SUMMARY, CONCLUSION AND RECOMMENDATIONS

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A. Summary

INTRODUCTION

1. In response to a request of the Government of Egypt, the Government of Japan decided to implement the feasibility study on Fayoum Agricultural Development Project, and Japan International Cooperation Agency (JICA), the official agency responsible for implementation of the technical cooperation programs of the Government of Japan, dispatched a study team for the first and second field works in winter and summer in accordance with the Scope of Works (S/W) for the feasibility study on Fayoum Agricultural Development Project.

2. The Feasibility Study Report has been compiled according to the results of survey and study conducted in the field and in Japan, and numerous discussion meetings were held among the Egyptian officials concerning the Project, the supervisory group and the study team.

   As for the Project Study, the field surveys were carried out by the first field work in February and March, 1984 and the second field work in July to September, 1984.

3. Objectives of the study are, as mentioned in S/W, (i) to formulate the Project and verify its technical and economic feasibility; and (ii) to undertake on-the-job training of the Egyptian counterparts and transfer the technology to them in the course of the study. The study area is defined by S/W as follows;

   a. About 5,700 feddan (2,390 ha) in North Wahby area and 3,300 feddan (1,390 ha) in Com Osheem area;

b. About 23,000 feddan (9,660 ha) of the existing farm land in Wahby Downstream area; and,

c. About 15,000 feddan (6,300 ha) lying along the southern coast of Lake Qarun.

4. Fayoum is a depression located some 100 kilometers southwest of Cairo in the Western Egyptian Desert and one of the oldest agricultural areas in the Arab Republic of Egypt. Fayoum area covers about 1,827 square kilometers and about 315,000 feddan (132,000 ha) of the present cultivated land. Major industries of Fayoum are agriculture, livestock farming, and fisheries. Among them, agriculture is the most important industry in Fayoum.

Population in Fayoum was about 1,316,000 in 1981. The annual growth rate was two percent from 1966 to 1976, and 2.8 percent from 1976 to 1981. The population of 12 villages in Wahby Downstream Area and the South Area of Lake Qarun amounted to about 116,600 in 1982.

For the settlement of tenant farmers and landless workers living in Fayoum and the increase in agricultural land, Fayoum Governorate has several agricultural development plans aiming to reclaim the desert area peripheral to Fayoum depression as well as to improve the existing irrigation and drainage facilities in cultivated land.

PROPOSED PROJECT AREA

5. The reclamation area of North Wahby and Com Osheem is located at the right bank of Bahr Wahby and Gomhouria canal in the desert area. However, part of the area which is relatively low in elevation and close to Bahr Wahby, is being reclaimed by a private enterprise. Excepting this area, the desert area of 5,100 feddan (2,140 ha) in North Wahby and 3,700 feddan (1,550 ha) in Com Osheem are proposed to be developed by the Project.

6. Wahby Downstream area is so-called a water shortage area, although served by the downstream of Bahr Wahby. Of the study area of 23,000 feddan (9,660 ha), an area of 17,200 feddan (7,220 ha) is proposed to solve the water shortage problem by implementing the Project.

7. The area in belt along the coast of Lake Qarun suffers from ill-drainage since the lake water rises in winter season. A high water level of Lake Qarun causes inundation and a high groundwater table as well. Of the study area of 15,000 feddan (6,300 ha), the major inundated/affected area of 6,770 feddan (2,830 ha) is proposed to improve the situations by the Project.

OBJECTIVES OF THE PROJECT

8. The Project aims to increase agricultural production in the Project Area through effective use of the water resources and expansion of farm land by reclaiming the desert area, to create employment opportunities throughout the year, and to improve the living environment from a view point of the rural development by which the social infrastructure and new rural communities will be provided.

9. To achieve the objectives promptly and to accrue benefits quickly in the Project Area, the following should be envisaged;

   a. Land reclamation in North Wahby and Com Osheem areas and provision of irrigation system;

   b. On-farm development for irrigated agriculture as well as for modernized agricultural practices;

c. Improvement/rehabilitation of the existing irrigation and drainage facilities including institutional arrangement and the strengthening of agricultural supporting services in Wahby Downstream area and the South Area of Lake Qarun;

d. The Model Farm in Com Osheem area for practical training of irrigation and water management; and

e. Provision of the agro-industrial and social infrastructure in the reclamation area.

PROJECT COMPONENTS

10. The Project involves the following components;

Land Reclamation

(1) Soil Improvement: To practice deep harrowing, to remove salt and obstructive materials and to add improvement materials

(2) Irrigation Facilities: To construct pumping facilities and pipeline networks

(3) On-farm Facilities: To construct on-farm facilities including sprinklers and drip irrigation facilities, other related facilities, and farm roads

Agricultural Development

(4) Irrigated Agriculture: To introduce the modern farming techniques with proper water management

(5) Livestock Breeding and Fattening: To introduce the animal husbandry under the proposed cropping pattern and the proposed land use

(6) Agro-industry: To introduce agro-industries for processing agricultural and animal products

(7) Agricultural Supporting Service: To establish and strengthen the farmers organization to support farmers in producing, processing, and marketing the products, and to carry out the proper operation and maintenance of irrigation and drainage system

(8) Model Farm: To establish the Model Farm in Com Osheem area for farmers' training and promotion of modernized agriculture and water management through practices

Rural Development

(9) Social Infrastructure: To provide the social infrastructure in the reclamation area, including construction of the trunk road, branch

roads and farm roads, domestic water supply, electrification, sewage facilities and others

(10) Villages: To provide villages and related facilities

CLIMATOLOGICAL CONDITIONS

11. The annual rainfall of only nine millimeters is recorded in the winter season from October to March. Temperatures of annual mean, mean maximum and mean minimum are 22.2°C, 28.6°C and 15.7°C, respectively. The maximum temperature is usually observed in July or August and the minimum in January. The annual mean relative humidity of 61 percent is observed, however, the diurnal range of humidity is wide.

The mean wind speed is about 2.5 meters per second. The wind direction is usually between north-east and north-west and the major wind direction is north throughout the year. Daily evaporation rate is ranging from two millimeters in the winter season to 15 millimeters in the summer season and annual evaporation rate amounts to about 3,000 millimeters by a class "A" Pan.

WATER RESOURCES

12. All kind of water for the Fayoum depression is carried by the major carrier of Bahr Yousef which irrigates the eastern zone of the area. The total amount of water to Fayoum was about 2,300 million cubic meters which is equivalent to 20 cubic meters per day per feddan of water duty on an annual average basis, which is lower than 25 to 30 cubic meters per day per feddan on the national average. The monthly discharge is varied from 153 million cubic meters in February to 247 million cubic meters in August (17 to 25 cu.m/day/feddan).

13. About 70 kilometer long Bahr Wahby which branches off from the Bahr Yousef, irrigates the existing farm land of about 79,000 feddan at present. The total annual discharge is about 310 million cubic meters at the Seka Hadid weir with an irrigable area of about 60,000 feddan. The monthly discharge fluctuates from 21 million cubic meters to 32 million cubic meters at the weir. The monthly water duty also fluctuates from 13 to 17 cubic meters per day per feddan which are smaller than the Fayoum average of 20 cubic meters per day per feddan and the national average of 25 to 30 cubic meters per day per feddan.

LONGITUDINAL WATER DISTRIBUTION IN BAHR WAHBY

14. According to discharge measurement in Bahr Wahby in August, 1984, discharge of Bahr Wahby longitudinally decreases from 11.9 cubic meters per second at the Seka Hadid weir to 2.0 cubic meters per second at the point where the Com Osheem canal branches off from Bahr Wahby. These values are equivalent to from 17.1 to 15.6 cubic meters per day per feddan of water duty. At the intermediate observed point of KM 49.71 where Bahr Green branches off from the Bahr Wahby, water duty is calculated at only 13.9 cubic meters per day per feddan.

FLUCTUATION OF LAKE WATER LEVEL AND SALINITY

15. The water level of Lake Qarun goes repeatedly up and down according to an amount of inflow discharge to the Lake and of evaporation from the lake surface. Normally, the water level is controlled between (-)43.5 and (-)44.0 meters (below the mean sea level). In 1981 and 1984, however, the high water level abnormally reached at about (-)43.2 meters gave various damages to farm land, public facilities, houses and so on which are located along the lake shore. It is supposed that the low evaporation rate from the lake surface, poor water management by farmers, inappropriate water control and so on would have caused these conditions.

16. The irrigation water requirements for the Project is being taken from Batts drain. The peak amount of water will be taken up to about 4.5 cubic meters per second. According to the analysis of water balance of Lake Qarun in 1976 as a model year, the water level would be decreased to 28 centimeters in October and the salt concentration would also increase by 0.3 percent at maximum. To protect such draw-down an amount of 6 million cubic meters in every month, which is equal to discharge of about 2.2 cubic meters per second would be supplied to Lake Qarun.

17. In order to study the salt balance of Lake Qarun, it is considered that three projects such as a salt extraction factroy with an annual salt extraction capacity of 213,000 tons proposed near the Abuksa bay, the Targen re-use water project and the Batts drain re-use water project would be proposed in Fayoum. In various case studies on salt balance of Lake Qarun, almost all cases without any supplemental water to the Lake indicated to annually increase salt concentration by 0.8 percent. Of which the one case that the supplemental water to the Lake will be gained by controlling the diversion water to the Wadi El Rayan channel shows no increase of salt content. However, the controlling of the diversion water to the Wadi El Rayan will affect fisheries in Lake Rayan.

SOILS

18. The texture of the surface soils in North Wahby and Com Osheem areas is specified into mostly sandy and a little sandy clay loam to clay, while the sub-soils mainly into sandy and sandy clay loam.

Hard pan is observed 30 cm below the surface in some parts of the area. However, it can be broken by machines, and can be softened by adding some water. The value of EC (mmhos/cm)

ranges from below four to over 15, and almost half of the area shows a value over 15. The value of EC (mmhos/cm) ranges from two to about 200 and great part of their soils have high salinity.

In terms of Soil Taxonomy Classification, soils of the area are classified into nine types, such as sandy soils with moderately hard pan, sandy over sandy clay with moderately hard pan (JCB), sandy loam over sandy clay loam with moderately hard pan, sandy soils with deep zone (EBA) and etc.

