
	Shokab	11,295.9							1,882.6	3,765.3	3,765.3	1,882.6	
	Subtotal	40,418.8		0.0	0.0	0.0	3,247.8	8,101.6	11,590.3	10,225.1	5,371.3	1,882.6	0.0
Irrigation and Farming Facilities	Water Sources Facilities	19,739.0			2,467.4	4,934.7	4,934.7	4,934.7	2,467.4				
	Water Distribution Facilitie	7,250.7			1,208.4	2,416.9	2,416.9	1,208.4					
	Irrigation Facilities	5,616.1			936.0	1,872.0	1,872.0	936.0					
	Green Houses	11,212.0			2,242.4	4,484.8	4,484.8						
	Subtotal	43,817.7		0.0	6,854.2	13,708.5	13,708.5	7,079.2	2,467.4	0.0	0.0	0.0	0.0
Water Source Facilities	Well	71,453.3			8,931.7	17,863.3	17,863.3	17,863.3	8,931.7				
	Submersible Pump	56,056.0			7,007.0	14,014.0	14,014.0	14,014.0	7,007.0				
	Subtotal	127,509.3		0.0	15,938.7	31,877.3	31,877.3	31,877.3	15,938.7	0.0	0.0	0.0	0.0
Desalinesed Water Supply	Pumping Station	93,046.7							18,609.3	37,218.7	37,218.7		
	Pipe Line Main/Distribution	4,975.0					452.3	904.5	904.5	904.5	904.5	904.5	
	Tank	146,857.8							73,428.9	73,428.9			
	Subtotal	244,879.4		0.0	0.0	0.0	452.3	904.5455	92,942.8	111,552.1	38,123.2	904.5	0.0
Groundwater Monitoring System		8,435.0						8,435.0					
Vegetable Center		1,500.0							1,500.0				
Administration Expenses		11,664.0	0.0	0.0	569.8	1,139.6	1,232.1	1409.942	3,111.0	3,044.6	1,087.4	69.7	0.0
Investment Cost Total		524,880.3	0.0	4,665.6	29,777.9	54,890.3	56,721.1	62049.1	131,791.5	129,093.1	48,823.3	7,098.3	0.0
Physical Contingency		47,822.4	0.0	0.0	2,336.3	4,672.5	5,051.8	5780.764	12,755.0	12,482.2	4,458.2	285.7	0.0
Price Escalation		362,608.8	0.0	419.9	6,040.7	17,572.8	25,424.6	36534.79	97,872.5	117,205.0	52,885.3	8,653.3	0.0
Total		935,311.5	0.0	5,085.5	38,154.9	77,135.5	87,197.6	104,364.7	242,419.0	258,750.3	106,166.8	16,037.3	0.0

Table 4.6.5. Financial Internal Rate of Return of Option-1

(Unit : US$ X10³)

Year		Costs				Benefit			Balance
		Investment	Replacement	O&M	Total	w/o Project	W/Project	Incremental	
0	1996	0	0	0	0	42,014	42,014	0	0
1	1997	3,315	0	1,275	4,590	39,625	39,625	0	-4,590
2	1998	32,255	0	1,275	33,530	37,236	37,236	0	-33,530
3	1999	57,920	0	1,534	59,455	34,847	34,847	0	-59,455
4	2000	66,511	0	2,165	68,676	32,457	32,457	0	-68,676
5	2001	46,922	0	2,818	49,740	30,068	30,068	0	-49,740
6	2002	25,667	0	3,276	28,944	27,679	27,679	0	-28,944
7	2003	10,161	734	3,546	14,441	25,289	25,289	0	-14,441
8	2004	5,868	1,469	3,685	11,023	22,900	22,900	0	-11,023
9	2005	0	734	3,761	4,495	20,511	30,580	10,069	5,574
10	2006	0	0	3,761	3,761	18,121	38,260	20,139	16,378
11	2007	0	0	3,761	3,761	15,732	45,940	30,208	26,448
12	2008	0	14,529	3,761	18,289	15,732	53,620	37,888	19,599
13	2009	0	29,058	3,761	32,818	15,732	61,301	45,568	12,750
14	2010	0	32,512	3,761	36,273	15,732	61,301	45,568	9,296
15	2011	0	17,983	3,761	21,744	15,732	61,301	45,568	23,825
16	2012	0	5,606	3,761	9,367	15,732	61,301	45,568	36,202
17	2013	0	734	3,761	4,495	15,732	61,301	45,568	41,073
18	2014	0	1,469	3,761	5,229	15,732	61,301	45,568	40,339
19	2015	0	734	3,761	4,495	15,732	61,301	45,568	41,073
20	2016	0	0	3,761	3,761	15,732	61,301	45,568	41,808
21	2017	0	0	3,761	3,761	15,732	61,301	45,568	41,808
22	2018	0	26,438	3,761	30,198	15,732	61,301	45,568	15,370
23	2019	0	52,875	3,761	56,636	15,732	61,301	45,568	-11,068
24	2020	0	56,906	3,761	60,666	15,732	61,301	45,568	-15,098
25	2021	0	30,753	3,761	34,513	15,732	61,301	45,568	11,055
26	2022	0	6,800	3,761	10,561	15,732	61,301	45,568	35,008
27	2023	0	1,353	3,761	5,113	15,732	61,301	45,568	40,455
28	2024	0	1,803	3,761	5,563	15,732	61,301	45,568	40,005
29	2025	0	734	3,761	4,495	15,732	61,301	45,568	41,073
30	2026	0	0	3,761	3,761	15,732	61,301	45,568	41,808
31	2027	0	0	3,761	3,761	15,732	61,301	45,568	41,808
32	2028	0	14,529	3,761	18,289	15,732	61,301	45,568	27,279
33	2029	0	29,058	3,761	32,818	15,732	61,301	45,568	12,750
34	2030	0	32,512	3,761	36,273	15,732	61,301	45,568	9,296
35	2031	0	17,983	3,761	21,744	15,732	61,301	45,568	23,825
36	2032	0	5,606	3,761	9,367	15,732	61,301	45,568	36,202
37	2033	0	734	3,761	4,495	15,732	61,301	45,568	41,073
38	2034	0	1,469	3,761	5,229	15,732	61,301	45,568	40,339
39	2035	0	734	3,761	4,495	15,732	61,301	45,568	41,073
40	2036	0	0	3,761	3,761	15,732	61,301	45,568	41,808
41	2037	0	0	3,761	3,761	15,732	61,301	45,568	41,808
42	2038	0	26,438	3,761	30,198	15,732	61,301	45,568	15,370
43	2039	0	52,875	3,761	56,636	15,732	61,301	45,568	-11,068
44	2040	0	56,906	3,761	60,666	15,732	61,301	45,568	-15,098
45	2041	0	30,753	3,761	34,513	15,732	61,301	45,568	11,055
46	2042	0	6,800	3,761	10,561	15,732	61,301	45,568	35,008
47	2043	0	1,353	3,761	5,113	15,732	61,301	45,568	40,455
48	2044	0	1,803	3,761	5,563	15,732	61,301	45,568	40,005
49	2045	0	734	3,761	4,495	15,732	61,301	45,568	41,073
50	2046	0	0	3,761	3,761	15,732	61,301	45,568	41,808
Total		248,619	563,513	177,517	989,649	960,032	2,789,938	1,829,906	840,257
IRR =		6.51%							

Table 4.6.6. Financial Internal Rate of Return of Option-2

(Unit : US$ X10³)

