THE PROJECT FOR DRAINAGE WATER QUALITY CONTROL FOR IRRIGATION IN MIDDLE NILE DELTA IN THE ARAB REPUBLIC OF EGYPT

Final Report

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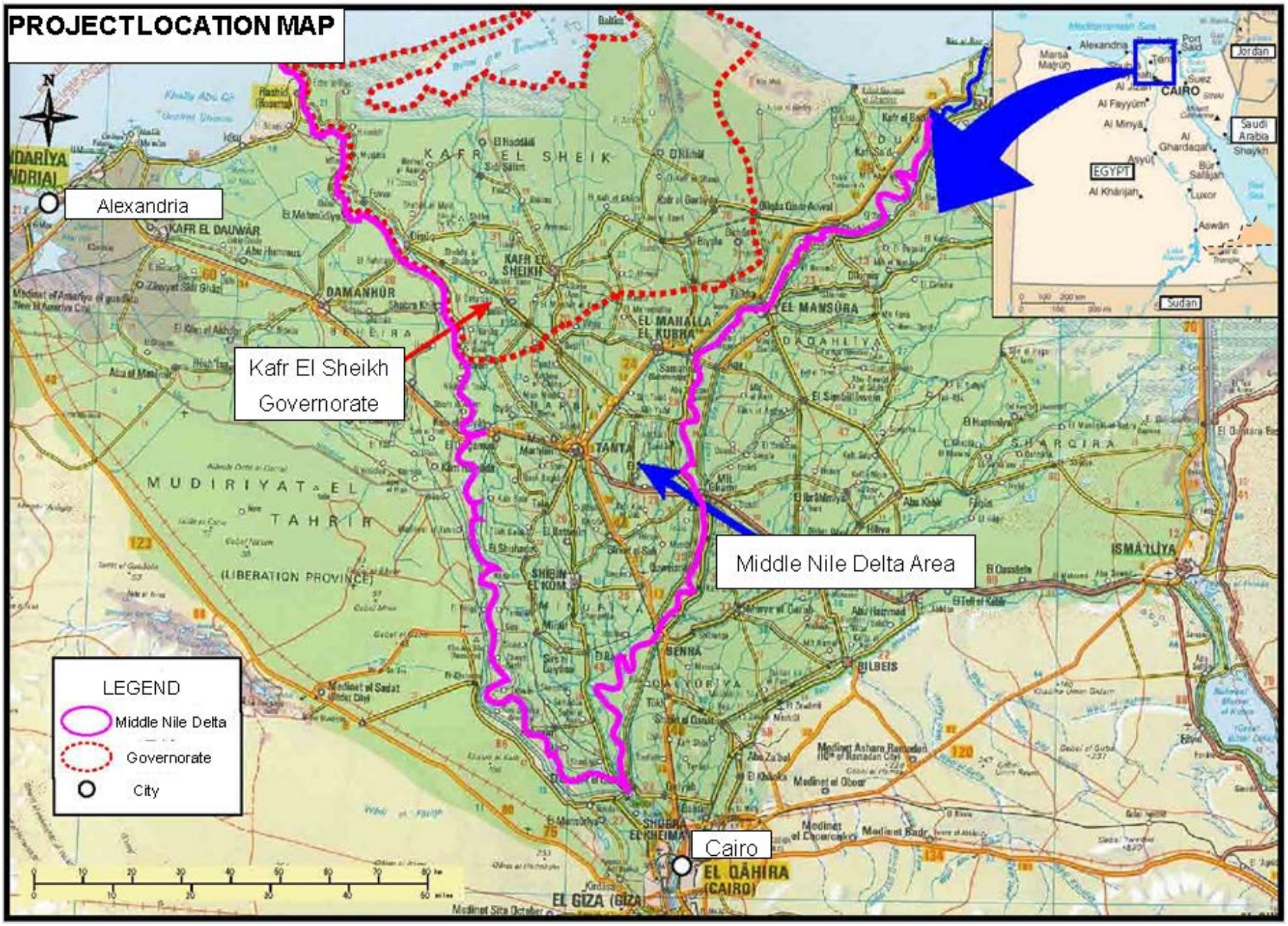
JAPAN INTERNATIONAL COOPERATION AGENCY

(JICA)

SANYU CONSULTANTS INC.


PROJECT LOCATION MAP
N
Alexandria
Kafr El Sheikh Governorate
Middle Nile Delta Area
Cairo
KAFR EL SHEIK
KAFR EL DAUWAR
DAMANHUR
EL MAHALLA EL KUBRA
EL MANSURA
DAQAHLIYA
TANTA
SHARQIA
MUDIRIYAT EL TAHRIR
(LIBERATION PROVINCE)
ISMA'ILIYA
SHIBIN EL KOM
MINUFIYA
SENHA
GHARBIYA
BILBEIS
SHUBRA EL KHEIMA
EL QAHIRA (CAIRO)
EL GIZA (GIZA)
LEGEND
Middle Nile Delta
Governorate
City
Jordan
Saudi Arabia
EGYPT
CAIRO
Sudan

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ABBREVIATIONS

AES	:	Agricultural Extension Service
BCM	:	Billion Cubic Meter
BCWUA	:	Branch Canal Water Users' Association
B/D	:	Basic Design
BOD	:	Biological Oxygen Demand
CDA	:	Community Development Association
CDIAS	:	Central Department of Irrigation Advisory Service
CFU	:	Colony Forming Unit
CLEQM	:	Central Laboratory for Environmental Quality Monitoring
CO_2	:	Carbon Dioxide
COD	:	Chemical Oxygen Demand
COD(Cr)	:	Chemical Oxygen Demand (potassium dichromate)
COD (Mn)	:	Chemical Oxygen Demand (potassium permanganate)
C/P	:	Counterparts
Cu	:	Copper
DAS	:	Drainage Advisory Service
D/D	:	Detailed Design
DO	:	Dissolved Oxygen
DPC	:	Drainage Pump Committee
DRI	:	Drainage Research Institute
DWB	:	District Water Board
DWMP	:	Decentralized Wastewater Management Project
EC	:	Electrical Conductivity
EEAA	:	Egyptian Environmental Affairs Agency
EIA	:	Environmental Impact Assessment
EP	:	End Point
EPADP	:	Egyptian Public Authority for Drainage Projects
EU	:	European Union
EWRMP	:	Enhanced Water Resources Management Project
F	:	Fluoride
FAO	:	Food and Agriculture Organization
FIRR	:	Financial Internal Rate of Return
F/S	:	Feasibility Study
GDIAS	:	General Directorate for Irrigation Advisory Service
GEF	:	Global Environmental Facility
GIS	:	Geographic Information System
GIZ	:	Deutsche Gesellschaft für Internationale Zusammenarbeit
GOJ	:	Government of Japan
HCWW	:	Holding Company for Water & Wastewater
IAS	:	Irrigation Advisory Service
ID	:	Irrigation Directorate

IIP	:	Irrigation Improvement Project
IIIMP	:	Integrated Irrigation Improvement and Management Project
IMT	:	Irrigation Management Transfer
IWMD	:	Integrated Water Management District
IRR	:	Internal Rate of Return
IWMI	:	International Water Management Institute
IS	:	Irrigation Sector
ISSIP	:	Integrated Sanitation and Sewerage Infrastructure Project
IWRM	:	Integrated Water Resources Management
IWSP	:	Improved Water and Wastewater Services Prgorammes
JARUS	:	Japan Association of Rural Resources Recycling Solutions
JICA	:	Japan International Cooperation Agency
JPY	:	Japanese Yen
JSC	:	Joint Steering Committee
Kfw	:	Kreditanstalt für Wiederaufbau
kW	:	Kilo Watt
LE	:	Egyptian Pond
lit/s	:	Litter per Second
m/s	:	Meter per Second
MALR	:	Ministry of Agriculture and Land Reclamation
MCM	:	Million Cubic Meter
m^3/day	:	Cubic Meter per Day
MED	:	Mechanical and Electrical Department
m^3/s	:	Cubic Meter per Second
mg/l	:	Mill Gram per Litter
MHUUD	:	Ministry of Housing, Utilities and Urban Development
Mn	:	Manganese
MOIC	:	Ministry of International Cooperation
MPS	:	Mixing Pump Station
MWRI	:	Ministry of Water Resources and Irrigation
NAWQAM	:	National Water Quality and Availability Management Project
NGO	:	Non Governmental Organization
N_2	:	Nitrogen
NH_3	:	Ammonia
NH_3-N, NH_4-N	:	Ammonium Nitrogen
NO_2	:	Nitrite
NO_2-N	:	Nitrite Nitrogen
NO_3	:	Nitrate
NO_3-N	:	Nitrate Nitrogen
NWRI	:	National Water Research Institute
NWRP	:	Nation Water Resource Plan 2017
OJT	:	On the Job Training
O&M	:	Operation and Maintenance

pH	:	Potential Hydrogen
PIM	:	Participatory Irrigation Management
PS	:	Pump Station
R/D	:	Record of Discussion
RRTC	:	Rice Research & Training Center
SAR	:	Sodium Adsorption Ratio
SS	:	Suspended Solid
SWMT	:	The Project for Strengthening Water Management Transfer
TDS	:	Total Dissolved Solid
T-N	:	Total Nitrogen
TOC	:	Total Organic Carbon
T-P	:	Total Phosphorus
TSS	:	Total Suspended Solid
USAID	:	United States Agency for International Development
WARUS	:	The Project For Drainage Water Quality Control for Irrigation in Middle Nile Delta
WMIP	:	Water Management Improvement Project
WQU	:	Water Quality Unit
W/S	:	Workshop
WTP	:	Wastewater Treatment Plant
WUA(s)	:	Water Users' Association(s)
WWMP	:	Water and Wastewater Management Program
Zn	:	Zinc
µS/cm	:	Micro Siemens per Centi Meter

Glossary

Feddan=0.42ha

Currency

JPY Japanese Yen

USD US Dollar

LE Egyptian Pound

Exchange Rate (February 2016)

USD = 118.74 JPY

LE = 15.211 JP Y

Chapter 1 Outline of the Project

1.1 Background: Drainage Water Reuse and Difficulties

The Arab Republic of Egypt (hereinafter referred to as "Egypt") has very few rainfall and depends on the Nile River thoroughly as the water source. Egypt can use 55,500 million cubic meters (MCM) from the Nile River annually based on the agreement with Sudan in 1959. The main issue of the water resources sector in Egypt is how to effectively utilize the limited water source.

Population in Egypt has been rapidly growing, namely, at 2% rate per year, demand of not only food production but also necessary amount of water use for agriculture, industry and households due to the economic growth is increasing, and consequently, water supply is a very serious issue. Especially, deficit of irrigation water in the Nile Delta area, which is located on downstream of the Nile River, is very severe, and securing irrigation water is one of the national urgent issues in Egypt.

Then, the Ministry of Water Resources and Irrigation (MWRI) took the initiative to develop the National Water Resources Plan 2017 (NWRP 2017) with the following strategies;

- Development of new water sources using underground water;
- Water saving of existing cultivated field; and
- Reuse of drainage water.