After the land reclamation and soil improvement, the land in the area can be classified as II and III classes based on the Land Capability Classification Category.

19. The texture of the surface soils in Wahby Downstream area is specified mainly into sandy, clay loam and clayey, while the sub-soils into clayey sandy clay loam and sand.

The value of EC (mmhos/cm) ranges from below four to 15, and almost of the entire area shows a value below eight.

In terms of Soil Taxonomy Classification, soils of the area are classified into seven types, such as sandy soils with very deep zone (EBE), clay loam soils with very deep zone (JAD), sandy soils with very deep zone (JAD) and etc.

20. The texture of the surface soils in South Area of Lake Qarun is specified mainly into clay and some sandy clay, while of the sub-soils into mostly clay and a little sandy clay.

Clay horizon is observed in some parts of the area. The value of EC (mmhos/cm) ranges from below four to over 15, and almost the entire area shows a value below eight.

In terms of Soil Taxonomy Classification, soils of the area are classified into five types, such as clayey soils with very deep zone, sandy over clay loam soils with very deep zone (JAD), clayey soils with moderately deep zone (JAB) and etc.

LAND USE PLAN

21. Reclamation area of North Wahby and Com Osheem covers the gross land of 5,100 feddan (2,140 ha) and 3,700 feddan (1,550 ha), respectively. It is proposed that the land holder areas to be disposed to farmers in North Wahby and Com Osheem areas are 4,420 feddan (1,850 ha) and 3,160 feddan (1,330 ha), respectively after deducting the lands for road, villages, and other facilities from the gross area.

22. In consideration of the present farm practice in Fayoum and future program of the Governorate in horizontal expansion of agriculture, it is proposed that cattle breeding and fattening farm should be developed in a part of Com Osheem area by the Governorate, and the other area should be disposed to farmers through the Land Reclamation Cooperatives to be established. The size of farms is proposed as follows;

Small farms:	5 feddan
Large farms:	15 and 20 feddan

The land reclamation cooperatives will be organized not only as the executive body but also as a multipurpose local cooperatives.

23. Present land use in Wahby Downstream area and the South Area of Lake Qarun will remain unchanged in future. However, improvement and rehabilitation of irrigation and drainage in the Area will allow the more effective land use than that is at present.

RECLAMATION PLAN

24. The reclamation area in North Wahby and Com Osheem is a desert area at present. The land reclamation is composed of the three-staged reclamation works including deep harrowing, soil dressing and leaching.

25. Deep harrowing of the desert area aims to improve soils at the top-layer or sub-layer for successful soil dressing, leaching, and cropping. According to the soil survey and the proposed cropping pattern, about 60 centimeters will be necessary for deep harrowing in top layer for common crops, while more than 60 centimeters in top and sub-layers for fruits crops. The deep harrowing will be executed at the first stage of the reclamation in the Area.

    According to experiments in the other reclamation projects, it is recommended to repeat the deep harrowing once every three to four years during the cultivation.

26. The soil dressing in the reclamation areas usually have two ways; one is to supply soil dressing materials and the other to dose gypsum. And there will be two kinds of materials available for soil dressing: barnyard manure and sedimented materials available by canal dredging. At the first stage of reclamation of the Project, the sediments for soil dressing will be easily available by Bahr Wahby and Gomhouria canals. On the other hand, soil survey and physical and chemical analysis of soil samples found that exchangeable sodium percentage in the area is mostly very low. In this stage, gypsum application is estimated for a half of the area at the rate of one ton per feddan for future contingency during the detailed survey and design.

27. Leaching shall be carried out in the reclamation area by using sprinkler facilities. In the initial stage and the cropping stage, an adequate amount of leaching water should be supplied through irrigation facilities for crops. The necessary amount of leaching water is studied by using several empirical and experimental formulae as well as the results of leaching tests conducted in the first field survey by the Study Team. Finally, it is proposed that the initial leaching water by using sprinkler would be 300 millimeters deep and 300 to 500 millimeters deep in the cropping period, depending on kinds of crops.

IRRIGATION PLAN IN RECLAMATION AREA

28. Of the total reclamation area, the net areas of 4,200 feddan (1,760 ha) in North Wahby and 3,000 feddan (1,260 ha) in Com Osheem are planned to be irrigated. Both sprinkler and drip irrigation methods will be introduced. Several case studies on the combination of irrigation blocks, the number of irrigation blocks, division, and the number of pumps, etc., are made for planning the ideal irrigation facilities. As a result, a proposal is made with five pump stations in North Wahby and three in Com Osheem.

29. For the reclamation of North Wahby and Com Osheem areas, the re-use of drainage water has been planned by Fayoum Governorate to secure the irrigation water source at 4.5 cubic meters per second. Batts drain water will be lifted at Tamiah to Bahr Wahby to mix it with fresh water of Bahr Wahby in order to provide irrigation water with tolerable salinity.

30. The irrigation methods will be selected in considering the natural conditions of the area, farm management, economic conditions, and basic intake rate, etc. Taking into consideration these factors, it is proposed the sprinkler and drip irrigation methods for the reclamation area in North Wahby and Com Osheem.

31. The irrigation water requirements for raising agricultural crops are estimated based on the crop water requirement (ETcrop), leaching water requirement (LWR), and irrigation efficiency (Ea). ETcrop is calculated from the crop coefficient (Kc) and the reference crop evapotranspiration (ETo). The ETo is predicted usually by the four formulae; Blaney-Criddle, Radiation, Modified Penman and Pan Evaporation. The Ea is applied at 76.5 percent for sprinkler irrigation system and at 81 percent for drip irrigation system.

DRAINAGE PLAN IN RECLAMATION AREA

32. The geological investigations in North Wahby and Com Osheem revealed that there existed no groundwater table. It will take a long period for groundwater table to appear in the area after the sprinkler and drip irrigations starts. It is estimated about 10 to 15 years to form a groundwater table in the area after the completion of reclamation and the commencement of irrigated agriculture.

33. Notwithstanding the provision of drainage facilities are not required in the area during the said early period, it is proposed construction of open drainage canals by the Project. However, improvement of the existing drains such as Nazzaz Saweres Drain, Azzam Drain and El Wastany Drain will be implemented later.

To confirm formation of groundwater and appearance of groundwater table in the reclamation area, it is proposed to provide 25 places of observation well and piezometers.

AGRICULTURAL DEVELOPMENT

34. For the reclamation area of North Wahby and Com Osheem, forage crops will be introduced in order to increase the source of organic matters to be supplied to the soils. The cropping pattern is planned to realize as much vegetable cultivation as labor power can afford. Fruits will be introduced at the fixed rate of 25 percent of the reclamation area. The three-year rotational cultivation in the remaining 75 percent of the area is proposed as follows;

Winter Crops		Summer Crops	
Berseem(long)	25% of the area	Watermelon	25% of the area
Berseem(short)	25% of the area	Groundnuts	25% of the area
Tomato	12.5% of the area	Sorghum	25% of the area
Wheat	12.5% of the area		

35. After the land reclamation and leaching, berseem and sorghum will be raised when ECe decrease to 10 mmhos/cm, and when ECe goes down to 7 mmhos/cm by continuous leaching, wheat will be introduced. From the third year of agricultural production, the cultivation mentioned above will be started. Yield of crops may be low at the early stage just after settlement however, will be rapidly increased by successful leaching and improvement of agricultural techniques. The target yield of proposed crops will be attained in the fifth year.

36. The income per feddan from agricultural crops presently cultivated in the Project Area is lower than that on an average of Fayoum Governorate, although the techniques of crop cultivation are fairly high. Superior varieties of vegetables

and cotton are diffused, and fertilizers and agricultural chemicals are used to a considerable extent in Fayoum Governorate. A few farm households have agricultural machinery, and many borrow from neighborhood or cooperatives.

37. In Wahby Downstream Area and South Area of Lake Qarun, the cropping intensity will be increased after improvement of the irrigation and drainage systems, and then, agricultural production will be also increased.

ANIMAL FARMING

38. The present animal husbandry in Wahby Downstream and South Area of Lake Qarun would be roughly specified into two types. One is small-scale farm having two or three head of baladi cow and buffalo, and the other is large-scale farm such as cooperative farms. At large-scale farms, friesian cows are bred for milking by using a milking machine. Baladi cows are mainly bred for fattening and for farm works, meanwhile buffaloes for milking. Cattle fattening management is observed here and there. Milk and meat production in Wahby Downstream and South Area of Lake Qarun was estimated at 5,877 ton and 253 ton, respectively in 1981.

39. Forage resources are berseem in winter, while sorghum, maize and wheat straw in summer. Concentrates are also fed throughout the year mainly in large-scale farms who pay for insurance system. Sheep and goats have been bred on stubble grazing and agricultural by-products.

40. As for the development plan, baladi cow and buffalo are selected for small-scale farms and friesian cow including the aforesaid two varieties for the Cattle Breeding and Fattening Farm. It is expected that friesian cow will contribute to milk and meat production increase and also to improve baladi cows by crossing.

41. In Com Osheem area, the Department of Agriculture has conceived a plan to establish a "Cattle Breeding and Fattening Farm" since 1983. According to the plan, eight units (1,000 head of adult cows per unit) will be established for a period of four years. One unit of them has been already completed outside of the Project Area based on the plan of the Department of Agriculture.

42. Milk and meat production in Wahby Downstream area and South Area of Lake Qarun in case with the Project is estimated at 7,708 ton and 305 ton, respectively. Meanwhile, it is estimated that 773 ton of red meat and 13,070 ton of milk will be produced in Com Osheem and North Wahby areas.

AGRO-INDUSTRIES

43. Alternative studies on tomato paste factory are conducted based on available production of tomato and profitable optimum price for the management of the factory.

Production of tomato is considered for the study not only production in the Project Area but also some percentage of future incremental production in the Fayoum depression. The profitable optimum prices for the management of the factory are considered at 100 LE, 80 LE and 60 LE per ton.

As a result, it is economically feasible providing that the quantity of tomato to be supplied is collected at more than 60 percent from the outside of the Project Area which is equivalent to about five percent of the future incremental in Fayoum depression and the profitable optimum price is less than 80 LE per ton.