Year		Costs				Benefit			Balance
		Investment	Replacement	O&M	Total	w/o Project	W/Project	Incremental	
0	1996	0	0	0	0	42,014	42,014	0	0
1	1997	4,666	0	1,275	5,941	39,625	39,625	0	-5,941
2	1998	29,778	0	1,275	31,053	37,236	37,236	0	-31,053
3	1999	54,890	0	1,320	56,210	34,847	34,847	0	-56,210
4	2000	56,721	0	1,410	58,131	32,457	32,457	0	-58,131
5	2001	62,049	0	1,727	63,776	30,068	30,068	0	-63,776
6	2002	131,792	0	2,294	134,085	27,679	27,679	0	-134,085
7	2003	129,063	936	3,105	133,104	25,289	25,289	0	-133,104
8	2004	48,823	1,872	3,821	54,516	22,900	22,900	0	-54,516
9	2005	7,098	1,872	4,197	13,167	20,511	20,511	0	-13,167
10	2006	0	936	65,042	65,978	18,121	41,424	23,303	-42,675
11	2007	0	0	65,042	65,042	15,732	62,338	46,606	-18,437
12	2008	0	16,104	65,042	81,146	15,732	83,251	67,519	-13,627
13	2009	0	32,207	65,042	97,250	15,732	104,165	88,433	-8,817
14	2010	0	32,207	65,042	97,250	15,732	125,078	109,346	12,097
15	2011	0	21,093	65,042	86,135	15,732	125,078	109,346	23,211
16	2012	0	28,084	65,042	93,126	15,732	125,078	109,346	16,220
17	2013	0	38,155	65,042	103,197	15,732	125,078	109,346	6,149
18	2014	0	39,091	65,042	104,133	15,732	125,078	109,346	5,213
19	2015	0	1,872	65,042	66,914	15,732	125,078	109,346	42,432
20	2016	0	936	65,042	65,978	15,732	125,078	109,346	43,368
21	2017	0	0	65,042	65,042	15,732	125,078	109,346	44,304
22	2018	0	25,035	65,042	90,078	15,732	125,078	109,346	19,269
23	2019	0	50,071	65,042	115,113	15,732	125,078	109,346	-5,767
24	2020	0	50,359	65,042	115,401	15,732	125,078	109,346	-6,055
25	2021	0	39,675	65,042	104,717	15,732	125,078	109,346	4,629
26	2022	0	38,043	65,042	103,085	15,732	125,078	109,346	6,261
27	2023	0	39,061	65,042	104,103	15,732	125,078	109,346	5,243
28	2024	0	39,567	65,042	104,609	15,732	125,078	109,346	4,737
29	2025	0	2,491	65,042	67,533	15,732	125,078	109,346	41,813
30	2026	0	1,841	65,042	66,883	15,732	125,078	109,346	42,463
31	2027	0	905	65,042	65,947	15,732	125,078	109,346	43,399
32	2028	0	17,008	65,042	82,050	15,732	125,078	109,346	27,296
33	2029	0	33,112	65,042	98,154	15,732	125,078	109,346	11,192
34	2030	0	33,112	65,042	98,154	15,732	125,078	109,346	11,192
35	2031	0	21,093	65,042	86,135	15,732	125,078	109,346	23,211
36	2032	0	28,084	65,042	93,126	15,732	125,078	109,346	16,220
37	2033	0	38,155	65,042	103,197	15,732	125,078	109,346	6,149
38	2034	0	39,091	65,042	104,133	15,732	125,078	109,346	5,213
39	2035	0	1,872	65,042	66,914	15,732	125,078	109,346	42,432
40	2036	0	936	65,042	65,978	15,732	125,078	109,346	43,368
41	2037	0	0	65,042	65,042	15,732	125,078	109,346	44,304
42	2038	0	9,097	65,042	74,139	15,732	125,078	109,346	35,207
43	2039	0	50,071	65,042	115,113	15,732	125,078	109,346	-5,767
44	2040	0	50,359	65,042	115,401	15,732	125,078	109,346	-6,055
45	2041	0	39,675	65,042	104,717	15,732	125,078	109,346	4,629
46	2042	0	38,043	65,042	103,085	15,732	125,078	109,346	6,261
47	2043	0	39,061	65,042	104,103	15,732	125,078	109,346	5,243
48	2044	0	39,567	65,042	104,609	15,732	125,078	109,346	4,737
49	2045	0	2,039	65,042	67,081	15,732	125,078	109,346	42,265
50	2046	0	936	65,042	65,978	15,732	125,078	109,346	43,368
Total		524,880	983,719	2,687,156	4,195,755	960,032	5,231,702	4,271,669	75,914
IRR =		0.46%							

Table 4.6.7. Sensitivity Analysis of Option-1, Case 1

(Unit : US$ X10³)

	Year	Costs				Benefit			Balance
		Investment	Replacement	O&M	Total	w/o Project	W/Project	Incremental	
0	1996	0	0	0	0	42,014	42,014	0	0
1	1997	3,646	0	1,403	5,049	39,625	39,625	0	-5,049
2	1998	35,481	0	1,403	36,883	37,236	37,236	0	-36,883
3	1999	63,712	0	1,688	65,400	34,847	34,847	0	-65,400
4	2000	73,162	0	2,382	75,543	32,457	32,457	0	-75,543
5	2001	51,614	0	3,100	54,714	30,068	30,068	0	-54,714
6	2002	28,234	0	3,604	31,838	27,679	27,679	0	-31,838
7	2003	11,177	808	3,900	15,885	25,289	25,289	0	-15,885
8	2004	6,455	1,616	4,054	12,125	22,900	22,900	0	-12,125
9	2005	0	808	4,137	4,944	20,511	20,511	0	-4,944
10	2006	0	0	4,137	4,137	18,121	28,669	10,547	6,411
11	2007	0	0	4,137	4,137	15,732	36,827	21,095	16,958
12	2008	0	15,982	4,137	20,118	15,732	44,985	29,253	9,134
13	2009	0	31,963	4,137	36,100	15,732	53,143	37,410	1,310
14	2010	0	35,763	4,137	39,900	15,732	61,301	45,568	5,669
15	2011	0	19,782	4,137	23,918	15,732	61,301	45,568	21,650
16	2012	0	6,167	4,137	10,303	15,732	61,301	45,568	35,265
17	2013	0	808	4,137	4,944	15,732	61,301	45,568	40,624
18	2014	0	1,616	4,137	5,752	15,732	61,301	45,568	39,816
19	2015	0	808	4,137	4,944	15,732	61,301	45,568	40,624
20	2016	0	0	4,137	4,137	15,732	61,301	45,568	41,432
21	2017	0	0	4,137	4,137	15,732	61,301	45,568	41,432
22	2018	0	29,082	4,137	33,218	15,732	61,301	45,568	12,350
23	2019	0	58,163	4,137	62,300	15,732	61,301	45,568	-16,731
24	2020	0	62,596	4,137	66,733	15,732	61,301	45,568	-21,164
25	2021	0	33,828	4,137	37,964	15,732	61,301	45,568	7,604
26	2022	0	7,480	4,137	11,617	15,732	61,301	45,568	33,952
27	2023	0	1,488	4,137	5,625	15,732	61,301	45,568	39,944
28	2024	0	1,983	4,137	6,120	15,732	61,301	45,568	39,449
29	2025	0	808	4,137	4,944	15,732	61,301	45,568	40,624
30	2026	0	0	4,137	4,137	15,732	61,301	45,568	41,432
31	2027	0	0	4,137	4,137	15,732	61,301	45,568	41,432
32	2028	0	15,982	4,137	20,118	15,732	61,301	45,568	25,450
33	2029	0	31,963	4,137	36,100	15,732	61,301	45,568	9,468
34	2030	0	35,763	4,137	39,900	15,732	61,301	45,568	5,669
35	2031	0	19,782	4,137	23,918	15,732	61,301	45,568	21,650
36	2032	0	6,167	4,137	10,303	15,732	61,301	45,568	35,265
37	2033	0	808	4,137	4,944	15,732	61,301	45,568	40,624
38	2034	0	1,616	4,137	5,752	15,732	61,301	45,568	39,816
39	2035	0	808	4,137	4,944	15,732	61,301	45,568	40,624
40	2036	0	0	4,137	4,137	15,732	61,301	45,568	41,432
41	2037	0	0	4,137	4,137	15,732	61,301	45,568	41,432
42	2038	0	29,082	4,137	33,218	15,732	61,301	45,568	12,350
43	2039	0	58,163	4,137	62,300	15,732	61,301	45,568	-16,731
44	2040	0	62,596	4,137	66,733	15,732	61,301	45,568	-21,164
45	2041	0	33,828	4,137	37,964	15,732	61,301	45,568	7,604
46	2042	0	7,480	4,137	11,617	15,732	61,301	45,568	33,952
47	2043	0	1,488	4,137	5,625	15,732	61,301	45,568	39,944
48	2044	0	1,983	4,137	6,120	15,732	61,301	45,568	39,449
49	2045	0	808	4,137	4,944	15,732	61,301	45,568	40,624
50	2046	0	0	4,137	4,137	15,732	61,301	45,568	41,432
Total		273,481	619,865	195,269	1,088,614	960,032	2,744,370	1,784,338	695,723
IRR =		5.05%							