Out of those strategies, it is expected that reuse of water drainage water will be increased from 3.5 billion cubic meters in 1997 to 8.9 billion cubic meters in 2017, which is 2.5 times of that in 1997. Therefore, various issues, namely, contamination by untreated drainage water from industrial factories and households, animal feces and urine, dumping of waste materials, and so on have to be solved. In such situation, the Government of Egypt requested to the Government of Japan (GoJ) to prepare the Master Plan for drainage water reuse to irrigation, and to implement the technical cooperation project. Based on the request, the Record of Discussions was exchanged between MWRI and Japan International Cooperation Agency (JICA) on November 16, 2011. Main counterpart (C/P) of the Project is Egyptian Public Authority for Drainage Project (EPADP) under the MWRI and the Kafr El Sheik Governorate.

1.2 Outline of Project

1.2.1 Utilization of Proposed Master Plan

In this project, a master plan for reusing drainage water will be formulated in order to increase the available irrigation water in the Central Nile Delta. The specific target area is Kafr El Sheikh Governorate. The master plan would include the measures for water quality conservation in mid-term (3-5 years) and long-term (around 10 years). The master plan is finalized after reflecting lessons to be learned from a pilot project implementation. Following are the targets of the proposed master plan for its utilization:

- Master Plan for drainage water reuse for irrigation will be incorporated in the water resources JICA policy of Egypt, and
- Short term or mid-term measures proposed by the Master Plan are implemented by Egyptian government or donors.

1.2.2 Expected Outputs

Expected outputs to achieve the utilization of the proposed master plan in Egypt are as follows:

- A drainage water reuse plan for irrigation including water quality conservation is prepared;

and

- Capacity development of the C/P regarding planning and implementation is achieved through the master plan preparation and the pilot project implementation.

1.2.3 Target Area

The target area of the project is the Central Nile Delta and direct target area of the master plan is Kafr El Sheikh Governorate. Given that the irrigation water and drainage water are discharged from the upstream of the Governorate, it is necessary to examine water quality conservation measures in the upstream, if any.

1.2.4 Organizations Concerned

The following authorities are concerned with the Project.

Ministries concerned (Joint Steering Committee: JSC)

- Ministry of Water Resources and Irrigation: MWRI
- Ministry of Agriculture and Land Reclamation: MALR
- Egyptian Environmental Affairs Agency: EEAA
- Ministry of Housing Utilities and Urban Development: MHUUD
- Ministry of International Cooperation: MOIC

Main sections and agencies at the regional level under the MWRI are follows:

Main section of the MWRI

- The Egyptian Public Authority for Drainage Projects: EPADP
- Drainage Research Institute: DRI
- Planning Sector: PS
- Irrigation Sector: IS

Central Delta Region

- Kafr El Sheikh Governorate
- General Directorate of Drainage of West Kafr El Sheikh
- General Directorate of Irrigation of West Kafr El Sheikh
- General Integrated Directorate of Water Resources and Irrigation of East of Kafr El Sheikh

Previously, the General Directorate of Kafr El Sheikh had two directorates, namely, west and east for both Directorate of Drainage and Directorate of Water Resources and Irrigation. However, General Directorate of Drainage of East Kafr El Sheikh and General Directorate of Irrigation of East Kafr El Sheikh are integrated into one directorate, and are renamed to “General Integrated Directorate of Water Resources and Irrigation of East of Kafr El Sheikh”. Those organization charts are illustrated in following figures:

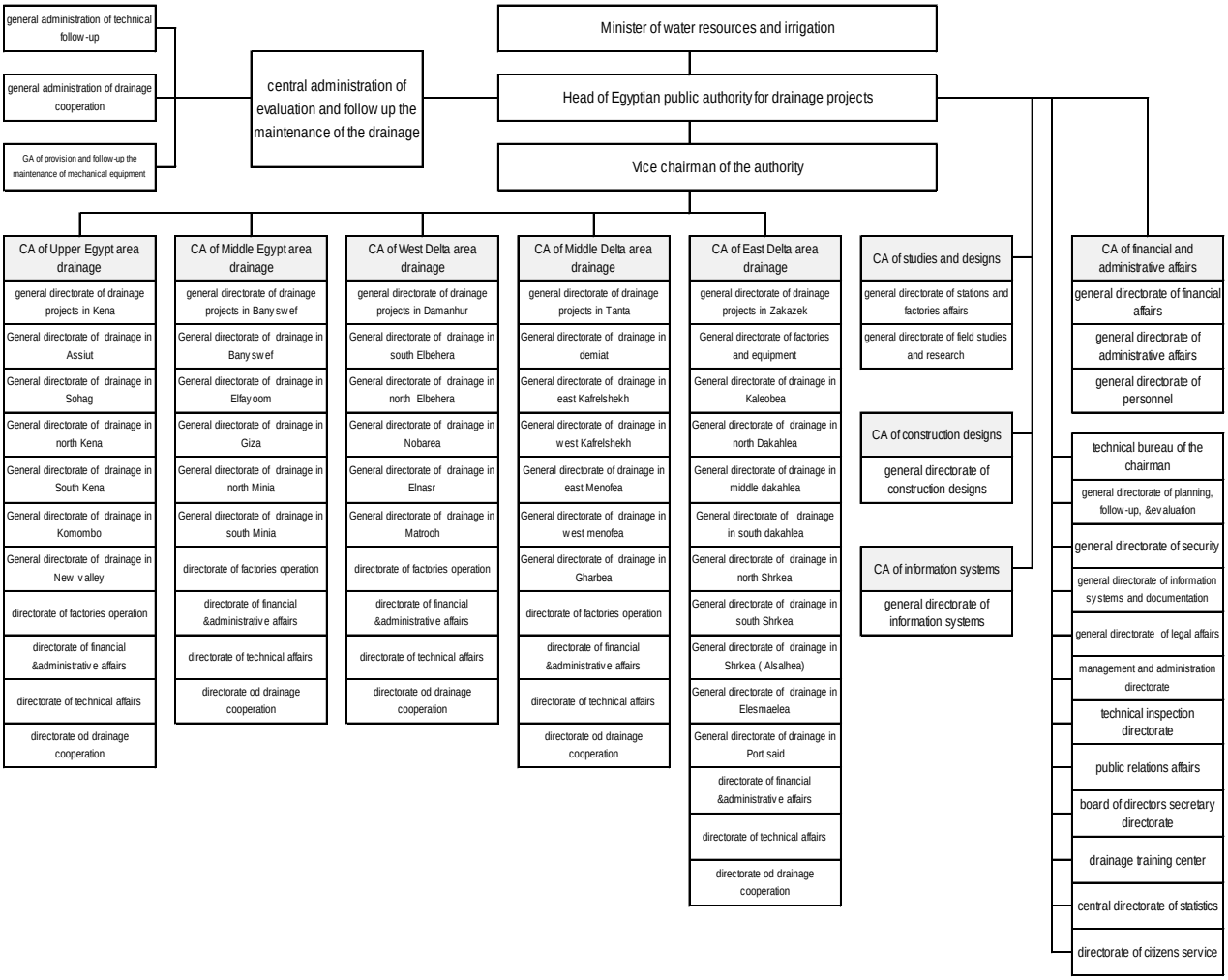


Figure 1.2.1 Organization Chart of EPADP

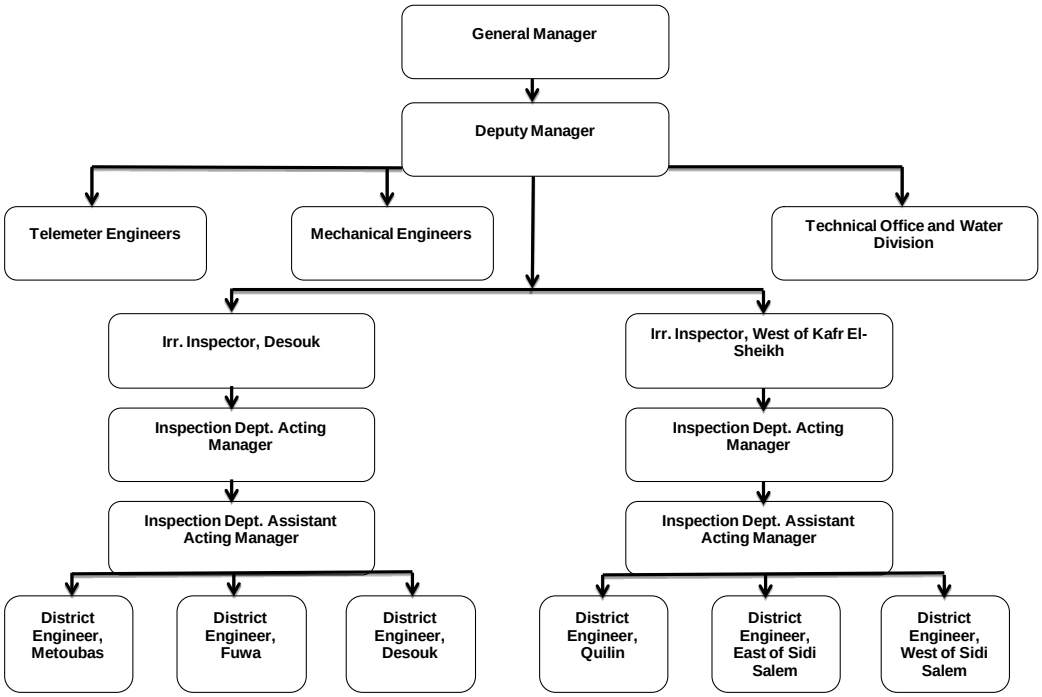


Figure 1.2.2 Organization Chart of General Directorate of Irrigation of West Kafr El Sheikh

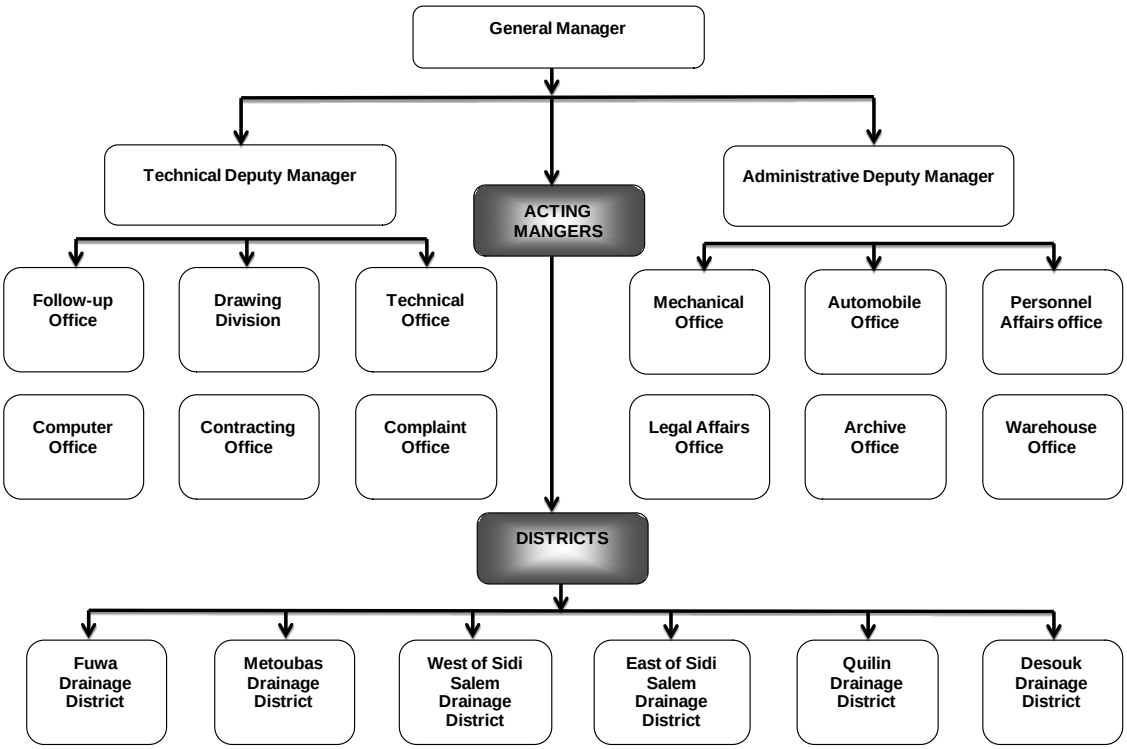


Figure 1.2.3 Organization Chart of General Directorate of Drainage of West Kafr El Sheikh