Taking into consideration the quantity of tomato available for the factory estimated in the alternative study and the

profitable optimum prices applied in the study, the size of the tomato paste factory seems not practical to propose in the Project. This program shall be implemented by the other isolated project and not included in the Project.

44. Fruits produced in the Project Area will also be marketed as fresh products, and the amount of products is too small to create merits from such processing. From the above it can be concluded that a plan for a tomato and fruit processing factory for this Project is not recommended and should prove necessary to market as fresh and to transport them to the Kaha factory.

45. There are no major processing facilities in Fayoum Governorate. Only 12 unefficient slaughterhouses are operating, and the Governorate recognizes the necessity of slaughterhouses with modern equipment. A limited amount of milk produced by small-scale farmers is processed by themselves, and marketed in the form of white cheese and drinking milk in the local markets. As same as processing facilities of animal products, these for agricultural products were hardly observed.

46. According to the estimate of animal products in case with the Project, annually 31,100 ton of milk and 7,440 head of cattle and sheep will be processed at the milk factory and slaughterhouse established in North Wahby area. Supposing operation by 300 days per year, daily capacity will be 25 head for slaughtering and 104 ton for milk processing, respectively. The capacity of the factories was decided taking into account the eight units (8,000 head of adult cows) which will be established in Com Osheem area based on the plan of the Department of Agriculture.

47. In the new reclamation areas of North Wahby and Com Osheem, it is proposed administrative organization composed of one local unit, two villages and 28 hamlets. The center of the local unit (town) to be located along the highway in North Wahby area has to be various facilities and infrastructure. One village each is to be located in North Wahby and Com Osheem areas. At the center of each village, a primary school and stores will be constructed. Hamlets are established at 16 in North Wahby area and 12 in Com Osheem area. A hamlet consists of approximately 30 households.

48. Population and the number of households to be settled in the new reclamation areas are as follows;

Area	Household		Total	Population
	Farmers	Non-farmers		
North Wahby	571	80	651	3,255
Com Osheem	270	78	348	1,740
Total	841	158	999	4,995

49. In a town, primary and preparatory schools, medical clinics, cooperatives, stores and such social service facilities such as mosque, police station, fire station, post office, bank and telephone office are to be established. One mosque is to be built for every four to five hamlets.

50. A 12-meter wide trunk road will run through the middle of the new reclamation areas, and be connected to the Cairo-Fayoum road and the road to Tamiah city. Besides these roads, 8-meter wide branch roads and 5.5-meter wide farm roads branch off from the trunk road. Windbreaks with four meters wide are to be provided along each road.

51. Potable water by about 950 cubic meters per day is required in the new reclamation area. Water is planned to be diverted from Bahr Wahby which runs along the eastern side of North Wahby area, and treated at a potable water treatment plant with a capacity of 1,100 cubic meters per day, including a loss in ten percent of water requirement. Electric power of about 9,000 kilowatts is necessary for pump stations and houses. Sewage facilities and telephone system will also be established.

IRRIGATION FACILITIES IN RECLAMATION AREA

52. Taking into consideration that the new reclamation areas are strips in shape; especially the North Wahby area, the following comparative study is conducted based on the model in order to find out the most appropriate plan of the number of pump stations to be provided.

a. Case I. 9 pump stations
b. Case II. 6 pump stations
c. Case III. 3 pump stations
d. Case IV. 1 pump station

As a result, Case II with six pump stations is considered most advantageous. Taking into consideration the above-mentioned as well as the intake site of Bahr Wahby, development plan of five pump stations in North Wahby and three pump stations in Com Osheem are proposed.

53. In terms of the location of service areas and water sources, elevated land for erection of ponds, and water supply in re-use of drainage water on 24 hours basis, a comparative study on the following two cases is carried out for the irrigation division No.3 as a model.

Case A: Direct water conveyance and distribution system through the main pump station with pressure tank

Case B: Individual systems for water conveyance and distribution by providing both farm pond and booster pump station with pressure tank.

As a result, case A is selected as an advantageous plan from the viewpoint of engineering and economy.

54. From the viewpoints of operation and maintenance as well as economy, the number of pumps for each pump station for service area is determined. Based on the discharge per unit pump and also total head requirement, the horizontal axis single suction multi-stage volute pump is employed.

55. Through the studies and discussions as mentioned above, the layout of pumps is made as follows;

Pump Station	Unit Discharge	Total Head (m)	Pump Diameter (mm)	Motor	No. of Pumps	Service Area (feddan)
North Wahby area						
P1	4.58	80	200	90	7	684
P2	4.53	72	200	90	7	676
P3	4.68	77	200	90	7	699
P4	6.11	79	250	120	10	1,367
P5	5.19	85	200	110	7	774
Com Osheem area						
P6	6.60	78	250	130	7	750
P7	8.04	83	250	160	7	1,200
P8	5.36	82	200	110	7	800

Note: a. Type of pumps is a single suction multi-stage volute pump. The number of pumps include one stand-by unit.

b. Service area in Com Osheem area is not included an area of the Model Farm.

c. Units of items of Unit Discharge and Motor are cu.m/min/unit and kw/unit, respectively.

d. Operation hour of pumps is adapted as 16 hours a day due to long durability of pump facilities.

56. As for distribution system, based on the pipe diameter from 200 to 700 millimeters and the design water pressure of 7.0 to 12.0 kilograms per square centimeter, the following types of pipes are applied that PVC pipe is for diameter of smaller than 300 millimeters and ductile iron pipe is for diameter of larger than 350 millimeters as a rule.

It should be noted that the water hammer pressure is provisionally taken at 40 percent of the static water pressure.

ON-FARM FACILITIES

57. The farm unit (the field), farm lot, farm block and irrigation block are decided at 1.25 feddan (100 x 52.5 m), 3.75 feddan (100 x 157.5 m), 60 feddan and 240 feddan, respectively. Roads in the areas are classified into trunk road, branch roads and farm roads depending on their respective functions. Furthermore, cultivation passway is provided along each farm lot. Windbreaks are planted along each road to protect the adjacent land and crops from strong winds.

Irrigation water is conveyed to the fields by pipeline. Special countermeasures for drainage of the fields is not considered for the early stage of the development.

58. Sprinkler and drip irrigation systems will be introduced in the Project. Intermittent operation will be carried out applying an irrigation interval of four days at the peak in summer. The rotation units are decided as follows;

Fruit area (Drip)	- 15 feddan	
Three year rotation area		
(Sprinkler)	- 5)	
(Drip)	- 2.5)	7.5 feddan
Forage area (Sprinkler) (Cattle Breeding and Fattening Farm)	- 15 feddan	

REHABILITATION OF WAHBY DOWNSTREAM AREA

59. Wahby Downstream area is defined as an irrigation water shortage area, and located considerably downstream of Bahr Wahby, covering about 17,200 feddan (7,220 ha). To solve the problem in the area, the following countermeasures are proposed;

a. Rehabilitation/renovation of the existing irrigation facilities;
b. Construction of supplemental laterals and canal structures; and
c. Strengthening the operation and maintenance and organization.

60. One of the reasons for short irrigation water in the area is unbalanced distribution which means that the farms located at the upstream reach of Bahr Wahby take abundant irrigation water and the farms located along Bahr Wahby take much more through vents, resulting in much troubles and a lot of obstructions for water management. In this connection, the construction of supplemental laterals aligned along Bahr Wahby to unify the vents directly intaken water from Bahr Wahby are proposed. From the upstream, five such laterals, so-called "Ganabiah canal" should be constructed to take away vents along Bahr Wahby to directly intake irrigation water. Besides, the construction of two laterals such as "New Hayar canal" and "New Koddoba canal" is recommended.

Meanwhile Ministry of Irrigation, Fayoum Office of Irrigation Department has a plan to construct pumping station of Casr Rashwan to supplement irrigation water from Batts Drain to the areas of Hayar and Koddoba canals. However, it is considered that the said pumping facilities will be transferred to the other area after completion of the Project.

61. Aside from the above-mentioned problems on the existing irrigation system and facilities, the present operation and maintenance system and organization should be improved and strengthened. One of the countermeasures is to increase number of engineers in charge of operation and maintenance of the irrigation system. The training of such staff for proper water management should be conducted.

62. In addition to the above, the final solution of the shortage in irrigation water is to secure some additional water resources. Supplemental water is expected by re-use of drainage water. Batts Drain water will be lifted to Bahr Wahby to produce irrigation water by 4.5 cubic meters per second, of which about 2.50 cubic meters per second will be supplied at the peak period to the reclamation area in North Wahby and Com Osheem, and the rest of water will be supplied to this area. It accounts about 10 cubic meters per day per feddan. This water quantity could be supplemented to the water of Bahr Wahby.

IMPROVEMENT OF THE SOUTH AREA OF LAKE QARUN

63. The South Area of Lake Qarun is defined as an area suffering directly or indirectly from a high water level of Lake Qarun. The area extends along the south coastal line of the lake, covering the farm lands of about 6,770 feddan (2,830 ha).

64. Although observation data of runoff in respective drains are not available, the monthly mean drain modulus in the whole Fayoum basin and also runoff from the Project Area are estimated based on the consideration of irrigation efficiency and irrigation water. As a result, the specific drain modulus for the Project is decided by 3.31 cubic meters per second per 100 square kilometers.

65. The drainage of the area aims at not only discharging the excess water to Lake Qarun but also lowering groundwater table in the area for restoring agricultural productivity. To keep the groundwater table at least 1.50 meters deep, the water level of the main drain should be planned as follows;

Elevation of bottom	-47.00 m
Low water level (LWL)	-46.00 m
Normal water level (NWL)	-45.50 m
High water level (HWL)	-44.00 m

66. The area consists of four sub-areas, namely Harawa Sub-area, Bats Said Sub-area, Abu Tarfaya Sub-area and Khor el-Hitan Sub-area. Improvement of the area includes the construction of dike and the improvement of Batts Drain in Harawa sub-area, and the construction of main drains and the improvement of lateral drains and sub-lateral drains in the other sub-areas.