Table 4.6.8. Sensitivity Analysis of Option-1, Case 2

(Unit : US$ X10³)

	Year	Costs				Benefit			Balance
		Investment	Replacement	O&M	Total	w/o Project	W/Project	Incremental	
0	1996	0	0	0	0	42,014	42,014	0	0
1	1997	0	0	0	0	39,625	39,625	0	0
2	1998	3,315	0	1,275	4,590	37,236	37,236	0	-4,590
3	1999	32,255	0	1,275	33,530	34,847	34,847	0	-33,530
4	2000	57,920	0	1,534	59,455	32,457	32,457	0	-59,455
5	2001	66,511	0	2,165	68,676	30,068	30,068	0	-68,676
6	2002	46,922	0	2,818	49,740	27,679	27,679	0	-49,740
7	2003	25,667	0	3,276	28,944	25,289	25,289	0	-28,944
8	2004	10,161	734	3,546	14,441	22,900	22,900	0	-14,441
9	2005	5,868	1,469	3,685	11,023	20,511	20,511	0	-11,023
10	2006	0	734	3,761	4,495	18,121	28,669	10,547	6,052
11	2007	0	0	3,761	3,761	15,732	36,827	21,095	17,334
12	2008	0	0	3,761	3,761	15,732	44,985	29,253	25,492
13	2009	0	14,529	3,761	18,289	15,732	53,143	37,410	19,121
14	2010	0	29,058	3,761	32,818	15,732	61,301	45,568	12,750
15	2011	0	32,512	3,761	36,273	15,732	61,301	45,568	9,296
16	2012	0	17,983	3,761	21,744	15,732	61,301	45,568	23,825
17	2013	0	5,606	3,761	9,367	15,732	61,301	45,568	36,202
18	2014	0	734	3,761	4,495	15,732	61,301	45,568	41,073
19	2015	0	1,469	3,761	5,229	15,732	61,301	45,568	40,339
20	2016	0	734	3,761	4,495	15,732	61,301	45,568	41,073
21	2017	0	0	3,761	3,761	15,732	61,301	45,568	41,808
22	2018	0	0	3,761	3,761	15,732	61,301	45,568	41,808
23	2019	0	26,438	3,761	30,198	15,732	61,301	45,568	15,370
24	2020	0	52,875	3,761	56,636	15,732	61,301	45,568	-11,068
25	2021	0	56,906	3,761	60,666	15,732	61,301	45,568	-15,098
26	2022	0	30,753	3,761	34,513	15,732	61,301	45,568	11,055
27	2023	0	6,800	3,761	10,561	15,732	61,301	45,568	35,008
28	2024	0	1,353	3,761	5,113	15,732	61,301	45,568	40,455
29	2025	0	1,803	3,761	5,563	15,732	61,301	45,568	40,005
30	2026	0	734	3,761	4,495	15,732	61,301	45,568	41,073
31	2027	0	0	3,761	3,761	15,732	61,301	45,568	41,808
32	2028	0	0	3,761	3,761	15,732	61,301	45,568	41,808
33	2029	0	14,529	3,761	18,289	15,732	61,301	45,568	27,279
34	2030	0	29,058	3,761	32,818	15,732	61,301	45,568	12,750
35	2031	0	32,512	3,761	36,273	15,732	61,301	45,568	9,296
36	2032	0	17,983	3,761	21,744	15,732	61,301	45,568	23,825
37	2033	0	5,606	3,761	9,367	15,732	61,301	45,568	36,202
38	2034	0	734	3,761	4,495	15,732	61,301	45,568	41,073
39	2035	0	1,469	3,761	5,229	15,732	61,301	45,568	40,339
40	2036	0	734	3,761	4,495	15,732	61,301	45,568	41,073
41	2037	0	0	3,761	3,761	15,732	61,301	45,568	41,808
42	2038	0	0	3,761	3,761	15,732	61,301	45,568	41,808
43	2039	0	26,438	3,761	30,198	15,732	61,301	45,568	15,370
44	2040	0	52,875	3,761	56,636	15,732	61,301	45,568	-11,068
45	2041	0	56,906	3,761	60,666	15,732	61,301	45,568	-15,098
46	2042	0	30,753	3,761	34,513	15,732	61,301	45,568	11,055
47	2043	0	6,800	3,761	10,561	15,732	61,301	45,568	35,008
48	2044	0	1,353	3,761	5,113	15,732	61,301	45,568	40,455
49	2045	0	1,803	3,761	5,563	15,732	61,301	45,568	40,005
50	2046	0	734	3,761	4,495	15,732	61,301	45,568	41,073
Total		273,481	619,865	195,269	985,889	960,032	2,744,370	1,784,338	798,449
IRR =		6.47%							

Table 4.6.9. Sensitivity Analysis of Option-1, Case 3

(Unit : US$ X10³)