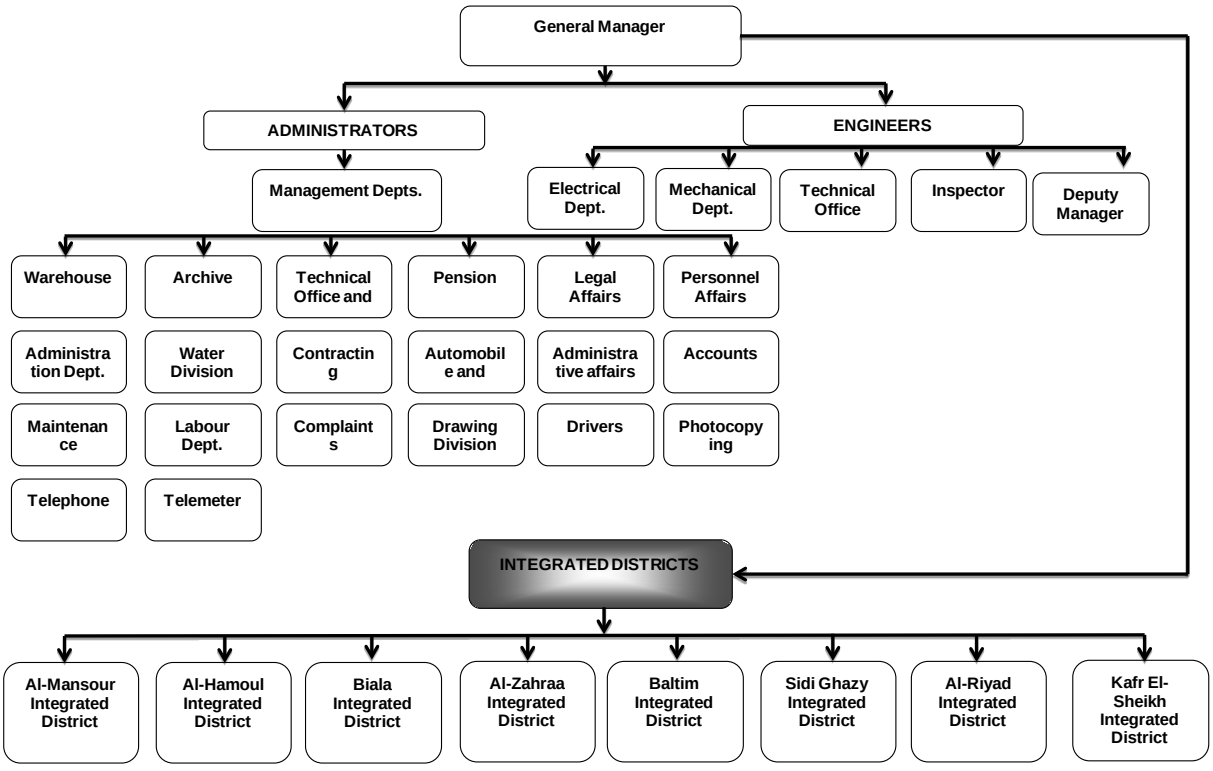


Figure 1.2.4 General Integrated Directorate of Water Resources and Irrigation of East of Kafr El Sheikh

1.2.5 Schedule and Scope of the Project

The Project consists of two phases, namely Phase 1 and Phase 2. In the Phase 1, based on the current condition analysis, the master plan for drainage water reuse was drafted, and components of the Pilot Project were designed from February 2012 to October 2012. In the Phase 2, based on the draft master plan, the proposed Pilot Project was implemented. In the last half Phase 2, based on the lessons learnt through the Pilot Project, the draft Master Plan was finalized. Due to the unrest in Egypt in July 2013, the Project was suspended for about three (3) months and the schedule was revised. Following figure shows the Project implementation schedule and scope.

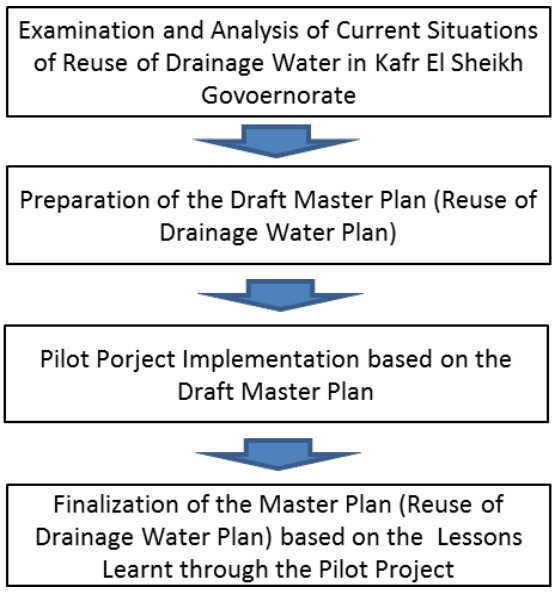
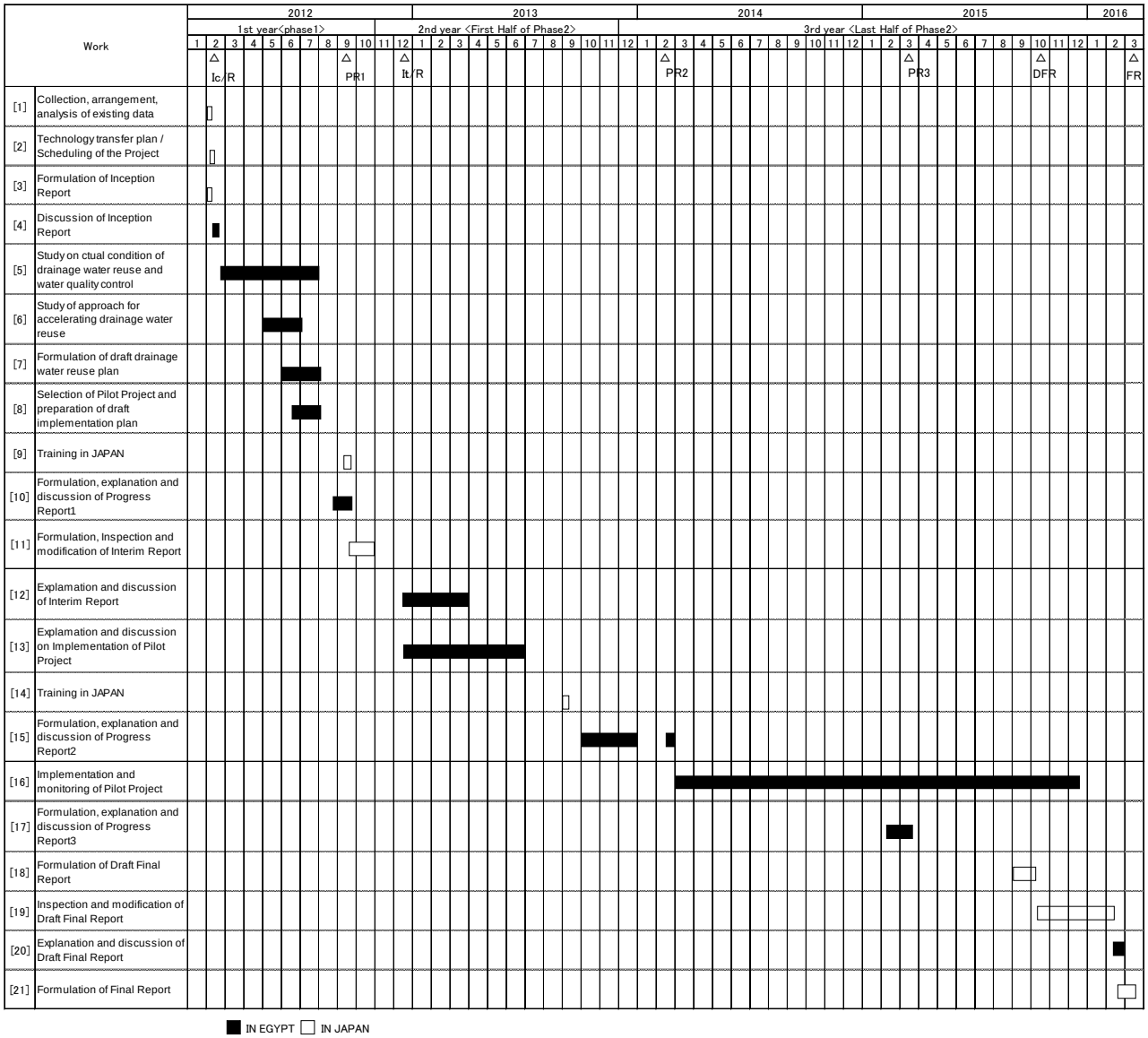


Figure 1.2.5 Project Flow

Table 1.2.1 Schedule and Scope of the Project



1.3 Water Quality of Drainage Water in the Nile Delta Region

1.3.1 Contamination of Drainage Water

The Nile River is the water resource of Egypt, and BOD at the Aswan High Dam is 1.2 mg/l, which has good quality. However, water quality is deteriorated in the downstream gradually, values of BOD at Cairo and the Delta, which are in the downstream of Nile, are 3.2 mg/l and 5 mg/l .Water quality survey results in the Nile Delta by DRI are shown in Table 1.3.1 to 1.3.4. Water quality of irrigation canals in the Eastern delta is relatively good considering that BOD values are less than 10 mg/l, while those in Western delta are higher than BOD 10 mg/l in the upstream.

BOD of drainage water ranges 10 - 30 mg/, and there is a tendency that BOD values at the middle stream are higher than those at upstream and downstream. It implies that contamination from the farmlands and the settlements at the middle stream deteriorates water quality, while self-purification seems to be slightly working at the downstream.