According to Ministry of Irrigation, Fayoum Office of Irrigation Department, the General Authority for Covered Drainage Projects at Beni Suef Governorate in conducting the study on the implementation of the drainage pump station. When the said plan is realized, this proposal will be revised during the detailed design.

MODEL FARM

67. The Mode Farm should be established in the reclamation area of Com Osheem for training and practice on the modernized irrigation facilities and farming techniques, training of leaders of farmers and farmers on water management and provision of the farm as a show window of modernized farming with proper water management.

68. The Model Farm covers a reclamation area of 310 feddan (130 ha) in gross and an arable land of 250 feddan (105 ha). The reclamation in North Wahby and Com Osheem areas aims to develop the area by introducing modernized irrigation methods such as sprinkler and drip. The training and practice of the operation and maintenance of the said irrigation system are quite important for the Project.

69. Taking into consideration the seasonal fluctuation of irrigation water requirements and the experimental use of irrigation facilities in the Model Farm, it is proposed proposed four units of pumps including one for standby.

Pump Station

Type	:	Horizontal Axis Single Suction Multi-stage Volute Pump 3-stage 4 units
Capacity	:	2.33 cu.m/min/unit
Pump bore	:	ϕ150 mm
Total dynamic head	:	90 m (End pressure: 40 m)
Power	:	66 KW (50 Hz)

Pipeline

Main Pipeline	:	ϕ300 mm, 1,620 m long
Branch pipeline	:	ϕ200 mm, 1,370 m long
Field pipeline	:	ϕ200 mm, 1,250 m long
"	:	ϕ150 mm, 840 m long
"	:	ϕ100 mm, 5,420 m long

Irrigation Facilities

Drip Irrigation	48 sets for 60 feddan
Sprinkler irrigation	76 sets for 190 feddan

PROJECT COST

70. The project cost is estimated at a total cost of 105.4 million Egyptian Pound including a foreign currency portion of 57.7 million Egyptian Pound or about 55 percent of the total cost and a local currency portion of 47.7 million Egyptian Pound or about 45 percent of the total cost on the basis of the prevailing unit costs as of August, 1984, physical contingency of ten percent and annual price escalation of five percent for the foreign currency portion and 12 percent for the local currency portion.

The project cost is summarized as follows:

Project Cost

(Unit: '000 LE)

		Total	Foreign Currency	Local Currency
I.	Engineering for Detail Design	2,000	1,700	300
II.	North Wahby & Com Osheem Areas	78,300	43,900	34,400
	North Wahby Area	38,300	19,600	18,700
	Land Reclamation	28,000	16,900	11,100
	Housing & Infrastructure	10,300	2,700	7,600
	Com Osheem Area	40,000	24,300	15,700
	Land Reclamation	20,000	12,300	7,700
	Housing & Infrastructure	5,800	1,600	4,200
	Agro-industry	14,200	10,400	3,800
III.	Wahby Downstream Area	9,400	3,900	5,500
IV.	South Area of Lake Qarun	11,400	5,000	6,400
V.	Model Farm	4,300	3,200	1,100
	Total of Project Cost	105,400 (55%)	57,700 (45%)	47,700 (100%)

ECONOMIC EVALUATION

71. As for evaluation of North Wahby and Com Osheem areas, the economic annual incremental net production value, which can be obtained by subtracting net production without project from net production with project, is expected to be LE 12.19 million in 2001. The financial project cost except for price escalation is LE 41.96 million and economic project cost is LE 37.50 million including cost for of Model Farm and Re-use Water Pump Project.

Economic internal rate of return (EIRR) is estimated at 12.1 percent taking 50 years of the project life as evaluation period, thus the development of the Project can be said economically feasible.

72. As for evaluation of Wahby Downstream area, the economic annual incremental net production value is expected to be LE 3.44 million in 1994. The financial project cost except for price escalation is LE 13.65 million and economic project cost is LE 11.43 million including cost for Re-use Water Pump Project.

Economic internal rate of return (EIRR) is estimated at 12.8 percent taking 50 years of the project life as evaluation period, thus, the development of the Project can be said economically feasible.

73. As for evaluation of South Area of Lake Qarun, the economic annual incremental net production value is expected to be LE 1.15 million in 1995. The financial project cost except for price escalation is LE 6.49 million and economic project cost is LE 5.70 million.

Economic internal rate of return (EIRR) is estimated at 15.3 percent taking 50 years of the project life as evaluation period. The development of the project can be said economically feasible.

74. The slaughterhouse is planned to slaughter and dress 7,430 head of cattle and sheep annually and implementation is scheduled in 1990 to 1992. The financial and the economic costs are estimated at LE 1,495 thousand and LE 1,435 thousand, respectively. The annual economic benefit in the full development stage in 1995 is estimated at LE 1.46 million.

EIRR is estimated at 39.3 percent in taking the project life by 25 years.

75. The establishment of a milk processing factory is planned in the reclamation area of North Wahby and will be constructed in a period from 1991 to 1992. The financial project cost excluding price escalation amounts to LE 4.98 million for equipment and building, etc. and the economic project cost is LE 4.83 million. The gross production income in 1995 is estimated at LE 12 million.

EIRR is estimated at 24.9 percent in taking the project life by 25 years.

76. Feasibility of investments to the social infrastructure such as municipal water supply, electrification, etc., although difficult in monetary evaluation, is studied a method introduced by the World Bank.

In case that the investment is not made to the municipal water supply in the Project, it requires to conduct a comparative study on the water supply system with daily capacity of 950 ton. The revenue from the water charge is used as economic benefit, which is only approximation and conservative value available. As a result, the annual benefit of LE 0.03 million is expected by using 10 piastre (0.1 LE) per ton as most conservative value of benefit.

In case that the investment is not made to power supply, 18.8 million KWH of requirements in the area have to be supplied by diesel generation as alternative plan. The different fuel cost between hydropower generation and diesel generation is considered as benefit by electrification. The annual benefit from electrification is estimated at LE 1.23 million.

77. Concerning the economic evaluation of the entire Project in the reclamation area of North Wahby and Com Osheem areas, EIRR of the project including components of agricultural land reclamation, housing and social infrastructure and agro-industries are calculated as follows;

1) Agricultural land reclamation project only 12.1%

2) Project composed of agricultural land reclamation, housing and social infrastructure.
   a. The case with benefit of water supply and electricity 13.2%
   b. The case without benefit of water supply and electricity 11.8%

3) Project composed of agricultural and reclamation, housing and social infrastructure and agro-industries 10.4%

78. The financial analysis of farm management in the reclamation area of North Wahby and Com Osheem by three land-holding types of five feddan, 15 feddan and 20 feddan resulted in that even the small-scale farm households would obtain the economic surplus of about LE 2,160 at the full development stage in future and medium/large-scale farm households would gain so much economic surplus as to invest for reproduction and to save money.

79. According to the statistic yearbook of Fayoum Governorate, the average farm size is estimated at 2.8 feddan in the Governorate. A farm budget study in Wahby Downstream area is carried out in using this average farm size. The ordinary farmer will gain about LE 1,670 of farm income at the full development stage. Incremental farm income is expected at about LE 1,020.

80. The farm budget analysis for the South Area of Lake Qarun is studied based on the average farm size of 2.8 feddan. The average farmer in Bats Said and Abu Tarfaya area will gain about LE 1,110 farm income at the full development stage. The incremental farm income is expected at about LE 240. Average farmer in Abu Harawa area will gain about LE 1,140 of the farm income at full development stage. The incremental farm income is expected at about LE 490.

SOCIO-ECONOMIC IMPACTS

81. In addition to the direct benefits, the Project will bring about the indirect benefits such as creation of employment opportunity, increase in tax revenue, expansion of consumers' goods market, income increase for local people during construction period, and saving a discharge of foreign exchange.

B. CONCLUSIONS

1. The results of economic evaluation for the reclamation of North Wahby and Com Osheem, Wahby Downstream area and South area of Lake Qarun show the economic internal rate of return (EIRR) of 12.1 percent, 12.8 percent and 15.3 percent, respectively, exceeding the marginal productivity of capital at border prices of 10.0 percent in this country (World Bank Staff Working Papers No.521). Therefore, it can be said that all the three components of the Project are feasible from the viewpoint of the national economy.

2. According to the farm income analysis of the average farmer in the Project Area, the farm income is only LE 600 on an average, and therefore, the farmer cannot live in ease unless he can acquire an off-farm income of more than LE 400. After completion of the Project, the farm income of the small farm (five feddan) in the reclamation area will be ranged from LE 6,000 to LE 4,000, without taking off-farm income into consideration. This means that farmer can save some surplus of his farm income without any off-farm income.

   Through the above farm budget analysis, it is quite clear that the proposed Project is feasible from the viewpoint of the individual farmer's economy.