Year		Costs				Benefit			Balance
		Investment	Replacement	O&M	Total	w/o Project	W/Project	Incremental	
0	1996	0	0	0	0	42,014	42,014	0	0
1	1997	3,315	0	1,275	4,590	39,625	39,625	0	-4,590
2	1998	32,255	0	1,275	33,530	37,236	37,236	0	-33,530
3	1999	57,920	0	1,534	59,455	34,847	34,847	0	-59,455
4	2000	66,511	0	2,165	68,676	32,457	32,457	0	-68,676
5	2001	46,922	0	2,818	49,740	30,068	30,068	0	-49,740
6	2002	25,667	0	3,276	28,944	27,679	27,679	0	-28,944
7	2003	10,161	734	3,546	14,441	25,289	25,289	0	-14,441
8	2004	5,868	1,469	3,685	11,023	22,900	22,900	0	-11,023
9	2005	0	734	3,761	4,495	20,511	27,522	7,011	2,516
10	2006	0	0	3,761	3,761	18,121	34,434	16,313	12,552
11	2007	0	0	3,761	3,761	15,732	41,346	25,614	21,854
12	2008	0	14,529	3,761	18,289	15,732	48,258	32,526	14,237
13	2009	0	29,058	3,761	32,818	15,732	55,171	39,438	6,620
14	2010	0	32,512	3,761	36,273	15,732	55,171	39,438	3,166
15	2011	0	17,983	3,761	21,744	15,732	55,171	39,438	17,695
16	2012	0	5,606	3,761	9,367	15,732	55,171	39,438	30,072
17	2013	0	734	3,761	4,495	15,732	55,171	39,438	34,943
18	2014	0	1,469	3,761	5,229	15,732	55,171	39,438	34,209
19	2015	0	734	3,761	4,495	15,732	55,171	39,438	34,943
20	2016	0	0	3,761	3,761	15,732	55,171	39,438	35,678
21	2017	0	0	3,761	3,761	15,732	55,171	39,438	35,678
22	2018	0	26,438	3,761	30,198	15,732	55,171	39,438	9,240
23	2019	0	52,875	3,761	56,636	15,732	55,171	39,438	-17,198
24	2020	0	56,906	3,761	60,666	15,732	55,171	39,438	-21,228
25	2021	0	30,753	3,761	34,513	15,732	55,171	39,438	4,925
26	2022	0	6,800	3,761	10,561	15,732	55,171	39,438	28,878
27	2023	0	1,353	3,761	5,113	15,732	55,171	39,438	34,325
28	2024	0	1,803	3,761	5,563	15,732	55,171	39,438	33,875
29	2025	0	734	3,761	4,495	15,732	55,171	39,438	34,943
30	2026	0	0	3,761	3,761	15,732	55,171	39,438	35,678
31	2027	0	0	3,761	3,761	15,732	55,171	39,438	35,678
32	2028	0	14,529	3,761	18,289	15,732	55,171	39,438	21,149
33	2029	0	29,058	3,761	32,818	15,732	55,171	39,438	6,620
34	2030	0	32,512	3,761	36,273	15,732	55,171	39,438	3,166
35	2031	0	17,983	3,761	21,744	15,732	55,171	39,438	17,695
36	2032	0	5,606	3,761	9,367	15,732	55,171	39,438	30,072
37	2033	0	734	3,761	4,495	15,732	55,171	39,438	34,943
38	2034	0	1,469	3,761	5,229	15,732	55,171	39,438	34,209
39	2035	0	734	3,761	4,495	15,732	55,171	39,438	34,943
40	2036	0	0	3,761	3,761	15,732	55,171	39,438	35,678
41	2037	0	0	3,761	3,761	15,732	55,171	39,438	35,678
42	2038	0	26,438	3,761	30,198	15,732	55,171	39,438	9,240
43	2039	0	52,875	3,761	56,636	15,732	55,171	39,438	-17,198
44	2040	0	56,906	3,761	60,666	15,732	55,171	39,438	-21,228
45	2041	0	30,753	3,761	34,513	15,732	55,171	39,438	4,925
46	2042	0	6,800	3,761	10,561	15,732	55,171	39,438	28,878
47	2043	0	1,353	3,761	5,113	15,732	55,171	39,438	34,325
48	2044	0	1,803	3,761	5,563	15,732	55,171	39,438	33,875
49	2045	0	734	3,761	4,495	15,732	55,171	39,438	34,943
50	2046	0	0	3,761	3,761	15,732	55,171	39,438	35,678
Total		248,619	563,513	177,517	989,649	960,032	2,540,156	1,580,124	590,474
IRR =		5.08%							

Table 4.6.10. Cash Outflow and Inflow of Option-1

(Unit : US$ X10³)

Year		Cash Outflow						Cash Inflow				Total	Accumulated
		Investment	Replacement	O&M	Loan Interest	Loan Repayment	Total	Foreign Loan	Government Budget	Government Subsidy	Total	Balance	Loan
1	1997	3,315	0	1,275	66		4,656	2,210	1,105	1,341	4,656	0	2,210
2	1998	32,255	0	1,275	711		34,242	21,503	10,752	1,986	34,242	0	23,713
3	1999	57,920	0	1,534	1,870		61,325	38,614	19,307	3,404	61,325	0	62,327
4	2000	66,511	0	2,165	3,200		71,876	44,340	22,170	5,365	71,876	0	106,667
5	2001	46,922	0	2,818	4,138		53,878	31,281	15,641	6,957	53,878	0	137,948
6	2002	25,667	0	3,276	4,652		33,595	17,112	8,556	7,928	33,595	0	155,060
7	2003	10,161	734	3,546	4,855		19,296	6,774	4,121	8,401	19,296	0	161,834
8	2004	5,868	1,469	3,685	4,972		15,995	3,912	3,425	8,658	15,995	-0	165,746
9	2005	0	734	3,761	4,972		9,467		734	8,733	9,467	0	165,746
10	2006	0	0	3,761	4,972		8,733		0	8,733	8,733	0	165,746
11	2007	0	0	3,761	4,724	8,287	16,772		0	16,772	16,772	0	157,459
12	2008	0	14,529	3,761	4,475	8,287	31,052		14,529	16,523	31,052	0	149,172
13	2009	0	29,058	3,761	4,227	8,287	45,332		29,058	16,276	45,332	0	140,884
14	2010	0	32,512	3,761	3,978	8,287	48,538		32,512	16,026	48,538	0	132,597
15	2011	0	17,983	3,761	3,729	8,287	33,760		17,983	15,777	33,760	0	124,310
16	2012	0	5,606	3,761	3,481	8,287	21,135		5,606	15,529	21,135	0	116,022
17	2013	0	734	3,761	3,232	8,287	16,014		734	15,280	16,014	0	107,735
18	2014	0	1,469	3,761	2,983	8,287	16,500		1,469	15,031	16,500	0	99,448
19	2015	0	734	3,761	2,735	8,287	15,517		734	14,783	15,517	0	91,160
20	2016	0	0	3,761	2,486	8,287	14,534		0	14,534	14,534	0	82,873
21	2017	0	0	3,761	2,238	8,287	14,285		0	14,285	14,285	0	74,586
22	2018	0	26,438	3,761	1,989	8,287	40,475		26,438	14,037	40,475	0	66,298
23	2019	0	52,875	3,761	1,740	8,287	66,664		52,875	13,788	66,664	0	58,011
24	2020	0	56,906	3,761	1,492	8,287	70,445		56,906	13,540	70,445	0	49,724
25	2021	0	30,753	3,761	1,243	8,287	44,044		30,753	13,291	44,044	0	41,437
26	2022	0	6,800	3,761	994	8,287	19,843		6,800	13,042	19,843	0	33,149
27	2023	0	1,353	3,761	746	8,287	14,147		1,353	12,794	14,147	0	24,862
28	2024	0	1,803	3,761	497	8,287	14,348		1,803	12,545	14,348	0	16,575
29	2025	0	734	3,761	249	8,287	13,031		734	12,296	13,031	0	8,287
30	2026	0	0	3,761	0	8,287	12,048		0	12,048	12,048	0	0
31	2027	0	0	3,761			3,761		0	3,761	3,761	0	0
32	2028	0	14,529	3,761			18,289		14,529	3,761	18,289	0	0
33	2029	0	29,058	3,761			32,818		29,058	3,761	32,818	0	0
34	2030	0	32,512	3,761			36,273		32,512	3,761	36,273	0	0
35	2031	0	17,983	3,761			21,744		17,983	3,761	21,744	0	0
36	2032	0	5,606	3,761			9,367		5,606	3,761	9,367	0	0
37	2033	0	734	3,761			4,495		734	3,761	4,495	0	0
38	2034	0	1,469	3,761			5,229		1,469	3,761	5,229	0	0
39	2035	0	734	3,761			4,495		734	3,761	4,495	0	0
40	2036	0	0	3,761			3,761		0	3,761	3,761	0	0
41	2037	0	0	3,761			3,761		0	3,761	3,761	0	0
42	2038	0	26,438	3,761			30,198		26,438	3,761	30,198	0	0
43	2039	0	52,875	3,761			56,636		52,875	3,761	56,636	0	0
44	2040	0	56,906	3,761			60,666		56,906	3,761	60,666	0	0
45	2041	0	30,753	3,761			34,513		30,753	3,761	34,513	0	0
46	2042	0	6,800	3,761			10,561		6,800	3,761	10,561	0	0
47	2043	0	1,353	3,761			5,113		1,353	3,761	5,113	0	0
48	2044	0	1,803	3,761			5,563		1,803	3,761	5,563	0	0
49	2045	0	734	3,761			4,495		734	3,761	4,495	0	0
50	2046	0	0	3,761			3,761		0	3,761	3,761	0	0
Total		248,619	563,513	177,517	67,668	165,746	1,237,063	165,746	666,366	426,911	1,257,043	-0	2,721,588