Salt content also affects the crop growth though it is not a contamination element. The salt content is generally measured by Electric Conductivity (EC) as shown in Tables 1.3.1 to 1.3.4. Salt tolerance of rice differs by the variety. According to "Water Quality for Agriculture" by Food and Agriculture Organization (FAO), in case of Oriza sativa the crop damage would not occur up to 2.0ds/m but the yield would decrease by 50% when EC gets 4.8ds/m.

As shown in Table 1.3.1, the EC of irrigation canal is less than 1.5ds/m, hence it would not affect crop growth. As for the quality of drainage water, EC shows more than 5.0ds/m in some places. This should be taken into consideration when reusing drainage water for irrigation. The downstream reaches of the drains show higher EC as affected by the Mediterranean Sea, as well. The development of salt tolerant variety of rice has been researched at the Rice Research & Training Center (RRTC).

Without treatment, reuse of drainage water for irrigation can cause decrease of production. In addition to treatment of industrial wastewater and domestic wastewater, decrease of chemical fertilizer application in the farmlands should be promoted. However, it takes many years to take such measures, therefore, it can be said that direct water improvement in the drainage canal is recommendable.

Table 1.3.1 Water Quality of Irrigation Canal

West delta (main canal)	**BOD(mg/l)**	**DO(mg/l)**	**EC(dS/m)**
Upstream	12.43	5.34	0.43
Midstream	13.00	5.19	0.60
Downstream	13.67	5.00	0.53
Middle delta(main canal)	**BOD(mg/l)**	**DO(mg/l)**	**EC(dS/m)**
Upstream	15.50	5.34	0.37
Midstream	17.67	6.28	0.52
Downstream	15.33	4.75	0.55
East delta (main canal)	**BOD(mg/l)**	**DO(mg/l)**	**EC(dS/m)**
Upstream	7.33	6.69	0.33
Midstream	10.31	5.43	0.67
Downstream	11.67	5.55	0.50
East Minor Canal（branch）	**BOD(mg/l)**	**DO(mg/l)**	**EC(dS/m)**
Upstream	N/A	N/A	N/A
Midstream	12.00	3.65	1.31
Downstream	18.50	2.32	1.24

Source: Drainage Water Status in the Nile Delta, Yearbook 2006/2007, Technical Report №77 (August 2008) National Water research Center, MWRI

Table 1.3.2 Water Quality of Drainage Canal (West Delta)

Edko Drain（main）	**BOD(mg/l)**	**DO(mg/l)**	**EC(dS/m)**
Upstream	13.00	3.91	0.90
Midstream	22.29	2.85	1.04
Downstream	16.00	2.39	2.12
Minor Drain（branch）	**BOD(mg/l)**	**DO(mg/l)**	**EC(dS/m)**
Upstream	12.00	6.26	3.19
Midstream	26.75	3.69	1.76
Downstream	15.50	4.94	2.93
Umoum Drain（branch）	**BOD(mg/l)**	**DO(mg/l)**	**EC(dS/m)**
Upstream	N/A	N/A	N/A
Midstream	19.80	3.70	3.18
Downstream	32.50	2.60	5.51

Source: Drainage Water Status in the Nile Delta, Yearbook 2006/2007, Technical Report №77 (August 2008) National Water research Center, MWRI

Table 1.3.3 Water Quality of Drainage Canal (Middle Delta)

Garbia Drain（main）	**BOD(mg/l)**	**DO(mg/l)**	**EC(dS/m)**
Upstream	23.25	3.23	1.06
Midstream	30.50	1.46	1.56
Downstream	23.33	2.73	3.84
Minor Drain（branch）	**BOD(mg/l)**	**DO(mg/l)**	**EC(dS/m)**
Upstream	16.00	6.07	0.96
Midstream	24.00	1.81	1.19
Downstream	18.00	3.36	2.57
No.1,2,7,8,11 Drain（main）	**BOD(mg/l)**	**DO(mg/l)**	**EC(dS/m)**
Upstream	N/A	N/A	N/A
Midstream	22.00	2.02	0.99
Downstream	18.29	4.44	3.50

Source: Drainage Water Status in the Nile Delta, Yearbook 2006/2007, Technical Report №77 (August 2008) National Water research Center, MWRI

Table 1.3.4 Water Quality of Drainage Canal (East Delta)

Bahr Bhadus（main）	**BOD(mg/l)**	**DO(mg/l)**	**EC(dS/m)**
Upstream	N/A	N/A	N/A
Midstream	23.10	1.83	1.66
Downstream	13.60	2.62	2.40
Bahr ElBaqar Drain（main）	**BOD(mg/l)**	**DO(mg/l)**	**EC(dS/m)**
Upstream	20.67	2.96	3.54
Midstream	22.88	2.42	1.32
Downstream	17.00	3.49	3.76
Minor Drain（branch）	**BOD(mg/l)**	**DO(mg/l)**	**EC(dS/m)**
Upstream	N/A	N/A	N/A
Midstream	N/A	N/A	N/A
Downstream	19.75	2.95	1.55

Source: Drainage Water Status in the Nile Delta, Yearbook 2006/2007, Technical Report №77 (August 2008) National Water research Center, MWRI

Agricultural drainage water contains nutrient such as nitrogen, therefore, reuse of drainage water for irrigation is effective for farmers since it is possible to reduce chemical fertilizer consumption. However, if polluted water with metal and pathogenic bacteria from households and industrial factories are discharged, and the drainage water is reused for agriculture, the farmers who use the drainage water could be damaged. Some cases of health hazard such as diarrhea, typhoid, ascariasis and so on due to improper reuse of agricultural waste have been reported in the world. Also in Egypt,

use of untreated waste water causes ascariasis and increase risks of Suborder Trichuroidina infection (IWMI, 2007)[1]. In addition, with repeated reuse of agricultural drainage water, salt, pesticides and chemical fertilizers in the drainage water are concentrated. Salinity of drainage water near the Mediterranean Sea reaches at 3,000 mg/l (Loufty, 2007)[2] and such high salinity is a hot issue.

1.3.2 Legal Framework for Drainage Water Reuse

Concerning legal framework of drainage water reuse in Egypt, the Law No. 48, which regulates the water quality standard of drainage water reuse, has been set in Egypt. In addition, there are other supplementary regulations and ministerial orders. The Law No. 48 is very stringent, consequently, most of drainage water cannot satisfy the standard values. For realistic solution, the water quality standard to be adapted for the Project was examined considering Law 48 and other standard drafted by National Water Quality and Availability Management Project (NAWQAM)[3] and the water quality standard to be adapted to the reuse pump and the rural sewerage treatment facility are shown in Table 1.3.5 and Table 1.3.6, respectively. Article 61, Article 62 and Article 66 of the Law 48 cover sanitation, irrigation water quality, drainage water at outlet and after mixing to drainage, respectively.

[1] International Water Management Institute, 2007, "11. Agricultural use of marginal-quality water-opportunities and challenges"

[2] N.M. Loutfy, 2010, "Reuse of Wastewater in Mediterranean Region, Egyptian Experience", Handbook Environmental Chemistry, DOI 10.1007/698_2010_76

[3] NAWAQM is improvement of water quality management system funded by the Government of Canada (CIDA as of the project implementation) and MWRI from 1997 to 2004.

Table 1.3.5 Water Quality Standards of Reuse Pump and In-stream Treatment

Statement	Article 61 by Ministry of Health	Article 62 by Ministry of Irrigation	Article 65 Drain Water	NAWQAM 2004 table 6 Irrigation	NAWQAM 2004 table 7b water treatment	Project
Color	Free from colored substances		< 100 unit			
EC				4.0ds/m		4.0ds/m
Total solid substances (SS)	800	1000	500	2000		1000
Temperature	35		5℃			
Odor			Free from colored substances			
Dissolved oxygen(DO)			> 5			
Hydrogen exponent (pH)	6 ~ 9		7 ~ 8.5	6 ~ 9		6 ~ 9
Absorbed biotic oxygen (BOD)		30	< 10	40	40	40
Chemically consumed oxygen (COD)	20	40	(Dichromate) < 15	80	80	80
	30		(Permanganate) < 6			
Organic nitrogen(ON)			-			
Ammonia			< 0.05			
Grease and oils	5	10	< 1	5		10
Total Alkalines			50 ~ 200			
Sulfates	1		-	1000		1
Mercury compounds	0.001		< 0.001			0.001
Boron				3	3	
Chloride				700		
Benzen				2.5		
Alminium				5	5	
Molybdenum				0.01	0.01	
Trichloroacetaldehyde				0.5		
Propionaldehyde				0.5		
Atrazine				0.01		
Dimethoate				0.003		
Chlorpyrifos				0.024		
Barium					0.01	
Cobalt					0.05	
Nickel					0.2	
Vanadium					0.1	
Iron	1		< 1	5	5	5
Manganese	0.5		< 1.5	0.2	0.2	0.5
Copper	1		< 1	1	1	1
Zinc	1		< 1	5	3	1
Detergents	0.05		< 0.5			0.05
Nitrates	30	30	< 45	30		30
Fluorides	0.5		< 0.5	1		1
Phenol	0.001	0.002	< 0.02	2		2
Arsenic	0.05		< 0.05	0.1	0.1	0.05
Cadmium	0.01		< 0.01	0.01		0.01
Cobalt				0.05		
Chromium	0.05		< 0.01	0.05	5	0.05
Cyanide			< 0.1			
Lead	0.05		-	5	5	0.05
Selenium			-	0.02	0.02	
Tannin and lignite			< 0.5			
Phosphate	1		< 1			1
Carbon-chloroform abstracts			< 1.5			
Nematode eggs					1	
Potential number of the colonic group 100 C3	2500		5000	1000	1000	-

Remarks: Highlighted parts shows values, which were applied for the Project.

Table 1.3.6 Water Quality standards of Rural Sewerage

Applied Facilities / Regulations / Parameters	Rural sewerage	
	Outlet	After mixing to drainage
	Article 66 in Law 48 / 1982 (Sewage water)	Article 68 in Law 48 / 1982 (Sewage water)
Temperature	< 35 ℃	≦+5 ℃
Hydrogen exponent (pH)	6 ~ 9	7 ~ 8.5
Absorbed biotic oxygen (BOD)	< 60 mg/L	
Chemically consumed oxygen (COD)	(Dichromate) < 80 mg/L	
	(Permanganate) < 50 mg/L	
Ammonia nitrogen (N-NH4)	< 0.5 mg/L	
Dissolved oxygen (DO)	> 4 mg/L	> 4 mg/L
Detergents		< 0.5 mg/L
Sediments		< 50UNIT
Grease and oils	< 10 mg/L	
Dissolved Substances	< 2000 mg/l	
Suspended substances	< 50 mg/l	< 650 mg/l
Colored substances	Free from colored substances	
Sulfates	< 1 mg/L	
Nitrates	< 50 mg/L	
Phenol	-	< 0.005 mg/L
Total heavy metals	< 1 mg/L	
Pesticides	None	
Potential number of the colonic group 100 cm3	< 5000 CFU	< 5000 CFU

1.3.3 Activities of Other Development Partners

There are several development partners who are cooperating with the Government of Egypt in the field of water environment conservation including wastewater treatment facility construction, awareness campaign and capacity development of farmer organizations in the Nile delta. These are the World Bank (WB), European Union (EU), United States Agency for International Development (USAID), GIZ, the Government of Netherlands, Government of Italia, Government of Swiss, etc. their activities are as follows:

(1)Drainage Water Reuse

USAID and MWRI had implemented the Integrated Water Resource Management Project (IWRM II) (2009-2012) together. Main activities were establishment and activation of Branch Canal Water User Associations (BCWUA) in the Eastern Delta. The project also covered reuse of drainage water and proposed involvement of Holding Company for Water Wastewater (HCWW).