3. The proposed scope of Fayoum Agricultural Development Project as a condition of the feasibility study is delineated as follows:

1) NORTH WAHBY AREA (5,100 feddan)

Reclamation

Gross Area	5,100 feddan
Arable Land	4,420 "
Farm Land	4,200 "

Land Disposal

Small Farm (5 fed)	2,210 feddan	(442 farms)
Large Farm (15 ")	1,110 "	(74 ")
" (20 ")	1,100 "	(55 ")
Total	4,420 "	(571 ")

Pump Stations

P_1 Horizontal Axis Single Suction Covering 684 fed.
Multi-stage Volute Pump
Pump Bore 200 mm 90 KW 7 units 4.58 cu.m/min/unit

P_2 - do - Covering 676 fed.
Pump Bore 200 mm 90 KW 7 units 4.53 cu.m/min/unit

P_3 - do - Covering 699 fed.
Pump Bore 200 mm 90 KW 7 units 4.68 cu.m/min/unit

P_4 - do - Covering 1,367 fed.
Pump Bore 250 mm 120 KW 10 units 6.11 cu.m/min/unit

P_5 - do - Covering 774 fed.
Pump Bore 200 mm 110 KW 7 units 5.19 cu.m/min/unit

Pipelines

Ductile Iron Pipe	ϕ700 mm	Length	345 m
"	ϕ600 "	"	815 m
"	ϕ500 "	"	695 m
"	ϕ450 "	"	1,610 m
"	ϕ400 "	"	1,325 m
"	ϕ350 "	"	3,440 m
PVC Pipe	ϕ300 "	"	8,585 m
"	ϕ250 "	"	6,905 m
"	ϕ200 "	"	7,695 m

On-farm Facilities

Sprinkler Irrigation	890 sets for	2,100 feddan
Drip Irrigation (Vegetables)	890 sets for	1,050 feddan
" (Fruits)	310 sets for	1,050 feddan
Pipeline (ϕ75 mm to ϕ200 mm)	Length	122.2 km

Drainage Facilities

Drainage Canal	Length	18.1 km

Rural Development

Road with Windbreak	Trunk Road	Width 12 m	Length	16.0 Km
	Branch Road	" 8 m	"	1.7 "
	Farm Road	" 5.5 m	"	106.3 "

Housing	Farmers' House	Small	442 Houses
		Large	129 "
	Non Farmers' House		
	Directors' House		12 "
	Technicians House		49 "
	Labor and Others		19 "
	Mosque		4 Bldg.
	Development Office		1 "
	Primary School		2 "
	Preparatory School		1 "
	Modical Clinic		1 "
	Police Station		1 "
	Post Office		1 "
	Telephone Office		1 "
	Fire Station		1 "
	Co-operative		1 "
	Bank		1 "
	Storage House		2 "
	Store		7 "

Potable Water	Treatment Plant	1 set
	Pipeline ϕ150 - ϕ50 mm	15.7 km

Sewage Treatment

Treatment Plant & ϕ200 mm Pipeline	L.S.

Electric Power

60 KV Trunk Line	7 km
11 KV Line	25.4 km
Sub-station	1 site
Distribution 100 KVA	18 sites

Telephone System

Trunk Cable Line	16 km
Connection Line	7.7 km
Control & Exchange	1 set

2) COM OSHEEM AREA (3,700 feddan)

Reclamation

Gross Area	3,700 feddan
Arable Land	3,160 "
Farm Land	3,000 "

Land Disposal

Cattle Breeding & Fattening Farm	1,060 feddan		
Small Farm (5 fed)	1,040 "	(208 farms)	
Large Farm (15 ")	540 "	(36 ")	
" (20 ")	520 "	(26 ")	
Total	3,160 "	(270 farms)	

Pump Stations

P_6 Horizontal Axis Single Suction Covering 750 fed.
Multi-stage Volute Pump
Pump Bore 250 mm 130 KW 7 units 6.60 cu.m/min/unit

P_7 - do - Covering 1,200 fed.
Pump Bore 250 mm 160 KW 7 units 8.04 cu.m/min/unit

P_8 - do - Covering 800 fed.
Pump Bore 200 mm 110 KW 7 units 5.36 cu.m/min/unit

Note: Pump station and pipeline for the Center of Model Farm is not included in this figures.

Pipelines

Ductile Iron Pipe	ϕ700 mm	Length 1,910 m
"	ϕ600 mm	" 1,100 m
"	ϕ500 mm	" 3,325 m
"	ϕ450 mm	" 1,845 m
"	ϕ400 mm	" 510 m
"	ϕ350 mm	" 3,365 m
PVC Pipe	ϕ300 mm	" 2,745 m
"	ϕ250 mm	" 1,900 m
"	ϕ200 mm	" 3,045 m

On-farm Facilities

Sprinkler Irrigation	530 sets for 1,750 feddan
Drip Irrigation (Vegetables)	420 sets for 500 feddan
" (Fruits)	150 sets for 500 feddan
Pipeline (ϕ75 mm to ϕ200 mm)	Length 81.8 km

Drainage Facilities

Drainage Canal	Length 15.9 km

Rural Development

Road with Windbreaks	Trunk Road	Width 12 m	Length 8.3 km
	Branch Road	" 8 m	" 3.8 km
	Farm Road	" 5.5 m	" 98.0 km

Housing

Farmers' House	Small	208 House
"	Large	62 "
Non Farmers' House		
Directors' House		5 "
Technicians House		31 "
Labor and Other		42 "
Mosque		3 "
Primary School		1 "
Storage House		1 "
Store		1 "

Potable Water

Treatment Plant	Cooperate with North Wahby
Pipelines ϕ75 - ϕ50 mm	11.3 km

Sewage System

Treatment Plant & ϕ200 mm Pipeline	L.S.

Electric Power

60 KV Trunk Line	Cooperate with North Wahby
11 KV Line	15.7 km
Sub-Station	Cooperate with North Wahby
Distribution 100 KVA	13 sites

Telephone System

Trunk Cable Line	Cooperate with North Wahby
Connection Line	5.3 km
Control & Exchange	Cooperate with North Wahby

Agro-industry

Cattle Breeding & Fattening Farm

Cattle Shed and Office	6 houses	8,490 sq.m
Land Grading	9 feddan x 4 unit	36 feddan
Agricultural Equipment		L.S.

Tomato Grading Station

Building	1,600 sq.m
Equipment	3 sets

Slaughterhouse

Building	1,000 sq.m
Equipment	L.S.

Milk Processing Factory

Building	1,820 sq.m
Equipment	L.S.

3) WAHBY DOWNSTREAM AREA (17,200 feddan)

Improvement of Canals

Bahr Wahby	Length 21.3 km
Branch Canal (5 lines)	" 28.1 km
Lateral & Sub-lateral (7 line)	" 35.5 km

Construction of Canals

New Hayar Canal	Length	2.8 km
New Koddoba Canal	"	3.6 km
Ganabiah Canal (5 line)		10.0 km

4) SOUTH AREA OF LAKE QARUN (6,770 feddan)

Harawa Sub-area

Abd el-Rahman Pump Station
Mixed Flow Volute Pump 2 units - ϕ200 x 9 PS

Abu Harawa Pump Station
Mixed Flow Volute Pump 3 units - ϕ250 x 18 PS

Qarun Dike		Length	3.5 km
Main Drain		"	3.5 km
Improvement:	Batts Drain	"	2.5 km
	Lateral Drain	"	3.0 km
	Sub-lateral Drain	"	4.0 km

Bats Said Sub-area

Bats Said Pump Station
Mixed Flow Volute Pump 4 units - ϕ250 x 18 PS

Main Drain		Length	2.3 km
Improvement	Lateral Drain	"	3.8 km
	Sub-lateral Drain	"	12.0 km

Abu Tarfaya Sub-area

Abu Tarfaya Pump Station
Mixed Flow Volute Pump 3 units - ϕ250 x 18 PS

Main Drain		Length	2.8 km
Improvement	Lateral Drain	"	1.1 km
	Sub-lateral Drain	"	6.2 km

Khor el-Hitan Sub-area

Khor el-Hitan Pump Station
Mixed Flow Volute Pump 2 units - ϕ250 x 18 PS

Main Drain		Length	2.7 km
Improvement	Lateral Drain	"	1.0 km
	Sub-lateral Drain	"	2.6 km

5) MODEL FARM (310 feddan)

Pump Station

Pump & Motor	Horizontal Axis Single Suction Multi-stage Volute Pump 3 stage 4 units - ϕ150 mm 66KW TDH 90m
	2.33 cu.m/min/unit

Pipelines

Main Pipeline	PVC Pipe	ϕ300	Length	1.62 km
Branch Pipeline	"	ϕ200	"	1.37 km
Field Pipeline	"	ϕ200	"	1.25 km
"	"	ϕ150	"	0.84 km
"	"	ϕ100	"	5.42 km

On-farm Facilities

Sprinkler Irrigation	76 sets for 190 feddan
Drip Irrigation	48 " for 60 feddan

Construction & Agri-Machineries

Construction Equipment	24 units
Agricultural Machineries	24 units

Buildings

Office, Research & Laboratory, Training and Others	1,140 sq.m

C. RECOMMENDATION

Survey on Existing Canals

1. Existing canals of Bahr Wahby (downstream from Seka Hadid Weir up to the end of Bahr Wahby Extension), Branch canals and Lateral and Sub-lateral Canals relating to the Project should be surveyed on longitudinal profile and cross section for the detailed design.

Geological Survey

2. Geological survey at proposed pump stations in the reclamation area of North Wahby and Com Osheem and in the South area of Lake Qarun and the site of proposed bridge should be carried out by means of boring up to required depth for structural design.

Detailed Soil Survey

3. Detailed soil survey including deep boring in the reclamation area of North Wahby and Com Osheem should be carried out for the detailed design on the land reclmation and development of the area and the implementation of the Project.

Meteorological and Hydrological Observation

4. The JICA Study Team installed and transferred five self-record water level gauging stations to Fayoum Governorate, a meteorological station equipped with thermometer and hygrometer, anemometer and vane recorder and evaporation pan, and salt concentration meter.

   Observation on these meters/recorders can be utilized for detailed design and development of the Project. According to the operation manual of these instruments, careful operation and maintenance and observation should be continued.

CHAPTER I. INTRODUCTION

CHAPTER I. INTRODUCTION

1.1. Background

Fayoum is a depression located some 75 kilometers southwest of Cairo in the Western Egyptian Desert, and one of the oldest agricultural areas in the Arab Republic of Egypt. Reportedly, it was B.C. 2000 of the 12th dynasty that the first land reclamation was carried out in this area.

Fayoum area covers about 1,827 square kilometers. The present cultivated area is some 315,000 feddan (132,000 ha) while the cropping area is about 470,000 feddan (198,000 ha) with a cropping intensity of about 149 percent according to the Statistical Yearbook of Fayoum Governorate in 1981 (Refer to Appendix D).

The major industries of Fayoum are agriculture, livestock farming, and fisheries in Lake Qarun and Lake Rayan, etc. Some resort facilities are observed around Lake Qarun.

Agriculture is the most important industry in Fayoum. Nevertheless, many tenant farmers and landless workers live in the Governorate working for owner farmers as farm laborers. For the settlement of these farm laborers and the increase and expansion of agricultural land, Fayoum Governorate has several agricultural development plans aiming to reclaim the desert areas peripheral to Fayoum depression as well as to improve the existing irrigation and drainage facilities in the cultivated land.