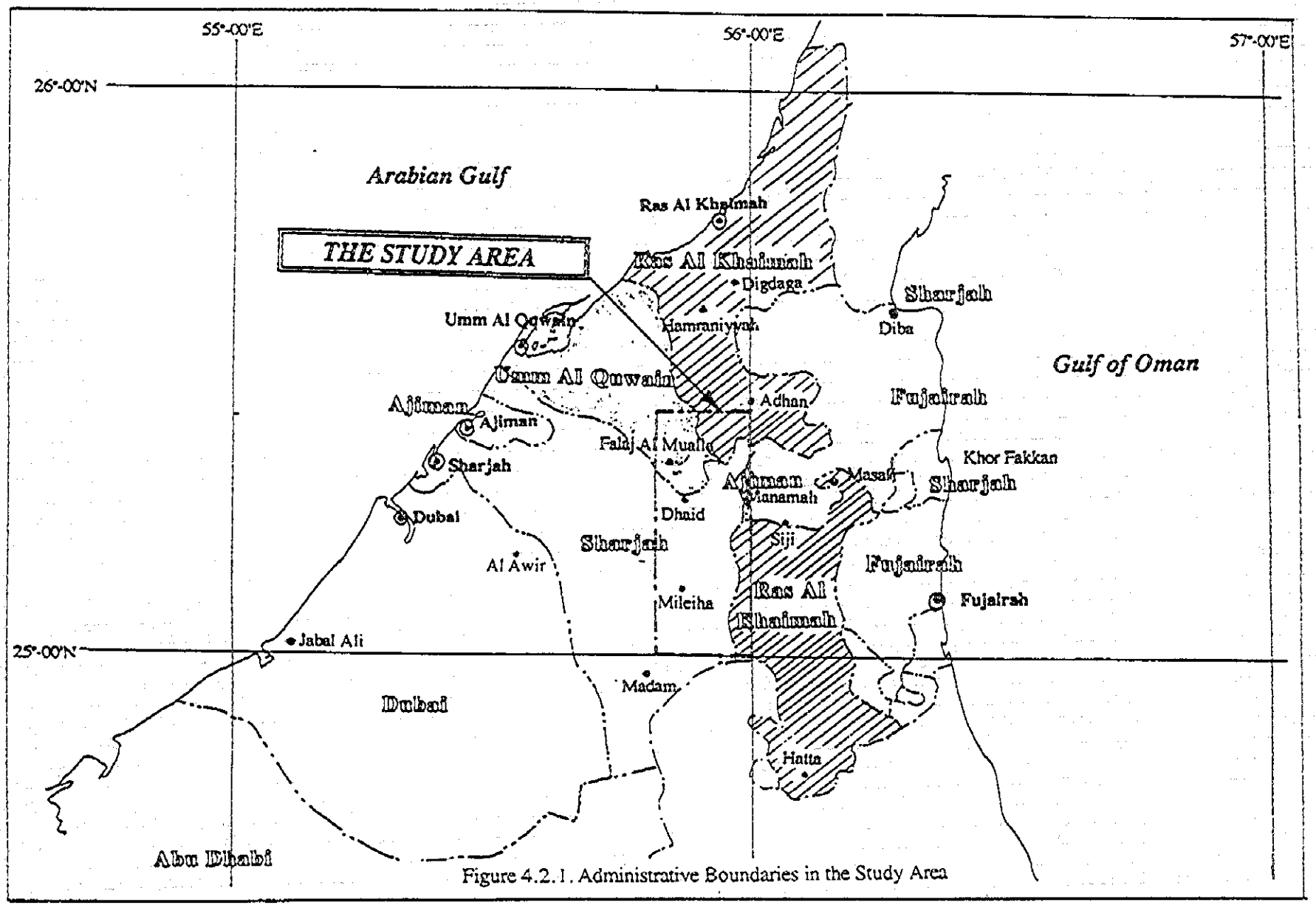
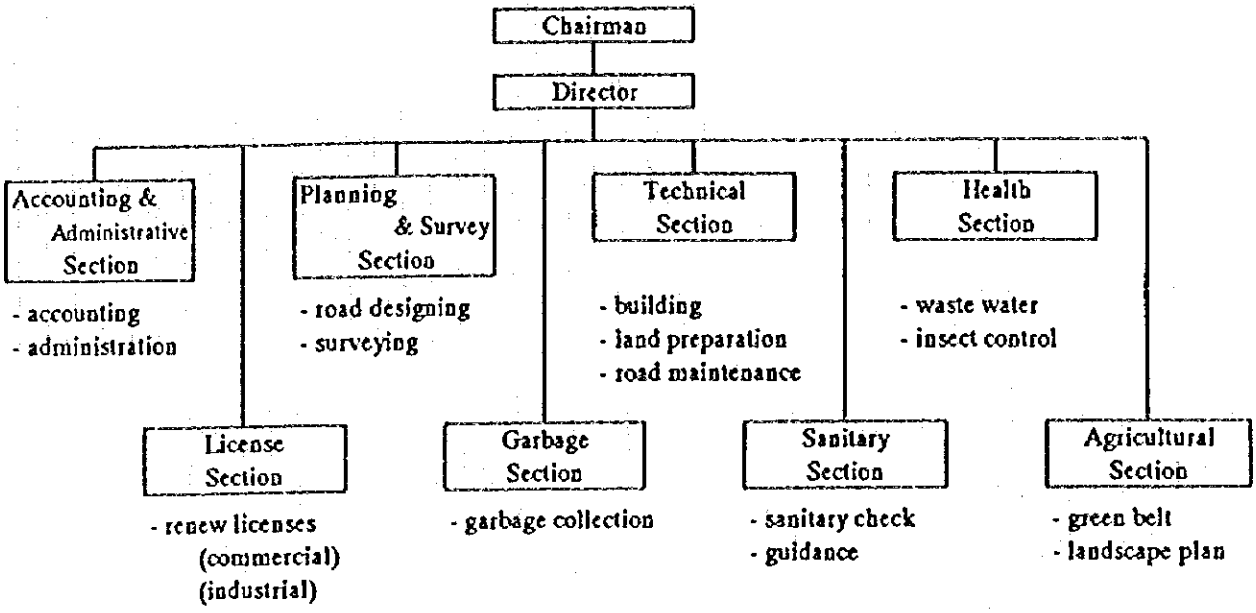