(2) Water Quality Conservation and Water Management

Italian - Egyptian Debt for Development Swap Program Phase II has been implemented by the National Water Research Institute (NWRI) as the main agency. This project introduces a pilot system including remote sensing systems for monitoring water quality in the regions of the Nile Delta in the Rosetta Branch. The effectiveness of the system is still under examination.

The WB, KfW and the Government of Netherlands have been implementing the Integrated Irrigation Improvement and Management Project (IIIMP) since 2004 and it will be completed in 2016 (WB fund ends in March and KfW fund ends in October 2016). IIIMP has been implemented in the Central and West Nile Delta. The project area includes west part of Kafr El Sheikh, namely, the part of the command area of Mit Yazeed canal. IIIMP comprises the components of rehabilitation of water control structures, subsurface drainage, institutional and capacity development of BCWUAs, District Water Board (DWBs), and Integrated Water Management District (IWMD). The breakthrough of IIIMP is to

trigger the users' participation in branch canal water distribution by continuous water supply to branch canals, namely decentralization of water resources management at the end level.

In association with IIIMP, the Global Environmental Facility (GEF) - The WB has funded MWRI to implement the technical assistance project, Enhanced Water Resources Management Project (EWRMP), which covers a wide range of water management facilities. In EWRMP, pilot projects for capacity development of BCWUA in terms of water quality management, drainage water management, waste management and so on are implemented at three sites in the West, Central and East Delta. EWRMP has been started in 2013 and will be completed in 2016.

The first stage of Water Management Improvement Project (WMIP I) funded by GoJ had been implemented from 2000 to 2006 for establishment and institutional strengthening of WUA in Vyara District of Kafr El Sheikh Governorate. In the WMIP II (2008-2012), various activities including capacity development of CDIAS and BCWUA, environmental campaign by BCWUA and canal rehabilitation by WUA have been practiced. In addition, the Technical Cooperation Project for Strengthening Water Management Transfer (SWMT) is on-going for irrigation canal management from November 2012 until March 2016. The technical cooperation project promotes participatory water management by labor and cost sharing with the beneficiaries.

(3) Rural Sewerage Treatment

WB has implemented the Integrated Sanitation and Sewerage Infrastructure Project (ISSIP-1) in the same project area of IIIMP since 2009. ISSIP is principally designed to construct wastewater treatment facilities with a scale of covering local city and its surrounding villages by clustering them to connect with pipelines to the collective treatment facility. However, due to modernization of the irrigation system in Egypt, the villages started scattering along the canals, bringing about small villages or hamlets called Izbah, which makes it difficult to promote sewerage system development by the cluster approach alone. It is needed to install individual wastewater treatment system; therefore, ISSIP also examines the option based on the situation, and implements technical cooperation including capacity development of HCWW and institutional strengthening of farmers using Japanese Social Development Fund. The Government of Swiss collaborates with WB under the project.

EU has also implemented the Improved Water and Wastewater Services Programme (IWSP) covering rehabilitation and function strengthening of wastewater treatment plants, as well as the capacity development of the implementation agency since 2006. Phase II of IWSP expanded the target area to whole Upper Egypt, also in Kafr El Sheikh, IWSP has implemented Kafr El Sheikh Wastewater Treatment Project, especially large scale sewerage system.

USAID provides financial support for construction of rural sewerage treatment by means of sand filter treatment plants. The treatment process including filtration is integrated into one steel tower tank; which means this system requires smaller area than conventional one. On the other hand, assignment of some technical staffs for daily pump operation and maintenance for each component are essential.

The Royal Netherlands Embassy (RNE) had supported the "Drinking Water Supply and Sanitation Programme in Fayoum" from 1990 to 2009. As for the rural sewerage system, RNE introduced a simple treatment system in Fayoum governorate, and the facilities with the same structure have been disseminated in other governorates.

GIZ has started Water and Wastewater Management Programme (WWMP) in 2007, which will be completed till 2017. The lead executing agencies in Egyptian side is HCWW under the MHUUD. In this programme, "Decentralized Wastewater Management in the Governorate of Kafr El Sheikh" has been implemented, which constructed seven wastewater treatment facilities in Kafr El Sheikh by 2012. The basic waste water management system is energy free oxidation pond in all the sites.

(4) Solid Waste Management

Solid waste management can give influence on water quality of canals and drainages, given that the villagers throw away solid waste into canals. The National Solid Waste Program has been funded by EU, GIZ and KfW since 2012, pilot projects have been implemented in four Governorates, namely, Kafr El Sheikh, Garbia, Asyut and Qena. The EEAA is the responsible agency, and existing environmental management unit at each governorate takes initiatives to implement the program. In Kafr El Sheikh Governorate, the project activities are capacity building of solid waste management administration including training staff and redistribution of official duties of the environmental unit, which will be done for 3 years since 2014. GIZ and KfW cover capacity development and infrastructure, respectively in the four governorates.

Chapter 2 Current Conditions of the Project Area

2.1 Natural and Social Conditions in Kafr El Sheikh Governorate

2.1.1 Location

Kafr El Sheikh Governorate is located in the lower Nile Delta, approximately 120km north of Cairo. It borders on the Mediterranean Sea, the Nile Rosetta tributary river, Dakahleyia Governorate and the Garbia Governorate on the north, west, east, and in the south, respectively. Garbia Governorate, which is located on upstream of Kafr El Sheikh Governorate has big cities such as Mahalla el-Koubra and Tanta. The Governorate has an area of 3,748 km2 and consists of 10 districts, 49 rural local units, 206 villages and 1,559 hamlets. The capital of the Governorate is Kafr El Sheikh City. There is the Lake Burullus is bordered by Mediterranean Sea in the north of the Governorate.

2.1.2 Temperature/Rainfall

Temperature and rainfall measured at Mansoura Observatory, which is located on the almost same latitude as Kafr El Sheikh Governorate, are shown in Table 2.1.1. Mean maximum monthly temperature range 19.5 to 34.5 and it is higher than 30 degree from May to September. Annual rainfall in 2012 is 51mm, no precipitation in July and August. According to the rain gage at Rice Research & Training Center in Kafr El Sheikh city, average annual rainfall is 106.3mmm.

Table 2.1.1 Mean Maximum Monthly Temperature/Rainfall (2012, Mansura Observatory)

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Max. Temp (℃)	19.5	20.5	24.5	28.0	31.5	34.0	34.5	34.0	31.5	28.5	25.0	21.5
Mini. Temp (℃)	9.5	9.5	11.0	13.5	16.5	19.5	21.5	21.5	20.0	17.5	14.0	11.0
Humidity (%)	74	72	99	62	58	60	68	71	69	69	72	74
Rainfall (mm/month)	11.0	9.2	7.7	2.7	2.8	0.4	0.0	0.0	0.1	2.9	5.6	8.8

Source: Statistical Year Book, September Issue 2014

2.1.3 Population

Population of Kafr El Sheikh Governorate reached 3.1 million in 2014. Kafr El Sheikh is an agricultural Governorate, 23 % and 77% live of the population live in urban and rural areas, respectively. Since average family size is 4.3 persons per house according to the Population Census in 2006, it is estimated that the total household is 719 thousands. The average yearly population growth rate and total growth rate from 2010 to 2014 and that from 2010 to 2014 are 2.19% and 8.91%, respectively and the percentages are lower than the national average. Population density in the total area is calculated 825 persons per km^2 in 2014.

Table 2.1.2 Nos. of Population over recent 5 years

Year		2010	2011	2012	2013	2014	Ave	From 2010 To 2014
Total in Egypt	Population	78,684,622	80,529,566	82,549,977	84,628,982	85,782,965	-	-
	Growth rate	2.29%	2.34%	2.51%	2.52%	1.36%	2.20%	9.02%
Kafr El Sheikh	**Population**	2,840,662	2,905,891	2,979,258	3,054,770	3,093,754	-	-
	Growth rate	2.32%	2.30%	2.52%	2.53%	1.28%	**2.19%**	8.91%

Source: Statistical Year Book, September Issue 2014

2.1.4 Economy

The agriculture sector is the major economic activity in the governorate. 395,100 persons, namely, 44.2% of the total 892,900 employment population in the governorate in 2013 are engaged in agriculture sector (agriculture & hunting as defined in the statistics), while percentages in the

second industry and tertiary Industry account for 14.0% and 41.8%, respectively. In these three years, while employment population in agriculture sector is stable, around 44 %. On the other hand, the percentage in second industry is slightly increasing, while that of tertiary industry is slightly decreasing.

Table 2.1.3 Percentage of Employment Population by Industry

Governorate	Agriculture & hunting (%)			Industry (%)			Services (%)		
	2011	2012	2013	2011	2012	2013	2011	2012	2013
Urban	2.4%	2.4%	4.0%	29.7%	31.8%	29.8%	67.1%	65.8%	66.2%
Lower Egypt	34.9%	32.3%	32.2%	21.0%	22.6%	22.3%	44.0%	45.1%	45.5%
Upper Egypt	34.6%	32.2%	33.8%	24.2%	24.8%	24.2%	41.0%	43.0%	42.0%
Frontier	19.7%	20.3%	24.1%	17.4%	19.2%	16.3%	62.7%	60.5%	59.6%
National	29.2%	27.1%	27.9%	23.5%	24.9%	24.1%	47.1%	48.1%	48.0%
Kafr El Sheikh	44.5%	44.1%	44.2%	12.8%	14.0%	14.0%	42.7%	42.0%	41.8%

Source: Statistical Year Book, September Issue 2012, 2013 and 2014

The area of cultivated land in the governorate in 2012 was 566,024 feddan, which accounts for 62.3% of total area. Main agricultural products are rice, cotton and sugar beet, which account for 20.0%, 25.7% and 25.0% of total amount of national products, respectively. As related business of these products, rice milling, cotton ginning and spinning, and sugar production have been developed. Cotton is a traditional production in Egypt, but due to the agricultural liberalization and the decline of international cotton price, the production in the governorate has been decreased, especially, in and after 2008. Sugar beet production has been rapidly increased by the promotion of the government, since it is regarded as a water saving crop.

Fishery is also one of important industries in the Governorate, as the northern end faces the Mediterranean Sea and El Burullus Lake. Inland aquaculture has also been operated in the north area of the governorate. It is estimated that tens of thousands of feddan had been transformed from farmland to fish ponds, it is illegal, though. Major kinds of cultivated fish are tilapia, mullet, and cat fish. Several factories for fish fodder making have been established in the Governorate due to the prevalence of the fish farming.