Among the development plans of the desert areas, the reclamation of North Wahby and Com Osheem areas is one of the development plans with high potentiality. In response to a request of the Government of Egypt, the Government of Japan decided to implement the feasibility study on Fayoum Agricultural Development

Project, and Japan International Cooperation Agency (JICA), the official agency responsible for implementation of the technical cooperation programs of the Government of Japan, dispatched a study team for the first field work for about a two-month period from February to March, 1984 in winter season, and then for the second field work for a three-month period from July to September 1984 in summer season in accordance with the Scope of Works (S/W) for the feasibility study on Fayoum Agricultural Development Project.

The first field work covered the field reconnaissance and survey of the study area in the winter season involving collection of data and information on the Project and investigation and survey on the reclamation area of North Wahby and Com Osheem areas, while the second field work aimed to make field investigation and survey in the summer season and to discuss the alternative development plans with officials of Egyptian Government concerned and to select a proposed development plan.

To the study team, H.E. Governor assigned Eng. Hussein Dawoud, Assistant Secretary General, as Chief Counterpart, and the personnel of the Ministry of Irrigation and the Ministry of Agriculture as counterparts.

The study team successfully carried out the field survey, and observed and collected data and information in connection with the agricultural and rural development in the Project Area.

During the field survey, soil survey, and survey on the existing irrigation and drainage facilities, present agriculture, present animal husbandry, and farm management were mainly carried out in Wahby Downstream Area and South Area of Lake Qarun as well as the investigation and survey in the new reclamation areas of North Wahby and Com Osheem.

This feasibility study report has been compiled according to the results of surveys and studies conducted in the field and in Japan, and numerous discussion meetings were held among the Egyptian officials, the supervisory group and the study team. The names of the member of the supervisory group, officials of Japanese Embassy and JICA, the Egyptian counterparts personnel assigned to the Project, major officials of Egyptian Government and the study team are listed in the later paragraph.

1.2. Objectives of the Study

The objectives of the Study are, as mentioned in the S/W, (i) to formulate the Project, and verify its technical and economic feasibility; and (ii) to undertake on-the-job training, and transfer the technology to the Egyptian counterpart personnel in the course of the study.

The study area of the Project is defined in the S/W as follows;

- About five thousand seven hundred (5,700) feddan in North Wahby area and three thousand three hundred (3,300) feddan in Com Osheem area;
- About twenty three thousand (23,000) feddan of the existing farm lands at Wahby Downstream Area; and
- About fifteen thousand (15,000) feddan lying along the south coast of Lake Qarun.

1.3. Proposed Project Area

The Project Area is located at about 75 kilometers south of Cairo and about 25 kilometers west of the Nile. It extends in the northern Fayoum depression. Of the study area, the following areas are proposed for the agricultural development of the Project.

1.3.1. North Wahby and Com Osheem Areas

North Wahby and Com Osheem areas are located at the right bank of Bahr Wahby and Gomhouria canal branching off from Bahr Wahby.

North Wahby area is a belt with two to three kilometers wide and about 12 kilometers long with an acreage of about 5,700 feddan (2,390 ha). A part of the area is being reclaimed by a private enterprise and also some parts were developed for poultry farms by a private enterprise. Excepting the above-mentioned areas, the desert area of 5,100 feddan (2,140 ha) is proposed to be developed by the Project. Of 5,100 feddan (2,140 ha), some 4,420 feddan (1,850 ha) of the land holders area and an area of 4,200 feddan (1,770 ha) of farm land are expected to be developed in the area.

Com Osheem area is an oval area about 10 kilometers long from east to west and about two to three kilometers long from north to south. In a part of the desert area, an investor of private sector has established a private enterprise and commenced the development of the desert area of about 600 feddan (250 ha) by providing irrigation facilities. Through the discussions with the officials of the Governorate, it is concluded to exclude the area of the private enterprise from the Project Area. Despite of this, some parts located at the western area can be included in the Project. Although the area is originally expected to be 3,300 feddan (1,390 ha), 3,700 feddan (1,550 ha) in total can be developed by the Project. Of 3,700 feddan (1,550 ha), land holders area and farm land acreages are expected to be 3,160 feddan (1,330 ha) and 3,000 feddan (1,260 ha), respectively.

1.3.2. Wahby Downstream Area

Wahby Downstream Area is, so-called water shortage area, served by Bahr Wahby covered by the downstream of Bahr Unsi (Station 46.823 km) until the end of Bahr Wahby. The land inclines at about 1/300 towards the west, that is, towards Lake Qarun and also at about 1/200 towards the south, that is, towards Batts drain. The elevation of the area varies from 15 meters above mean sea level (AMSL (+)15.0 m) to about 44 meters below mean sea level (BMSL (-)44.0 m).

Of the study area of 23,000 feddan (9,660 ha), an area of 17,200 feddan (7,200 ha) is proposed to solve the water shortage problem by the Project.

1.3.3. South Area of Lake Qarun

South Area of Lake Qarun is a belt extending along the lake coastal line. The area suffers from ill-drainage since the lake water rises in the winter season from December to May. A high water level of Lake Qarun causes inundation and a high groundwater table as well.

Of the study area in South Area of Lake Qarun which covers 15,000 feddan (6,300 ha), the major inundated/affected area of 6,770 feddan (2,830 ha) is proposed to improve the present situations by the Project. At present, an area of 480 feddan (200 ha) is submerged or seasonally inundated while some 4,320 feddan (1,810 ha) and 1,970 feddan (820 ha) are affected directly by drainage water and indirectly by groundwater, respectively. The provision of dikes, drainage channels, and drainage pump stations could rescue these areas from inundation, and restore their agricultural productivity.

1.4. List of Personnel Concerned

1.4.1. Supervisory Team

	Name	Position
1.	Chairman Dr. Michio Nakahara	Director General National Research Institute of Agricultural Engineering, Ministry of Agriculture, Forestry and Fisheries, (MAFF)
2.	Member (Meteorology & Hydrology) Mr. Hideo Yoshino	Irrigation Engineer Second Laboratory of Hydrolics, Department of Hydrolic Engineering, National Research Institute of Agricultural Engineering, MAFF.
3.	Member (Irrigation & Drainage) Mr. Shintaro Hayashi	Chief Irrigation Engineer Investigation and Research Department, Japan Institute of Irrigation and Drainage
4.	Member (Cultivation & Soil) Mr. Toshihiko Kameoka	Deputy Director Laboratory of Soil Conservation, Civil Engineering Research Institute Hokkaido Development Bureau
5.	Member (Agro-economy) Mr. Takayuki Ogasawara	Deputy Director Agricultural Survey Division, Agricultural and Fisheries Department, Hokkaido Development Bureau
6.	Member (Project Evaluation) Mr. Ryotaro Yamane	Manager First Technical Appraisal Division, Economic Research and Technical Appraisal Department, The Overseas Economic Cooperation Fund (OECF)
7.	Coordinator (Field Surveys) Mr. Teruhisa Tajiri	Official, Technical Affairs Division, Agricultural, Forestory and Fisheries, Planning and Survey Department, Japan International Cooperation Agency (JICA)
8.	Coordinator (Explanation Mission) Mr. Shin Imai	Official, Technical Affairs Division, Agricultural Forestory and Fisheries, Planning and Survey Department, JICA

1.4.2. Officials of Japanese Embassy and JICA

Name	Assignment
Mr. Masaaki Noguchi	Minister, Japanese Embassy
Mr. Osamu Nakai	First Secretary, Japanese Embassy
Mr. Junsaku Koizumi	Resident Representative of JICA,Cairo
Mr. Shozo Matsuura	Deputy Resident Representative of JICA,Cairo
Mr. Masao Yamawaki	Expert of JICA

1.4.3. Counterpart Personnel

Name	Assignment
Eng. Hussein Dawoud	Chief Counterpart
Eng. Hamdy Kotb Metwalli	Irrigation and Drainage
Eng. Samir Ibrahim Jacob	Meteorology and Hydrology
Eng. Galal Gholam	Soil
Eng. Mohmed Mahmoud	Soil and Land Use
Eng. Essam Salama	Agronomy
Dr. Mohamed Hendi	Animal Husbandry
Mrs. Abla A. Marzouk	General Administration

1.4.4. Cooperators

Major officials of Egyptian Government contacted by the study team are listed as follows (Detailed list of cooperators is attached in Appendix A-1);

Name	Assignment
H.E. General Tharwat Attallah	Governor of Fayoum Governorate
Dr. Foaud Iskander	First Under-secretary of State International Economic Cooperation with Asiatic Countries Ministry of Planning and International Cooperation

Name	Assignment
Mr. Saad Mohamed Bayoumy	Director General Ministry of Planning and International Cooperation
Dr. Samir R. Nagmoush	Under-secretary of State General Authority for Rehabilitation Projects and Agricultural Development (GARPAD)
Dr. Rifky Anwar	Consultant GARPAD
Eng. Salah Shehab	First Under-secretary Ministry of Irrigation
Eng. Helmy Mahmoud Ibrahim	Under-secretary for Horizontal Expansion Ministry of Irrigation
Eng. Nady Selim	Under-secretary of State, Ministry of Irrigation,Fayoum
Eng. Hamdy Kobt Metwalli	General Director Ministry of Irrigation, Fayoum
Dr. Yassin Osman	Director Ministry of Agriculture, Fayoum

1.4.5. Study Team Members Assigned to the Project in Egypt

Name	Period Assigned to the Project
1. Team Leader Mr. Kazunori Tamaki	February 3 to March,29 1984 July 7 to July 21, 1984 September 17 to October 1, 1984 December 11 to December 24, 1984
2. Irrigation & Drainage Sub-leader Mr. Yoshio Arai	February 3 to March 29, 1984 July 7 to October 1, 1984 December 11 to December 24, 1984
3. Meteorology & Hydrology Mr. Masahiro Iida	February 3 to March 29, 1984 July 7 to October 1, 1984
4. Soil & Land Use Dr. Naruo Kondo Dr. Yukio Sakanoue	February 3 to March,29 1984 July 7 to September 1, 1984

	Name	Period Assigned to the Project
5.	Agriculture	February 14 to March 29, 1984
	Mr. Katsura Kariya	July 7 to September 1, 1984
6.	Animal Husbandry	February 3 to March 29, 1984
	Mr. Kensuke Iriya	July 17 to October 1, 1984
7.	Irrigation & Drainage Facilities	
	Mr. Haruo Homma	July 17 to October 1, 1984
8.	Land Reclamation	
	Mr. Shunsuke Nakamura	August 2 to October 1, 1984
9.	Rural Development	
	Mr. Toshiyuki Matsunaga	August 2 to October 1, 1984
10.	Construction Planning & Cost	
	Mr. Masahiro Isomura	August 2 to October 1, 1984
11.	Agri-economy	
	Mr. Shoji Yamada	February 14 to March 29, 1984
		August 2 to October 1, 1984
		December 11 to December 24, 1984

CHAPTER II. ECONOMIC AND SECTORAL BACKGROUND

CHAPTER II. ECONOMIC AND SECTORAL BACKGROUND

2.1. National Level

The statistical Yearbook, 1982 shows that the gross domestic products (GDP) in Egypt enlarged at 218 percent from LE 5,246 million in 1975 to LE 16,698 million in 1980/81 at current prices.