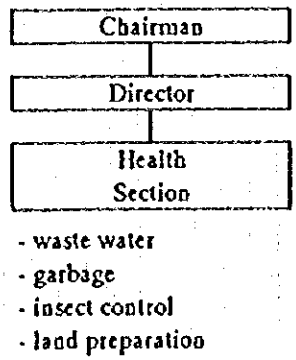
Figure 4.2.1. Administrative Boundaries in the Study Area

Figure 4.2.2. Organization Chart of Municipal Offices in the Study Area

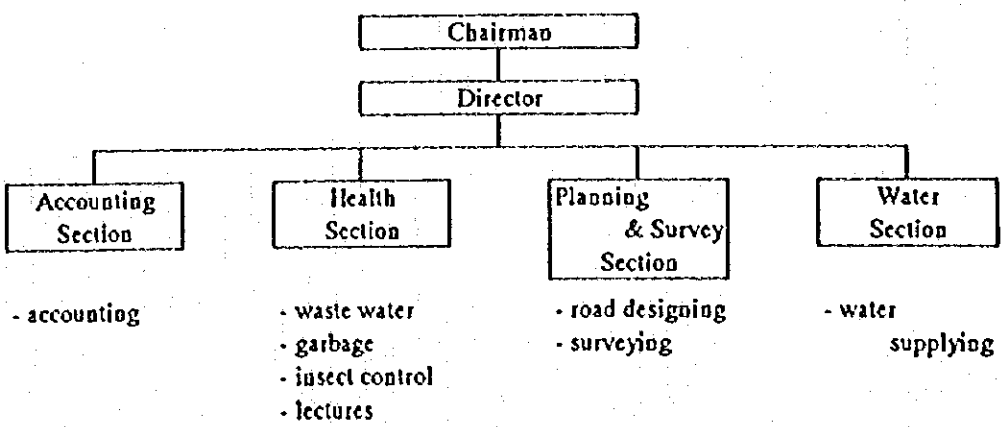
Sharjah Municipality, Dhaid Section



Sharjah Municipality, Dhaid Section, Mileiha Branch



Umm Al Quiwain Municipality, Falaj Al Mualla



VOLUME TWO : SECTOR REPORT

CHAPTER FIVE : FACILITIES

VOLUME TWO : SECTOR REPORT

CHAPTER FIVE : FACILITIES

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER FIVE: FACILITIES

5.1. Irrigation Facilities

5.1.1. Farm Facilities

(1) Layout of Water Sources and Farming Facilities

Figure 5.1.1-1 and Figure 5.1.1-2 show the layout of water sources and farming facilities and represent the "Farming Plan" and the "Irrigation Plan." Dimensions of these farms are shown in Table 5.1.1-1 and Table 5.1.1-2. The farm size of both options is 4.68 ha with 4 ha of cultivation area. This farm size includes the estimated unit facility cost. Although its size is common in the Study Area, the Team did not include the ideal size of the farm in the Study.

When the total cropping area is 4 ha, the cultivation area in Option 1 is 2.7 ha for dates, 0.4 ha for vegetables, and 0.9 ha for alfalfa. On the other hand, the areas in Option-2 are 1.0 ha for dates, 1.6 ha for vegetables, and 1.4 ha for alfalfa. Since Option-2 has a larger area for dates and alfalfa than Option-1, it consumes 150% more of irrigation water than Option-1.

Facilities and dimensions for both options do not have any remarkable differences. Since Option-2 has to store the water from an alternative source (desalinated pipeline), however, the capacity of the on-farm storage tank in Option-2 is larger than that in Option-1. For the Option-2 farm with 4 ha cropping area, 200 m^3 tank was installed. The water requirement in the dry season is about 80%.

(2) Cost Estimation for Construction

Both farms in Figure 5.1.1. adopt the water-saving irrigation method described in "Irrigation Plan." Bubbler or drip irrigation systems are applied to the vegetable and dates area while sprinkler irrigation system is applied to alfalfa. Basin irrigation was not applied.

Water for irrigation is pumped from a well or wells in the farm, delivered to and collected by the on-site tank. Then, water stored in the tank is boosted by pump and distributed by pipeline for irrigation use. The construction cost of water source facilities including the well, pipeline, tank and booster pump and farming facility consisting of distribution pipeline, sprinkler, bubbler, and greenhouse is 262,390 dollar per 4 hectares (=$65,600/ha) for Option-1. The cost for Option-2 is 149,500 dollar per 4 hectares (=$37,375/ha).

Generally, the water-saving method works when the set of facilities is completed. Several

farms in the Study Area have already adopted bubbler and sprinkler systems but they have not installed delivery pipelines yet, or still have not adopted basin irrigation for part of the farming area. Therefore, the estimated cost of construction of a water source and farming facility was based on the total farming area in the Study Area and the cost for the complete facility set.

5.1.2. Operation and Maintenance of Farm Facilities

(1) Operation and Maintenance Plan

Presently, the irrigation period and amount of irrigation water are determined by the administrator of each farm and the water from the resources of each farm is used for irrigation. In the case of drying up of the individual water resources, cultivation is abundant except on the issue of getting water from neighboring farmers. Before starting to use individual wells (at the time, people used using falajes which are drying up now), collaborative use of ground water was carried out. In other areas, collaborative operation of wells is observed. Considering the condition in the Study Area that most farm are the property of absentee-owners, an irrigation system involving collaborative operation of wells cannot be applied. Thus, the present irrigation system will continue to be applied. In Option-2, desalinated sea water is distributed to the water tanks installed at individual farms.

(2) Estimated Maintenance Cost

Operation and maintenance costs, which include of the cost of the pump and pipeline, working life of bubbler and sprinkler, maintenance cost of facility, cost of electricity is 11,900 dollar per 4 hectare (=$2,550/ha) for Option-1 while for Option-2 it is 11,800 dollar per 4 hectare (=$2,530/ha).

5.2. Groundwater Augmentation

5.2.1. Introduction

The rainfall on the Bahada Plain does not contribute to the groundwater recharge due to water retention in the surface layer and the large amounts of loss through evapo-transpiration. Meanwhile, the floods generated in the mountain wadi flow down the wadi channels in the Bahada Plain and seem to recharge the groundwater substantially. Remarkable flood records observed by MAF indicate that the mean annual flood runoff from the major mountain wadis (Wadi Siji and Khadrah) in the Study Area during 15-year period from 1975/76 to 1989/90 ranged from 1.5 to 2.1 MCM/a; and there was a flood runoff of only 0.5 MCM/a. From the specific runoff (0.0107 MCM/a/km^2) and the total mountain catchment area (983 km^2), the mean flood runoff generated in the mountain wadi in the Study Area was estimated to be 11 MCM/a. If this floodwater could be forced to permeate the ground at the foot of the mountain, the groundwater may be augmented by several million m^3/year.

Measures for such augmentation are as below:

-Recharge (Flood-Detention) Dam;

The function of the scheme is to store the major part of a flood in the reservoir in order to prevent the unnecessary discharge of water from the basin, releasing stored water in line with the infiltration capacity of the wadi channel below the dam, and to thus augment groundwater recharge within the basin. A number of such recharge dams have been constructed in UAE and Oman.