As for the industry and service sectors, two industrial zones established to enhance the industry of the governorate along the international coastal road across the north edge of the governorate. One zone is called Balteem with the area of 114 feddan and another is Motobas zone covering 1,160 feddan. 55 factories were operational in the zones (Cabinet Information and Decision Support Center, 2007). The coastal area has the potential to develop tourism in connection with the historical monuments in the governorate, especially the El Burullus Lake, which has been set as a natural protectorate, therefore, environmental conservation is crucial.

2.1.5 Traffic

The total length of the road in Kafr El Sheikh Governorate is 4,618km, and the pavement ratio is 91.3%, and especially, highways linked to main cities are paved by asphalt, which makes it easy to access to the Governorate. As for secondary roads along the branch canals, some parts are paved. A new highway linked to Baltim located at the northeast coast was newly constructed, thus the accessibility to the northeast part of the governorate has been improved.

2.1.6 Electricity

According to the Egyptian Electricity Holding Company (EEHC), electrification rate in Egypt is more than 99%, which means that most of households access to electricity. EEHC comprises 16 affiliated companies, and one of the problems in the sector is rapid increase of electricity demand. According to the WB, the demand has been increased by 7.5% on average since 2003. In fact,

people in Kafr El Sheikh also experience intermittent blackouts.

In the agriculture sector, the use of electricity for pump stations has been promoted. For example, IIIMP has installed electric pump stations in some of the project sites. In addition, IIIMP has agreed with the Egyptian Electricity Authority that lower price of electricity is applied for the operation under the IIIMP. This price is lower than public charge, making it the same as electricity charge for schools and hospitals. Thus, electric pump stations contribute to reduction of irrigation cost. However, some farmers pointed out that electricity supply is not stable and blackout is a problem in the electric pump stations.

2.1.7 Water Supply

There are 7 water treatment plants in Kafr El Sheikh Governorate and water is distributed through a pipeline network system with 19 local elevated tanks. According to the statistics in 2006, the average water consumption is 371 liters per capita/day and 63 liters per capita/day in urban area and rural area, respectively. The ratios of households with access to the water supply as of 2006 are 96% and 99% in the urban area and rural area, respectively.

Table 2.1.4 Water Supply Condition In Kafr El Sheikh Governorate in 2006

Area	Water Production (thousand m^3/d)	Water Consumption (thousand m^3/d)	Water Consumption per Capita (litters per capita/day)	Households with access to the water
Urban	336.2	224.4	371.6	99.4%
Rural	173.2	128.2	63.6	96.1%
Total	509.4	352.6	134.7	96.9%

Source: Description by Information 2007, the Cabinet Information and Decision Information Center

2.1.8 Sewerage System

According to HCWW as of February 2015, sewerage facilities have been constructed in 50% of the municipalities (city/town/village) on average at nationwide. 78% of them are covered in urban area while only 12.6% is covered in rural area as shown in Table 2.1.5. Concerning Kafr El Sheik Governorate, 100% and 35% are covered in urban and rural area respectively, they are high compared with those of average of whole country.

Table 2.1.5 Cover Rate of Sewerage System in Egypt (Feb., 2015)

Area	National			Kafr El Sheikh		
	No. of city/town/village	Covered by WTP	(%)	No. of city/town/village	Covered by WTP	(%)
Urban	222	173	78.0%	10	10	100%
Rural	4,617	582	12.6%	206	72	35%
Total	-	-	50.0%	-	-	44%

Source: Hearing from HCWW staff. The total cover rate is weighted mean considering population of city/town/village.

There are 10 major cities in Kafr El Sheikh Governorate, namely Kafr El Sheikh, Desouk, Biyala, Kellien, Motobas, Al Riad, Foah, Balteem, Al Hamoul, and Sidi Salem. Urban sewerage systems have been established in these cities, but due to population increase, capacity expansion of the sewerage systems is necessary in some cities like Biyala. In addition, there are 206 villages in the governorate and the average population per village in 2006 has reached around 10,000. Therefore, it is needed to plan to install a new sewerage system in such large villages. There are also 1,559 hamlets in the governorate. Following table shows the list of sewerage systems including planned one in Kafr El Sheikh.

Table 2.1.6 List of Sewerage System in Kafr El Sheikh Governorate

No.	Ca.	District	Name of Plant	Drain	Pos Tion		Date of Google	Population *	Remarks
					Latitude	Longitude			
1	A	Biyala	Biyala	Drain No.4	31° 09' 04.32" N	31° 14' 25.95" E	2013/5/	66,663	
2	A	Hamoul	Hamoul	Drain No.6	31° 17' 16.97" N	31° 06' 36.27" E	2013/5/	51,209	
3	A	Burlos (Baltim)	Baltim	Nasir Drain	31° 30' 55.78" N	31° 04' 32.89" E	2013/11/1	40,199	
4	A	El Reyad	El Reyad	Abu Khashabah	31° 12' 21.90" N	30° 56' 22.59" E	2013/10/2	18,263	
5	A	Kafr El Sheikh	Kafr El Sheikh	Drain No.7	31° 05' 01.64" N	30° 57' 41.92" E	2013/4/2	147,39	
6	A	Qillin	Caleen	Nashart al-A'la	31° 01' 31.76" N	30° 52' 06.56" E	2013/4/2	35,033	
7	A	Sidi Salem	Sidi Salem	Nashart	31° 14' 21.10" N	30° 47' 05.16" E	2013/8/2	45,906	
8	A	Desouq	Desouq	Tahwilat Hud al-Hajar	31° 09' 10.14" N	30° 42' 19.56" E	2013/10/2	106,82	
9	A	Fuwa	Fuwa	No.11 Drain	31° 13' 16.84" N	30° 32' 24.59" E	2013/10/2	63,175	
10	A	Motobas	Motobas	Zaghlul	31° 17' 44.67" N	30° 32' 20.89" E	2013/8/2	29,428	
11	B	Biyala	Ibshan	Drain No.5	31° 09' 09.25" N	31° 09' 33.96" E	2013/5/	11,502	
12	B	Biyala	Al Garayda	al-Banawan	31° 14' 13.11" N	31° 15' 27.15" E	2013/5/	18,556	
13	B	Hamoul	Al Zaffaran	Ibshan	30° 15' 41.17" N	31° 08' 17.60" E	2013/5/	5,801	
14	B	Burlos (Baltim)	Al Burg	Gharb al-Burullus	31° 34' 44.02" N	30° 59' 02.59" E	2013/11/1	32,994	
15	B	El Reyad	Al Hasfa	Drain No.7	31° 18' 44.59" N	30° 57' 14.72" E	2013/8/2	4,608	
16	B	Kafr El Sheikh	Sidi Ghazi	Umm Ja'far	31° 12' 41.60" N	31° 02' 22.95" E	2013/5/	14,092	
17	B	Qillin	Shabas Omare	Fir'awn	31° 06' 03.48" N	30° 48' 12.83" E	2013/10/2	22,800	
18	B	Sidi Salem	Abu Ghanimah	Drain No.10	31° 15' 43.52" N	30° 39' 14.43" E	2013/8/2	8,214	
19	B	Desouq	Sanhur al-Madinah	Sanhur ash-Sharqi	31° 07' 09.59" N	30° 44' 29.90" E	2013/10/2	28,410	
20	B	Desouq	Shabas al-Malh	Drain No.10	31° 12' 21.69" N	30° 39' 07.67" E	2013/10/2	14,305	
21	B	Fuwa	Kabreet	Kabreet	31° 11' 41.51" N	30° 35' 47.65" E	2013/10/2	10,965	
22	C	Desouq	Agoozain	Drain No.9	31° 09' 28.54" N	30° 44' 45.00" E	2013/10/2	7,785	
23	D	Hamoul	Koleaah	Ibshan	31° 16' 28.66" N	31° 08' 12.35" E	2013/5/	1,517	GIZ supported
24	D	El Reyad	Om Sen	Fars Al-Ganaen	31° 15' 45.79" N	30° 59' 40.61" E	2013/8/2	4,848	GIZ (Not working, beside E1)
25	D	Sidi Salem	El Moufty	Al-Minsha	31° 13' 40.61" N	30° 53' 08.25" E	2013/10/2	3,779	GIZ supported
26	D	Biyala	Handakokha	Drain No.4	31° 17' 22.88" N	31° 11' 29.87" E	2013/5/	2,249	GIZ supported
27	D	Hamoul	Om Shour	Drain No.4	31° 18' 14.69" N	31° 11' 46.28" E	2013/5/	3,800	GIZ supported under
28	D	Kafr El Sheikh	Kafr El Gedid	small drain	31° 11' 07.56" N	30° 50' 05.72" E	2013/10/2	4,396	GIZ supported under
29	D	Qillin	Kouzman	small drain	31° 04' 20.91" N	30° 48' 27.61" E	2013/4/2	5,158	GIZ supported under
30	E	El Reyad	Karsa (Kheregin) 3 El	Al-Admah	31° 18' 24.10" N	31° 02' 34.55" E	2013/5/	3,400	
31	E	El Reyad	Karsa (Kheregin) 5 Om El	-	31° 20' 23.79" N	31° 01' 28.71" E	2013/8/2	3,500	position of target village
32	E	El Reyad	Karsa (Kheregin) 6 El	-	31° 20' 22.65" N	30° 59' 46.96" E	2013/8/2	2,000	position of target village
33	E	El Reyad	Arymon (ISSIP KSH-3)	branch drain	31° 11' 02.93" N	30° 55' 07.96" E	2013/10/2	-	ISSIP proposed site

Source: Location Maps of HCWW, GIZ, Google Earth * Population needs to revise

Population: Cities; 2006 Population Census (CAPMAS), GIZ supported:; GIZ, Others; HCWW (2012)

Category: A: Treatment Plant in City D: GIZ supported
B: Kfw funded projects E: WB funded
C: NOPAWSD

In the cities except district capitals, sewerage systems have been established by KfW, in addition, 33 small-scale sewerage systems have been constructed by GIZ in the Governorate. Moreover, cluster type sewerage system establishment including new system construction and strengthening of existing facilities under the ISSIP, and three (3) clusters are planned (KSH-1, 2 and 3 in the Figure 2.1.1). In each cluster, several dozens of villages will be connected to the sewerage system through pipeline. EU also has a plan of the rehabilitation/capacity enhancement of three (3) existing sewerage systems and construction of two (2) sewerage systems and 694km pipeline including 52 pump stations.