The national income in the agricultural sector has not increased like that in industrial sector. Though the amount of agricultural income at current prices is still occupying the largest share of the total income, the development in agriculture is under the stagnation (refer to Appendix A-2).

A balance of trade has been always negative. Although the export value expanded from LE 595 million in 1979 to LE 2,263 million in 1981, the negative balance of LE 894 million in 1976 was not improved, and arrived at LE 3,925 million in 1981 because the import value also increased from LE 1,490 million in 1976 to LE 6,187 million in 1981. The import value of vegetable products which is amounted to LE 1,146 million occupied the largest rate of 18.5 percent of the total import value in 1981. The value of live animals and animal products occupied only 6.7 percent of the total import value. However, the annual growth rate of import value of live animals and animal products was larger than that of vegetables (refer to Appendix A-2).

The new Five Year Plan for Economic and Social Development from 1982/83 to 1986/87, aims that the annual growth rate of production and GDP would be 8.0 and 8.1 percent, respectively. The proposed growth rate of GDP in each sector is 3.7 percent for agriculture, 10.3 percent for industry and mining, 12.2 percent for oil and its products, 10.7 percent for electricity, and 8.3 percent for construction. The plan also aims to provide about 2.1 million

workers with new job to cope with an incremental rate of 420,000 workers per annum. As for the agricultural sector, 4.2 million workers in 1981/82 will increase to 4.7 million before the end of the target year of the plan.

The regional development strategy aims to mitigate regional difference in every aspect. The development policy for North Saeed (Upper Egypt) region including Fayoum Governorate bears great resemblances to those of Delta region. The plan aims at;

- Mechanization of agriculture, and improvement of irrigation and drainage systems; and,
- Development of Cattle breeding, poultry and fodder industries.

2.2. Provincial Level

The agricultural productivity in Fayoum Governorate is lower than that of the national average and the yield of Nili crops are specially too low (refer to Appendix A-2).

The grazing capacity of a cultivated area of berseem (Egyptian clover) in Fayoum (1.44 head per feddan) is slightly smaller than 1.52 head of the national average.

The main factors forcing the low productivity in agricultural sector are insufficient irrigation water and the less cropping intensity.

CHAPTER III. THE PROJECT AREA

CHAPTER III. THE PROJECT AREA

3.1. Location and General Features

3.1.1. Geographic Location and Road Systems

(1) Geographic Location

The Project Area is located at the northern part of Fayoum depression which is about 75 kilometers distance south of Cairo, capital city of Egypt, and about 25 kilometers west of the Nile river. Fayoum city, capital city of Fayoum Governorate, exists at about 25 kilometers south of the Area. Geographic latitude and longitude are 29°25' north and 31° east, respectively.

(2) Road Systems

The road systems in the depression area are classified into three categories. Several roads with asphalt pavement are maintained by the Road Authority of Beni Suef. The highway running between the North Wahby and Com Osheem areas and through the western part of Wahby Downstream area from north to south is the major road for transport of every goods from and to Cairo. The road which forms the northern boundary of the South Area of Lake Qarun is also classified into the same category.

The other roads with asphalt pavement in the second category are maintained by the Road Authority of Fayoum.

Many dusty roads in the third category are located along canals and drains. Some of them are maintained by the Road Authority of Fayoum. These roads have a function as the operation and maintenance roads of irrigation and drainage systems. However, MOI is not in charge of maintaining the roads and is responsible for canal sections and their appurtenant structures only.

3.1.2. Population and Living Conditions

(1) Population

The whole population of Fayoum Governorate was about 1,316,000 in 1981. The annual growth rate was two percent during ten years from 1966 to 1976, and 2.8 percent from 1976 to 1981. The population density was 720 persons per square kilometer in 1981 in Fayoum Governorate and 456 persons in Tamiah district in Fayoum Governorate. (refer to Appendix A-2).

As for administrative units, Fayoum Governorate consists of five cities and 157 villages, or of 37 local units which consist of three to four villages. Tamiah district has one city and 18 villages, or five local units.

The population of villages related to the Project Area is 8,551 in Mazatley, 1,197 in Fanaus, 24,243 in Tamiah, 18,964 in Rashuwan, 7,409 in Menshat, 4,774 in Saedia, 9,035 in Shakshok, 11,955 in Khalidiya, 15,107 in Kahk, 4,497 in Abu Lutei Basil, and 5,452 in Misharrak in year 1982. (refer to Appendix A-2)

The average family size of farmhousehold in Fayoum was 5.2 persons in 1976. The workable population with an age over 15 years old was about 648,000 in 1976. The number of people working in agriculture, animal farming, and fisheries sectors occupy the largest share, specially in Tamiah. (refer to Appendix A-2)

(2) Living Conditions

The potable water supply system in Fayoum Governorate distributes water to inhabitants in the almost whole villages. However, some villages in Tamiah district cannot receive potable water because of poor system and a high land elevation. People in rural areas can get drinking water from public or common supply

facilities located at the entrance of these villages. In general, each farm household has no outlet of water supply system.

The greater part of villages in Fayoum Governorate are already electrified. However, some villages without electricity are seen in Ibshwai, four in Itsa, two in Senorus, and one village in Tamiah.

The transportation in and around villages is made mainly by animals like donkey. Many buses, cars, and tractors are also operated for transporting daily necessaries.

There are several small grocery stores in each small village. The inhabitants can buy simple daily necessaries at the stores. A fair is opened once a week in certain village. The inhabitants buy and sell vegetables, cereals, animals, and daily necessaries. Since there are no shop for special goods such as cloths, medicine, and furnitures in a village, they have to go to Tamiah city or Fayoum city.

3.2. Physical Conditions

3.2.1. Topography and Canals

(1) Topographic Conditions

The Project Area of 32,770 feddan (13,740 ha) in total involves three project components such as reclamation in North Wahby and Com Osheem areas, improvement of irrigation system of the Wahby Downstream area, and improvement of inundation of the South Area of Lake Qarun.

North Wahby area of 5,100 feddan (2,140 ha) is located north of Bahr Wahby which is the main irrigation canal of the area, and lies stretching northwest and southeast. A length and width of the belt-shaped area are about 13 kilometers and two kilometers, respectively. The area is bounded by the highway on the west, by the edge of the existing farm lands on the south, and by the hilly area with an elevation of 30 to 40 meters above the mean sea level on the north and the east. An elevation of the reclamation area ranges from about 15 meters to 28 meters above the mean sea level. Rolling and undulating area inclines toward south with a land slope of 1:150 on an average.

Com Osheem area of 3,700 feddan (1,550 ha) to be also reclaimed expands in the west of North Wahby area mentioned above. The eastern boundary of the area exists two kilometers distant from the Cairo road, avoiding the elevated ground which lies beside the said road. The southern boundary is the edge of the existing cultivated lands, and the other sides are surrounded by hilly areas about 30 to 40 meters above the mean sea level. The area is measured six kilometers long towards west and two kilometers wide to north. The area occupies a rolling and undulating desert area with an elevation of ten to 28 meters above the mean sea level. The inclination is 1:200 mainly towards south. Gomhouria canal, the main irrigation canal branching off from Bahr Wahby, places lower than the area.

Wahby Downstream area of 17,200 feddan (7,220 ha) mostly consists of cultivated area, and is bounded by Bahr Wahby on the north, Unsi canal on the east, a branch canal of Bahr Wahby, and by Batts drain on the south, one of the main drainage canals of the Fayoum depression. The area lies downstream of the service area of the Fayoum depression. The area lies downstream of the service area of Bahr Wahby, and lies with 17 kilometers long and four kilometers wide. The area extends in the elevation between 15 meters above the mean sea level and 40 meters below the mean sea level, and inclines toward west with a slope of 1:300, and towards the drain with a slope of 1:180 on an average. Especially, part of the area located along Bahr Wahby shows a steeper slope than 1:100 towards south.

South Area of Lake Qarun of 6,770 feddan (2,830 ha), which is located at the northern edge of the depression, literally lies along the south side of Lake Qarun. The boundaries of the area are the lake shore and the drain in the north, the edge of the presently cultivated land with an elevation of (-)38 meters (below the mean sea level) at the other sides. The area is a long and narrow belt about 10 kilometers long along the lake shore and about two kilometers wide. The slope is gentle towards Lake Qarun.

(2) Canals

Batts drain runs along the naturally deepest depression in Fayoum. The total length and drainage area of the drain are 50.9 kilometers and about 152,000 feddan (about 640 sq.km), respectively. Its discharge fluctuates from about five to ten cubic meters per second according to a water quantity supplied to Fayoum Governorate and also the extent of irrigation efficiency. The hydraulic gradient of this drain is about 1:1,500 at the sections from KM 3.2 to KM 19.2. The annual discharge to Lake Qarun is calculated at 178 million cubic meters approximately from discharges of Batts and Wadi drains. The mean discharge is about six cubic meters per second.