-Recharge Trench

The permeability of sedimentary layers in the wadi beds and the Bahada Plain is much larger in the horizontal direction than in the vertical direction. A drastic improvement in the total infiltration capacity of the wadi bed may possibly be made by installing a trench of certain depth and width. Consequently, the trench is to be refilled with filter gravel, and river works are necessary to some extent. A remarkable effect in groundwater augmentation may be expected if such trenches are constructed along the base of the mountain in the Study Area.

-Underground Dam

A water-storage dam constructed on the surface cannot avoid evaporation loss from the water surface and silt sedimentation in the reservoir bottom. Due to the high intensity of the said phenomena, the construction of a storage dam on the surface is, in many cases, not feasible in an arid area.

However, a water-storage dam and reservoir could be constructed under the ground where

appropriate conditions prevail. Many advantages may be expected from the underground dam scheme in that no evaporation loss or sedimentation takes place. The groundwater is stored in the shallow area of the upper reaches in order to prevent loss to the lower reaches. Some possible sites from underground dams are available in the Study Area.

5.2.2. Recharge Dam (Flood Detention Dam)

In this Study, three recharge dams on wadi Siji, wadi Khadrah, and wadi Shoukah were proposed. The dimension, cost estimation and its effect were studied. These three wadis have their catchment area in the mountains which are located on the east of the Study Area. When a flood occurs on these wadis, it crosses the gravel plain located on the east part of the Study Area, passes the agricultural area located in the middle of the Study Area, and then flows in a north-west direction. To improve the underground water recharge, the proposed recharge dams are located on the wadis at the entrance to the gravel plain where the east end of the Study Area and the wadis approach the mountain side. The location and scale of the proposed recharge dams are as follows:

(1) Location of Proposed Recharge Dam

Location of proposed recharge dams are shown in Figure 5.2.1. The proposed recharge dam on wadi Siji is close to the wadi gauge which was constructed in the mountain side. Proposed dam site on wadi Khadrah is located on the east of Khadrah village, while the proposed dam site on wadi Shoukah is located near the quarry site located on the edge of the gravel plain.

Three dam sites with topographical maps are shown in Figure 5.2.1., Figure 5.2.2., and Figure 5.2.4. Siji dam is located in a mountain area and has a saddle dam. Khadrah is located on the gravel plain, and Shoukah dam is followed by three saddle dams.

Catchment area of each proposed dam is shown in Table 5.2.1. Khadrah dam has a relatively large capacity. Several farms are inundated, however, when dam storage reaches its full capacity of water. On the other hand, both Siji dam and Shoukah dams have less capacity and bring no inundation to the farming area.

(2) Flood Run-off

MAF has collected run-off data of flood since the installation of wadi gauges on wadi Siji, wadi Khadrah, and two branches of wadi Khadrah (wadi Ashwani and wadi Shifuni) in 1977. MAF has constructed 9 rainfall stations in the Study Area or catchment area and has collected rainfall records for 20 years. Relations between rainfall and flood run-off was found in the long-term data (monthly or yearly).

However, no relations between rainfall and flood run-off can be found in the daily data because the number of rainfall stations is not enough to determine rainfall in the mountain side by Thiessen-polygon method. Also, 19 year-flood records are not enough to determine the design of the flood discharge by means of statistics. Also, flood magnitude and volume for different return-periods, which were shown in HYDROLOGY, published by MAF, was applied to determine the dam capacity and spillway capacity. This magnitude and volume are based on the MAF survey and flood return-period according to rational formula.

In this Study, 25 year-return periods and 10,000 year-return periods are applied to determine both dam capacity and spillway capacity. These return-periods are generally, similar to studies made in other projects. Table 5.2.1. sunumarizes catchment area, dam capacity with flood volume of 25 year-return period, surface area of dam storage, and full water level for each proposed dam. Flood discharge at dam site is calculated by specific discharge and catchment area. Full water level is considered with the sedimentation volume, which was obtained by annual sedimentation volume in HYDROLOGY.

Spillway capacity, which has the magnitude of flood discharge of a 10,000 year-return period is shown in Table 5.2.2. Maximum flow of spillway in Siji dam and Shoukah dam was 500 m^3/sec while maximum flow of spillway in Khadrah dam was 700 m^3/sec. With settings of 1.5 m overflow depth and 2.5 m freeboard, design flood level, dam height, and spillway dimension were shown in Table 5.2.2. A spillway is a concrete weir with a trapezoid cross-section. Coefficient of discharge is 1.81 which is based on hydraulic formula. Surface area of storage with design flood level of Khadrah dam is 1.2 km^2 and surface area of Siji dam and Shoukah dam are 1.0 km^2.

(3) Ground Water Augmentation

Simulation of Synthetic Storage Model with recharge dam operation with run-off data from mountain wadis (1977 to 1995) was carried out to determine how it contributes to the ground water recharge. As a result, it was found that peak-cut and constant discharge for downstream does not contribute to groundwater recharge but increases evapo-transpiration. In a particular year, a negative effect on ground water recharge was found. In this simulation, the design discharge capacity was set to discharge full dam storage within 10 days.

(4) Estimated Construction Cost

The proposed recharge dam is a homogeneous embankment dam and has a concrete spillway and discharge conduit. Figure 5.2.5 shows the standard cross-section of an

embankment. The embankment volume for each dam increases in proportion to the dam height. Figure 5.2.6 shows the spillway cross-section. Figure 5.2.7 shows the typical dam vertical-section. Figure 5.2.8 shows the outlet cross-section. This conduit is planned to be made of concrete. It is installed and back-filled under the ground. Considering the sedimentation, the intake of the conduit has formed an "L"-shape concrete box with stop logs.

The construction cost, based on the UAE market price and the embankment volume, was estimated. Estimated cost for each recharge dam are shown in Table 5.2.3. The cost for Siji dam was the highest due to the large amount of excavation necessary for the spillway construction. Shoukah dam ranked second, and Khadrah, the third. The cost per unit storage water for Khadrah dam was highest, Shoukah dam was the second, and Siji dam was the third.

5.2.3. Recharge Trench

The following are the dimensions and estimated construction costs of the proposed recharge trenches on wadi Siji, wadi Khadrah, and wadi Shoukah.

(1) Dimension of Recharge Trench

Location of proposed recharge trenches were shown in Figure 5.2.1. Cross section of a trench with embankment protection works is shown in Figure 5.2.9. The trench has a dimension of 1.5 m width, 6.0 m depth, and 1,000 m length. Construction of the trench follows the course of the river and the revetment is shored up with gabions (0.5 m × 1.0 m × 2.0 m). These works are necessary to guide the water route along the trench and to keep the trench full with water. Excavated trench and wadi bed are backfilled by the filter material that was used in the infiltration test.

Although deterioration of infiltration rate of the trench by siltation may occur, it may not be serious because of a muddy stream on the proposed site which brings silt at the beginning of a flood and later changes to clean stream. It is supported by the fact that the surface of the present wadi bed has less siltation on site. Moreover, the sites are considered as appropriate because three of them are far from farms; No farms shall be removed from the proposed site.

(2) Cost Estimation for Construction

The construction cost for a recharge trench with the dimensions described is estimated to be US$ 1.43 million (=158 million Japanese Yen). Table 5.2.4. shows the breakdown of the construction cost. The cost and dimensions of the trench are the same for all three

sites.

According to the 19-year runoff data, annual average permeability of Siji trenches 390 thousand m^3/year, Khadrah trench is 40 thousand m^3/year, and Shoukah trench is 340 thousand m^3/year, respectively. Computer simulation of synthetic storage model with these parameters entered implied that annual total recharge increases to 300 thousand m^3/year, which is considered to be a developed water resource.