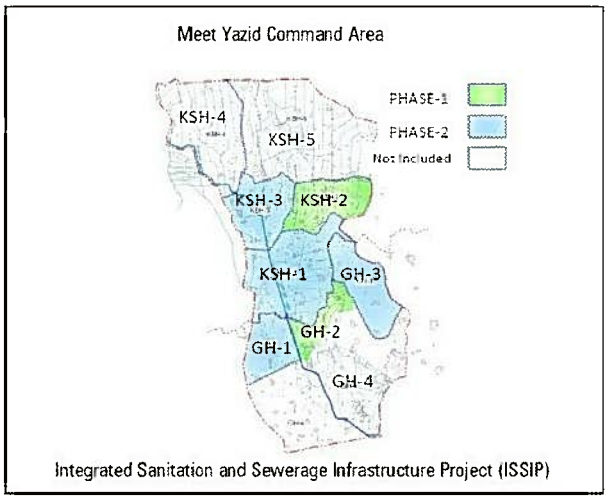


Figure 2.1.1 Sewerage Area Covered by ISSIP

2.2 Agriculture in Kafr El Sheikh Governorate

2.2.1 Land Ownership

Land registration is done at the agricultural cooperatives, land owners' names including governmental offices shall be reported. However, the update of registration has not been done at least for these 10 years, there is a possibility that farmland segmentation by even inheritance is promoted than expectation. One of the main characteristics in the land ownership in Kafr El Sheikh is that number of small scale farmers is not big compared to that in other regions in the country, particularly, the number of farmers with less than 1 feddan is very small. The percentages of farm households which have less than 1 feddan at the national level, in Lower Egypt, and in Upper

Egypt are 56.9%, 52.4% and 62.9%, respectively, while that in Kafr El Sheikh is 33.3%. In addition, with regard to the numbers of farmers owning from 1 to 4 feddan, its share in Lower Egypt is about 40%, while that in Kafr El Sheikh is about 32.5%. This indicates that small-scale farmers owning more than 1 feddan accounts for large part of farmers in the Governorate.

Table 2.2.1 Share of Land Holding (no. of owners) by Size

Land Holding	National	Urban	Lower Egypt	Upper Egypt	Kafr El Sheikh
Less 1 fed	56.9%	54.4%	52.4%	62.9%	33.3%
1<2	14.8%	11.3%	15.6%	14.2%	15.8%
2<3	9.0%	6.1%	10.4%	7.6%	12.4%
3<4	5.6%	3.2%	6.5%	4.6%	11.6%
4<5	4.8%	19.8%	4.6%	3.2%	9.1%
5<10	3.8%	2.5%	4.4%	3.1%	5.9%
10<20	2.3%	1.3%	2.6%	2.0%	4.8%
20<50	1.6%	0.5%	1.9%	1.3%	4.4%
50<100	0.7%	0.1%	0.8%	0.6%	2.1%
More than 100	0.6%	0.7%	0.8%	0.5%	0.6%

Source: Statistical Year Book, September, 2014

2.2.2 Farmers' Organization/ Water Users Association

Water Uses Associations (WUAs), which have been started in 1980s, play an important role as farmers' organizations for irrigation management. WUA is also very important for reuse of drainage water, current conditions and functions regarding WUA and other farmers' organization are as follows:

(1) WUA

WUAs in Egypt are categorized into three layers; 1) WUA at Mesqa level (tertiary), 2) Branch Canal Water Users Associations (Secondary), and 3) District Water Board (DWB). DWB establishment is still under the progress, they have been established at only three sites in Beheira Governorate and five sites in Fayum Governorate.

Most of WUAs have been established and Mesqa have been promoted under IIP by MWRI. At this moment, IIIMP funded by WB, Dutch Government and KfW promote WUA establishment and Mesqa improvement of the Meet Yazid Irrigation canal, which covers both Gharbayia and Kafr El Sheikh Governorate, and the Mahamdia canal in the West Delta. As of November 2015, 2,402 WUAs and 113 BCWUAs have been organized in Kafr El Sheikh Governorate. The percentages of organization of WUA and BCWUA are 23% and 65%, respectively as shown in following table. Since IIMP establishes WUA prior to BCWUA, WUA organization rate is higher than that of BCWUA.

Table 2.2.2 Organization of Water Users Association in Kafr El Sheikh Governorate

Association	Number of organized associations (1)	Beneficiary area (fed)	Target number of organized associations (2)	Target area (fed)	Organization rate (1)/(2)
WUA	2,402	118,000	10,255	556,000	23%
BCWUA	113	352,740	174	556,000	65%

Source: WUA : IIS Tanta、BCWUA : GDIAS Tanta

Remarks: Target WUA organization rate at Mesqa level as of 2015 was 3,652 (198,000 feddan). However, final target is all of WUA establishment in the whole area, therefore, target number of organized associations covering whole governorate is estimated based on average size of WUA.

After WUA organization, CDIAS (Central Department of Irrigation Adversary Service) and IIS (Irrigation Improvement Sector) will be responsible for following up their activities by providing

trainings, encouraging them to have meetings, and monitoring of their activities. CDIAS pointed out that they have responsibility for promotion and establishment of WUAs; however, they focus on following up of activities by existing WUAs rather than newly establishment of WUAs due to budget limitations.

The Japanese government has also supported for establishing and strengthening of WUAs. JICA implemented the projects "Water Management Improvement Project: WMIP (2000-2007)" and "Water Management Improvement Project II: WMIP II (2008-2012)". Also, Strengthening for Water Management Transfer (SWMT) was started in November 2012. SWMT has been implemented to establish implementation structure for nationwide water management transfer. There are three pilot areas under SWMT; Ebhee (Fayum), Shubra Baloola (Middle Delta), and Bisintaway (West Delta). Strengthening the capacity of the WUAs is conducted in these areas, and the Project is formulating a road map for implementation of water management transfer.

(2) Role of Water Users Associations

Legal framework regarding the organization of WUA and their roles has been prepared as Law No.12 (1982) and Law No.213 (1994). The Law No.12, which covers irrigation and drainage, stipulates that irrigation canal, drainage, intake, embankment are official properties, and also regulates installment of those facilities. The Law No. 213 was revised one based on the Law No. 12, and it is a basic law to regulate legal status of the WUA. Based on the Law No. 213, MWRI can collect project cost for Mesqa improvement projects from the beneficial farmers. WUA organization for Mesqa improvement is on-going based on the No.213.

At this moment, MWRI tries to revise No. 12 to provide BCWUA with legal status. In November and December of 2015, the parliament election has been implemented, it is planned to discuss the revision at the parliament. MWRI has already issued the Ministerial Decree No. 977, which defines BCWUA' roles and responsibilities to give legal status, therefore, the Decree is effective before the revision of Law No. 12.

Table 2.2.3 Main Difference between Mesqa WUAs and BCWUAs

	Mesqa WUA	BCWUA
Legal framework	Irrigation and Drainage LawNo.12/ Law No.213)	Ministerial Decree No. 977
Main Activities	Participation in Irrigation Improvement Project, Operation and Maintenance of facilities, Management of WUA, Formulation of WUA action plan, Problem solution, etc.	Participation in regular meetings, irrigation plan/water distribution rotation management, support of MWRI for priority ranking of maintenance activities and Mesqa WUA organization, conflict management, awareness of water users and representatives (water use at field, water quality conservation, effective water use), determination of commitment of water users and approval at representation committee, formulation of participation framework for main and tributary irrigation canals, organization of regular/monthly meeting (for maintenance, financial condition, internal regulation), formulation and implementation of BCWUA action plan, communication network establishment with government, NGOs, local unit, accounting (electric fee collection)
Organization Structure	1)General assembly consists of all the beneficiaries and 2) the Executive Committee	CDIAS makes decision for BCWUA organization and GDAIS (General Directorate for Irrigation Advisory Service) supports for the organization (no detailed provision for concrete BCWUA organization)

Originally, Mesqas are owned by individual farmers and irrigation canals also have been managed by the farmers. On the other hand, tributary canals are governmental properties and managed by MWRI, therefore, roles and activities of WUA and BCWUA at tributary level are different. Following table shows the summary of WUA and BCWUA.

Mesqa WUAs are organized based on Law No. 213 (1994), and their main activities are management of pumps, water distribution in Mesqas, and coordination of crop cultivation. For example, one Mesqa WUA in the Mehazan canal in Kafr El Sheikh has a meeting at the beginning of the season to discuss crops to be cultivated and cultivation areas. Also, they collect 50LE/ feddan from the members to hire a pump operator and a repairman of pumps. Since the WUA utilizes diesel pump, each member prepares fuels for pump operation themselves based on their demand.

In another case, the Mesqa WUA under the Nesheer Irrigation canal under the IIIMP collects 300LE/feddan for employment of a security guard/pump operator per year from the members, and the saved money is used for the pump repair. In the IIIMP, the investment cost of the irrigation improvement project shall be paid by the beneficiaries (farmers), and cost is estimated between 4,000LE to 5,000LE/feddan, after five-years payment moratorium, the cost is collected from the farmers through 20 years divided payment. The collection is done altogether with land tax collection by governmental staffs directly.

On the other hand, legal status of BCWUA has been approved by the Ministerial Decree No. 977, maintenance of irrigation facilities by BCWUA has not been progressed yet, and activities of BCWUA are limited. The main activities of BCWUAs are various depending on each organization, however, in general, they cover conflict management, which cannot be fixed under WUA, coordination for water distribution and so on. Some of the BCWUAs negotiate with the government to settle down water shortage issue.

In some areas, BCWUAs collect money for their specific activities. In these cases, BCWUAs have been registered as NGOs to open their own bank accounts, or, they have got special permission from the MWRI. For example, Bahr Nemra BCWUA, which was established in 2006 under the IIIMP, collects 30LE from each member for canal dredging. They also collected the money to buy a garbage collection vehicle and operate garbage collection activities. Under WMIP and SWMT Project funded by GOJ, the target WUA continuously operated garbage collection. These cases, however, are rare, and canal management transfer to the BCWUA has not been fully ready to start.

(3) Other Farmers Organizations: Agricultural Cooperatives

Agricultural Cooperative is one of the major farmers' organizations and there are 248 cooperatives in Kafr El Sheikh. They are organized at three levels, namely, governorate, district and village level. Land owners have duty to participate in the cooperative. Main functions of village level cooperatives are farmland management, sale of agricultural inputs such as pesticides and chemical fertilizers, technical extension, information provision of disease and insect control. It is not general, however, some cooperatives manage open Mesqa cleaning, by cleaning schedule coordination, arrangement of heavy machines and fee collection from the farmers. According to such cooperatives, 25LE/feddan is collected from the farmers annually. Almost all farmers agree with the payment. Seemingly, farmers have enough incentives to pay the fee, given that they cannot access to agricultural input through the cooperatives, if they refuse.

(4) Other Farmers Organizations: Community Development Association

Community Development Association (CDA) is one of general farmers' organizations in rural areas. CDA organization is regulated by the Law No. 84 (2002). Since the Law is called as NGO law,

sometimes CDA is called as NGO. When CDA is established, it is needed to apply CDA registration with description of organization structure, main activities, accounting system and so on to the Ministry of Social Solidarity based on the Law No. 84. Activities of CDA are various, education of women in rural area, mutual assistance, operation of nursery school, livestock loan and so on.

A CDA has legal status, therefore, it can provide community service and collect fee for garbage collection and sewerage system operation from the members, and open a bank account. Sewerage systems established by GIZ are managed by CDAs, which had been newly organized. Such CDAs are generally organized in big villages (mother villages).