3.2.2. Meteorology and Hydrology

(1) Meteorological Conditions

1) Observatories

There are three observatories in Fayoum depression, namely, Fayoum station under the Meteorology Department, Shakshok station under DRI, MOI, and Azba station established by the study team of JICA, Japan. The maximum and minimum temperatures, relative humidity, and wind speed and direction are observed at each station. Shakshok Station collects data of water level of Lake Qarun, air vapor pressure and various evaporation rates. The data of Fayoum Station are not applied to the Project because its location is far from the Area as compared with the other stations. (refer to Appendix B-1)

Azba station was established by the study team of JICA in March 1984. This station is equipped with an automatic (self-recording) thermometer and hygrometer, automatic wind vane and anemometer, and automatic evaporation recorder with a class "A" Pan. The latitudinal and longitudinal locations and altitude are 29°23' north, 39°59 east, and 13.7 meters above the mean sea level, respectively. The observed data have been recorded since the later half of March 1984.

2) Meteorological Conditions

As known well, the Project Area belongs to the arid zone. Therefore, the meteorological data show several special features such as low humidity, large diurnal range, and small amount of rainfall.

The annual amount of rainfall is negligibly small at 9.2 millimeters. This small amount of rainfall takes place in winter season from October to March. However, the daily maximum rainfall was recorded at 16 millimeters.

The annual mean, maximum mean, and minimum mean temperatures are 22.2°C, 28.6°C, and 15.7°C, respectively. The hottest month comes in July or August. The mean temperature arrives at nearly 30°C in these months. The coldest is in January with the minimum temperature of 6.3°C.

The mean value of relative humidity is 61 percent. The monthly fluctuation of mean relative humidity is not so big. In winter season from November to February, the value is 67 percent, which is slightly higher than the annual mean. In summer season from May to August, its value is 57 percent, which is lower than the mean value.

The mean wind speed of 2.5 meters per second was recorded at Shakshok Station. In May and June the wind speed of 3.2 meters per second is observed and in December to February of 1.7 meters per second.

Various evaporation rates are observed by sizes of pan and kinds of water. All the evaporation data show the same trend that in winter season the evaporation rate ranges from three to six millimeters per day, and in summer season the rate increases to about 12 millimeters per day. The annual evaporation with a class "A" Pan filled with fresh water, and with salt water, and a pond scaled 12 meters times ten meters filled with lake water are 2,952, 2,701, and 1,934 millimeters, respectively. (refer to Appendix B-1)

(2) Hydrological Conditions

1) Water Resource

The water resource for the Fayoum depression is only the Nile river. The amount of water to be supplied to the Fayoum depression is controlled by the Ministry of Irrigation Beni Suef, at the Lahoun barrage, which is located at the west edge of the depression.

The annual amount of water supplied to Fayoum depression is recently observed at about 2,300 million cubic meters controlled depending on the water level of Lake Qarun because the lake has no drainage outlet to the outside, so-called a closed drainage system.

The discharge flowing into the depression monthly fluctuates under the control of the MOI. The monthly maximum discharge ranging from 220 to 260 million cubic meters usually appears in July or August in summer season. The monthly minimum discharge of 93 to 150 milion cubic meters appears in December or February in winter season. In January water supply is forcedly halted for 19 days for maintenance of canals. However, out of 59.9 million cubic meters the amount of 2.5 million cubic meters is supplied for domestic water throughout the water closure period in January.

The average water duty is calculated at 20 cubic meters per day per feddan (4.8 mm/day) supplied to the depression of about 315,000 feddan (132,000 ha). In the maximum water demand season, the figure increases to 25.3 cubic meters per day per feddan (6.0 mm/day). On the other hand, in the minimum water demand season 17.4 cubic meters per day per feddan (4.1 mm/day) is observed.

2) Re-use of Water

The observation data of discharge of the Batts drain were available only for a three-year period of 1975, 1980, and 1981. These data show that the maximum discharge of ten cubic meters per second took place in September 1980, and the minimum of 5.04 cubic meters per second in July 1975. It can be said that the proposed discharge of 4.5 cubic meters per second for the Project is certainly secured throughout the year.

3) Bahr Wahby

Bahr Wahby branches off from Bahr Yusef at Hawara, Fayoum, and functions as the main water carrier for the Project Area. The discharge records in recent five years from 1980 to 1984 show that the mean annual discharge is 310 million cubic meters at the Seka Hadid weir with a service area of about 60,000 feddan (25,200 ha), which is equivalent to 14.2 cubic meters per day per feddan occupying about 13 percent of the total amount of discharge to Fayoum. The area served by Bahr Wahby covers 19 percent of the total cultivated acreage of Fayoum (315,000 feddan).

The above-mentioned water of 14.2 cubic meters per day per feddan is only about 70 percent of the mean water duty of 20 cubic meters per day per feddan. Even in the case excepting January, the mean water duty of the area served by Bahr Wahby is computed at 15 cubic meters per day per feddan. The maximum water duty of 17.2 cubic meters per day per feddan has occurred in July. A water duty for a period from March to August is bigger than the other months. These water duties above-mentioned are lower than the those of Fayoum and the national average.

The water level records observed at the stations established by JICA study team show a very interesting fact that the water level has dropped down during the nighttime. This fluctuation remarkably appears at the downstream area of Bahr Wahby. A difference of water levels between daytime and nighttime is observed at 16.5 centimeters.

4) Observatories

The existing observatory is located only at the Seka Hadid weir on Bahr Wahby, where the water depth on the crest of the weir is recorded.

During the first field survey in March,1984, the Study Team installed five sets of automatic water level recorder on Bahr Wahby, Batts drain and Lake Qarun. The location of the said recorder are as follows;

1. Shakshok for the Lake Qarun water level;
2. Casr Rashuwan on Batts drain;
3. Gerza on Bahr Wahby at KM 34.66;
4. Intake point of Bahr Green on Bahr Wahby at KM 49.71 point;
5. Intake point of Com Osheem canal on Bahr Wahby at KM 55.64.

The Study Team also installed a salinity concentration automatic recorder at the intake point of Bahr Fanaus on Bahr Wahby during the second field survey in August, 1984. This station will observe salt concentration of water in Bahr Wahby after mixing with drain water and will play a very important role for the Project.

5) Longitudinal Discharge on Bahr Wahby

The field surveys revealed that the longitudinal discharge of Bahr Wahby decreases in accordance with the distance from

the starting point of this canal. The discharge at the Seka Hadid weir was 11.9 cubic meters per second on 6 August 1984, but it decreased to 7.6 cubic meters per second at Gerza, to 3.6 cubic meters per second at Bahr Green, and to 2.0 cubic meters per second at the Com Osheem point. In this connection, when it is converted the discharge of cubic meters per second to the water duty of cubic meters per day per feddan which are 17.1 cubic meters per day per feddan at the Seka Hadid weir, 20.7 at Gerza, 13.9 at Green and 15.6 at Com Osheem, it is very obvious that more severe water shortage occurs at the downstream of Bahr Wahby, especially at the downstream of Green (refer to Appendix B-2.5).

6) Water Level of Qarun Lake

The variation of water level of Lake Qarun is observed at about 50 centimeters in a year. In winter the water level goes up to 43.5 meters below the mean sea level while in summer it goes down to 44.0 meters below the mean sea level. Usually the highest water level takes place in March or April whereas the lowest water level in August or September. Monthly and daily variations are very small, about ten centimeters and three millimeters, respectively.
(For further details about the hydrological conditions, refer to Appendix B-2)

Before 1973, the amount of water of 1,968 million cubic meters was annually supplied to the Fayoum depression and out of which an amount of 365 million cubic meters was annually drained to Lake Qarun. The annual mean water level of Lake Qarun was slightly going up in accordance with an amount of water to the Fayoum area.

On the next period from 1974 to 1977 after completion of the Wadi El Rayan channel, the amount of drainage water of 155

million cubic meters was diverted to Lake Rayan. Although the annual mean discharge to the Fayoum depression was slightly increased up to 2,160 million cubic meters, the amount of drainage discharge to Lake Qarun was decrease up to 266 million cubic meters and the annual mean water level of Lake Qarun became lower.

Notwithstanding a part of drainage water from the Fayoum depression is continuously being diverted to Lake Rayan through the said channel after 1978, the water level of Lake Qarun was going high. As for the reasons, increasing the amount of water supply to the Fayoum depression and decreasing extent of evaporation from the water surface of Lake Qarun and other unknown factors would be supposed. (for further details, refer to Appendix B-3)

7) Salt Balance of Lake Qarun

In order to study the salt balance of Lake Qarun, it is considered that three projects such as a salt extraction factory with an annual salt extraction capacity of 213,000 tons proposed near the Abuksa bay, the Targen re-use water project and the Batts drain re-use water project would be proposed in Fayoum. In various case studies on salt balance of Lake Qarun, almost all cases without any supplemental water to the Lake indicated to annually increase salt concentration by 0.8 percent. Of which the one case that the supplemental water to the Lake will be gained by controlling the diversion water to the Wadi El Rayan channel shows no increase of salt content. however, the controlling of the diversion water to the Wadi El Rayan will affect fisheries in Lake Rayan.
(for further details, refer to Appendix B-4)

3.2.3. General Geology

The Fayoum depression itself was appeared in Middle Eocene rocks, which form the oldest exposed beds in the area, composed essentially of gypseous shales, white marls, limestone and sand (known as ravine beds).

The southern and western parts of the Fayoum area consists of white limestone, argillaceous sand and sandy shales (known as Wadi El Rayan formation).

The northern terraces overlooking Fayoum depression are essentially of Upper Eocene beds composed of shales and limestone in the lower beds with sand and sandstone in the upper beds (known as Qarun El Sagha formation).

The Upper Eocene beds are followed by Oligeous beds which are composed mainly of fluvio-marine variegated sands and sandstone with alternating beds of shallow marls and calcareous grits containing silicified wood (known as Qatrani formation). Above the Qatrani formation there is the basalt intrusions fissured as a sheet of constant horizon (20 to 25 m thick).

The lower Miocene rocks are constituting the north-western parts of the area. These beds are composed essentially of sands, gravels, silicified tree trunks and unfossilferous sandstone quartizite (known as Gabel El Kahshab beds).

The pleistocene deposits, mainly of fluvio-lacustrine origin, are constituting the subsurface of the Fayoum depression between the recent Holocene deposits.