5.2.4. Underground Dam

(1) Location of Proposed Underground Dam Site

Location of the underground dam is shown in Figure 5.2.1. Storage area and location of the cut-off wall is shown in Figure 5.2.10. The site is located in north-east of Khadrah village and the storage area is located between two hills that run east to west.

Cut-off wall (axis of underground dam) is located on a line between the east end of two hills. Extension of the cut-off wall is 18 km and the average depth of the aquifer to storage water is 70 m. With a 2% storage coefficient in the aquifer, this underground dam has 9 million m^3 storage capacity.

With river training and construction of a low height embankment in wadi Khadrah, flood discharge can be introduced to the catchment area of the underground dam. Flood discharge of a return-period of 10,000 at the run-off gauge of wadi Khadrah is 10 million m^3. If 100% of flood discharge is recharged, 90% of flood with 10,000 years return period can be stored; however, 100% cannot be recharged. In addition, since flood discharge of a return-period of 25 years is 3.3 million m^3 and average annual discharge at the run-off gauge of wadi Khadrah is 1 million m^3, the storage capacity of the dam is large enough to catch almost all wadi flood in this site even though 100% of flood discharge was recharged.

Considering the infiltration rate with a recharge trench in the past 19 years, the average yearly storage in this underground dam is 36 thousand m^3, which is 4% of the total capacity. Therefore, this underground dam cannot be expected to bring appropriate benefits.

(2) Estimated Cost for Construction

The estimated cost for construction of the underground dam was US$ 140 million. Since the installed cut-off wall was free from maintenance, the water cost was calculated at 14 dollar/m^3 with a 50 year working life. For the actual operation of the underground dam, an intake facility involving such things as production wells, water transportation and a distribution pipeline system are required. Therefore, the unit water price of a farm site is

much higher than the price of raw water. Also, organization of a water users' group should be established to maintain and operate these facilities.

5.2.5. Summary

The underground dam has a different concept from the detention dam and the groundwater recharge trench. It is basically constructed to obtain profit related to the water management in the basin in order (1) to secure the water storage, and (2) to stabilize water production by the water management. While the detention dam and groundwater recharge trench has a function to produce the groundwater recharge by restricting evapo-transpiration and surface runoff.

Based on the studies made, the underground dam is not appropriate in the Study Area from the viewpoint of hydrological balance. The water balance in the Study Area is constantly negative or insufficient. This means that the surplus water to be allocated to the underground reservoir is not enough to operate a dam aiming at the stabilization of a water source. As a new method for solving this difficulty, this dam may be utilized as a local reservoir for the desalinated water conveyed out of the Study Area.

Although the detention dam is aiming to promote the groundwater recharge by detaining the flood water and by preventing invalid runoff from the Study Area, this dam will not be effective in the Study Area due primarily to its high rate of evaporation. The groundwater recharge newly produced by this facility is very small because most of the flood has already permeated the Bahada Plain. Furthermore, the observed value of 0.4 MCM/a at the lowest reach of the Study Area does not coincide with the rainfall pattern in the mountain area; thus the flood which occurs at the down reach is mostly coming from rainfall on the Bahada Plain. In such conditions, the detention dam constructed at the mountain will not be suitable. Only the dam construction in a confined area, where floods constantly flow down to the sea or dune area, may have some effect for this type of dam.

The groundwater recharge trench has a clear advantage over the other two facilities by directly filtering water into the subsurface. The effectiveness of this facility is twofold: (1) prevention of the evaporation loss at the surface by a steady movement of water to the subsurface, and (2) decreasing the evapo-transpiration when water does permeate. The purpose of the groundwater recharge trench is substantially pointed out by prevention of evapotranspiration loss, and the role is played well with such high potential: as large as 3,700 mm/a of the Study Area. To fulfill its function in the Study Area, however, these difficulties of (1) high permeability at the surface, (2) the wide space to set up the trench, (3) effective measuring to prevent silting after flood, (4) management plan, shall need to be solved.

Under this study, the two proposed groundwater augmentation schemes: (1) three recharge trenches plan and (2) three recharge dams with three trenches plan were examined by the computer simulation of synthetic storage model.

According to a computer simulation of the three trenches plan, namely trench construction in wadi Siji, wadi Khadrah, and wadi Shoukah, the dam develops an additional 300 thousand m^3/year. The total construction cost of the three trenches are 4.29 million dollar (=$1.43 million×3) and the unit water cost is 2.05 dollar/m^3.

On the other hand, combination of three sets of recharge dam and trench plan develops 1,970 thousand m^3/year. In this plan buffer, the function of the dams extend the full water period of the recharge trench. Computer simulation over the past 19 years run off data shows that total infiltration volume of Plan (2) is 4 to 10 times larger than that of Plan (1). The average annual filtration of the dam and trench plan is 1.58 million m^3/year at Siji, 0.4 million m^3/year at Khadrah, and 1.28 million m^3/year at Shoukah. Unit water cost for Plan (2) is 2.87 dollar/m^3, which is 1.4 times larger than unit water of Plan (1). The developed water volume of Plan (2), however, is 6.6 times larger than that of Plan (1). Therefore, Plan (2) can supply the necessary water for "Option-1."

5.3. Facilities Required for Alternative Water

Groundwater is only the resource in the Study Area, and if other resources are required, desalinated water must be considered as an alternative plan. To support the farming plan in "Option-2," 33.9 MCM/a of desalinated water will need to be delivered from the plant to the Study Area. The following table shows the amount of required water for the two cases, particularly the following proposed options:

Table 5.3.1. Water Source for "Option-1" and "Option-2"

Case	Groundwater Resources	Alternative Water Resources
Case required by Option 1	21.5 MCM/a (sustained yield + development yield by artificial facility)	- not required -
Case required by Option 2	21.5 MCM/a (ditto)	33.9 MCM/a (water demand - sustained yield - development yield by artificial facility)

(1) Desalinated Water Pipeline

This pipeline system consists of the delivery line and the distribution branches. The delivery line extends from the plant at Sharjah port to the hills extending to the west end of Al Dhaid. The distribution pipeline system are branch A to Falaj Al Mualla, branch B to Dhaid I, the branch to Dhaid II, and branch C' to Fili. The location of the pipelines is shown in Figure 5.3.1.

The delivery pipeline will be installed alongside the highway connecting Sharjah city with Dhaid city. As this highway crosses the desert and already exist between these two cities, it will be the shortest way. On the way to Al Dhaid, three pumping stations are planned to boost the water up a hill with 120 meter ASL. The pipe is made of steel with a 1,000 mm diameter and the extension of pipeline is 58 km.

The distribution pipeline is made of steel with a diameter of 600 mm or 700 mm, while the distance of the extension is 46 km. Basically, water flows by gravity in this system. Only branch C' to Fili has a pumping station because it has to pass 3 wadis by means of a pipe bridge and convey water to the southernmost part of the Study Area. Table 5.3.2. shows the dimensions of this pipeline.

(2) Cost Estimation for Pipeline Construction

The total construction cost is US$ 240 million and O & M cost is US$ 1.8 million per year. Table 5.3.3. contains the construction costs for the pipeline system components. Water cost is US$ 2.76/m^3, which consists of the transportation cost of $1.49/m^3 and the

production cost of 21 Dh/1000 gallon (=4.56 Dh/m^3) at the plant. This cost of desalinated water from the pipeline is 7% cheaper than the water costs of the recharge facility. Actual water cost on farmland is, however, higher than that of the recharge facility because the pipeline system does not include the construction cost of the connection pipe-networks from the main branches to each farm.