2.2.3 Cropping Pattern and Agricultural Production

(1) Cultivation Area by Season

Table 2.2.4 shows the cultivation area and cropping intensity of each farming season in Kafr-El Sheikh from the winter season in 2012 to the summer and Nile season in 2013 with those of national total values. Total cultivated area in the Governorate is 556,024 feddan, which was 6.2 % of total cultivated land in Egypt. The total cropping intensity is about 199%, which is higher than that at national level (173%, see Table 2.2.4). The cropping intensities in winter and summer seasons are 98% each, and they are prominently higher than national values (76% and 67 % at national level, respectively). Such high cropping intensities result in high ratio as a whole, even though the intensity rates of the Nile season and permanent crop in the governorate are only 1% and 2% respectively. The majority of cultivated area belongs to the Old Land. Almost 100% of the Old Land is cultivated in summer and winter. In general, total cropping intensity per year in the Old Land is almost 200%, higher than that in the New Land.

Table 2.2.4 Cultivation Area and Intensity (Winter 2012, Summer and Nile 2013)

Governorate	Land Category	Cultivated Area (10^3fed) (1)	Cropped Area (1,000fed) and Cropping Intensity (%)									
			Winter		Summer		Nile*1		Permanent*2		Total	
			10^3fed (2)	% (2)/(1)	10^3fed (3)	% (3)/(1)	10^3fed (4)	% (4)/(1)	10^3fed (5)	% (5)/(1)	10^3fed (6)	% (6)/(1)
Kafr-El Sheikh	Old Land	543.0	532.3	98%	535.3	99%	8.1	1%	10.6	2%	1,086.4	200%
	New Land	13.1	11.5	88%	7.0	54%	-	0%	1.6	12%	20.1	154%
	Total	556.0	543.8	98%	542.3	98%	8.1	1%	12.2	2%	1,106.4	199%
	%*3	(6.2%)	(8.0%)		(9.1%)		(1.4%)		(0.6%)		(7.1%)	
National	Old Land	6,183	5,298	86%	5,008	81%	471	8%	884	14%	11,662	189%
	New Land	2,772	1,507	54%	964	35%	93	3%	1,264	46%	3,829	138%
	Total	8,954	6,806	76%	5,972	67%	564	6%	2,149	24%	15,490	173%

Source: Study of The Indicators Agricultural Statistics Summer and Nile Crops 2012/2013, 2014 MALR

Note1: Nile cropping season is from May to October, and is categorized separated from summer cropping according to the statistic of MALR

Note2: Permanent crop includes sugarcane and cotton according to the category of MALR. Note3: Percentages of total areas in Kafr-El Sheikh to National total areas.

(2) Cropping pattern and production

The major summer crops in Kafr El Sheikh are paddy, cotton and maize. Those crops share 83% of total cultivation area on average from 2009 to 2013 (see Table 2.2.5). The main winter crops are wheat, sugar beet and alfalfa, and those cropped areas account for 90% of total cropped area on average (see Table 2.2.5). With regard to the summer crops, more than half of the total cropped area is shared by paddy. The share of the cotton cropped area exceeded that of maize until 2010, however the share of maize cropped area overtook that of cotton recently. The shares of paddy, cotton and maize on average in the last five (5) years, (2009-2013), are 54%, 14% and 15% respectively. As for the winter crops, wheat shares are nearly half of the total cropped area,

followed by alfalfa and sugar beet. Those crops' shares on average in the recent five (5) years, (2009-2013), are 45%, 24% and 21% respectively.

Table 2.2.5 Cropped Area Ratio in Kafr El Sheikh

Year	Summer Season				Winter Season			
	Paddy	Cotton	Maize	Total Area of 3 crops in Summer	Wheat	Sugar Beet	Alfalfa	Total Area of 3 crops in Winter
2009	62%	13%	10%	83%	49%	17%	19%	84%
2010	51%	19%	11%	84%	44%	21%	21%	86%
2011	51%	10%	23%	84%	45%	20%	28%	93%
2012	53%	14%	16%	83%	43%	23%	28%	94%
2013	54%	13%	16%	82%	44%	23%	27%	94%
Ave 2009- 2013	54%	14%	15%	83%	45%	21%	24%	90%

Source: MALR Agriculture Statistics, 2009-2013

Figure 2.2.1 shows the change of the major crops' planted areas in summer and winter season in the Governorate during the last ten (10) years, namely, from 2004 to 2013. As for the actual figures of cropped areas in 2013, rice accounts for the largest percentage, followed by wheat, alfalfa, sugar beet, cotton and maize. Even though rice, wheat and cotton planted areas had been fluctuated drastically from 2007 to 2011, sugar beet and maize have been increased gradually, while alfalfa and cotton cropped areas have been decreased compared with those 10 years before. It is seemingly, due to low price of cotton in these years.

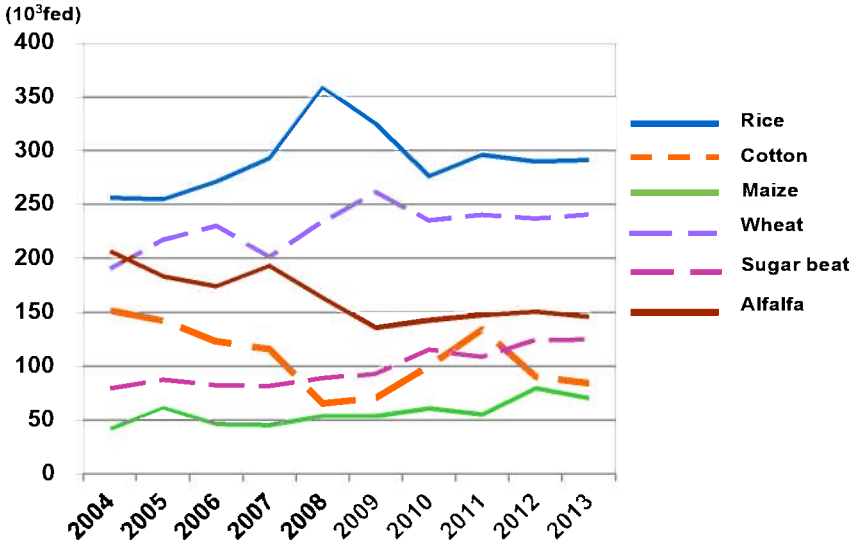


Figure 2.2.1 Change of the Major Crops' Cultivation Area in Kafr El Sheikh

Source: MALR Agriculture Statistics, 2004-2013

Figures from 2.2.2-1 to 2.2.2-6 show the change of yield and production of each major crop in the Governorate from 2004 to 2013, while Table 2.2.6 shows the average of yield and production from 2004 to 2008 and those from 2009 to 2013. The production of cotton and alfalfa is generally on decrease in the recent ten (10) years due to decrease of their cultivation areas (see Figure 2.2.2-2 and 2.2.2-6). The average production of those crops from 2009 to 2013 accounted for 67.3% and 78.0% of those from 2004 to 2008 (see Table 2.2.6). Meanwhile, cotton yield has been fluctuated over years compared to other crops, while alfalfa yield has been slightly decreased since 2007 (see Figure 2.2.2-2 and 2.2.2-6). With regard to maize and sugar beet, the production shows significant increase and the average production of those crops from 2009 to 2013 became 128.0% and 131.7% of those from 2004 to 2008 (see Table 2.2.6). The production has been increased, probably, mainly due to the expansion of

those cropped area with stable yield. As for rice and wheat, the production does not show remarkable trend; however, those yields have been slightly decreasing during recent ten (10) years.

Table 2.2.6 Average of major crops' yield and production (2004-2008 and 2009-2013) in Kafr El Sheikh

Crop	Rice		Cotton*2 *3		Maize		Wheat		Sugar beat		Alfalfa	
	Yield (t/fed)	Prod. (103 t)	Yield (Q.M./fed)	Prod. (103 Q.M)	Yield (t/fed)	Prod. (103 t)	Yield (t/fed)	Prod. (103 t)	Yield (t/fed)	Prod. (103 t)	Yield (t/fed)	Prod. (103 t)
Ave (a) (2004-2008)	4.29	1,227	6.75	829	3.67	183	2.78	594	20.74	1,728	62.12	6,502
Ave (b) (2009-2013)	3.93	1,163	5.70	558	3.65	234	2.65	644	20.13	2,276	58.91	5,073
(b)/(a)*1	91.5%	94.8%	84.5%	67.3%	99.6%	128.0%	95.6%	108.3%	97.0%	131.7%	94.8%	78.0%

Source: MALR Agriculture Statistics, 2009-2013
Note*1: (b)/(a) figures show the average yield and production from 2009 to 2013 as a percentage of each averages from 2004 to 2008.
Note*2: 1 Q.M. is equal to 0.1575 ton.
Note*3: Cotton in the table is seed cotton and its production was estimated according to Agricultural directorate, MALR.

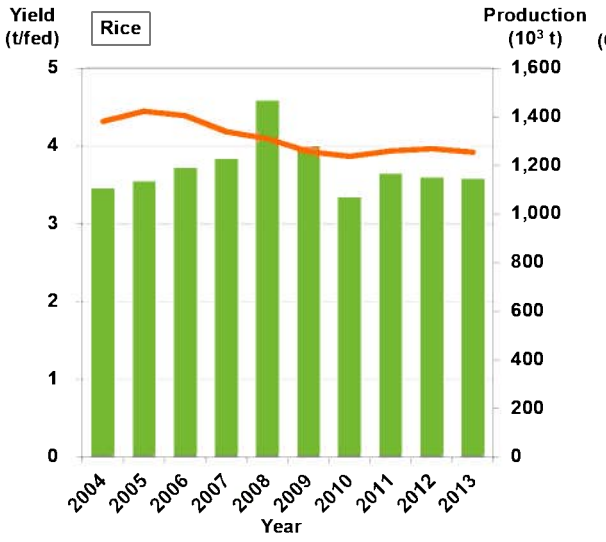


Figure 2.2.2-1 Rice Yield and Production in Kafr El Sheikh
Source: MALR Agriculture Statistics, 2004-2013

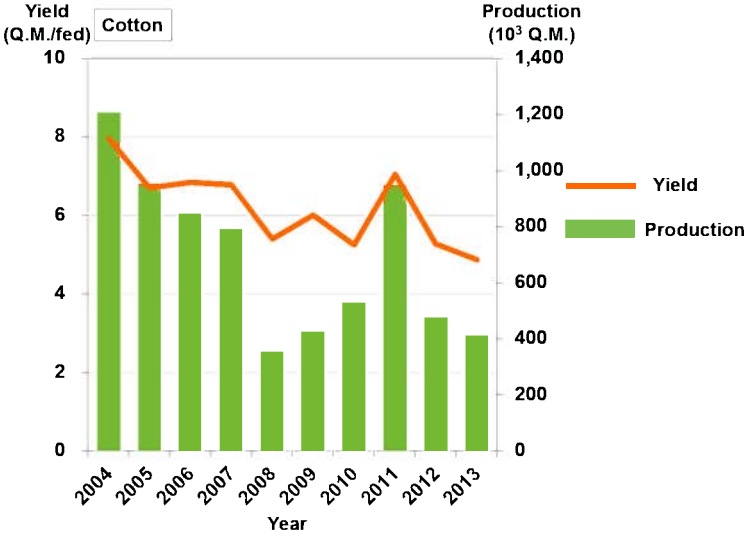


Figure 2.2.2-2 Cotton Yield and Production in Kafr El Sheikh
Source: MALR Agriculture Statistics, 2004-2013

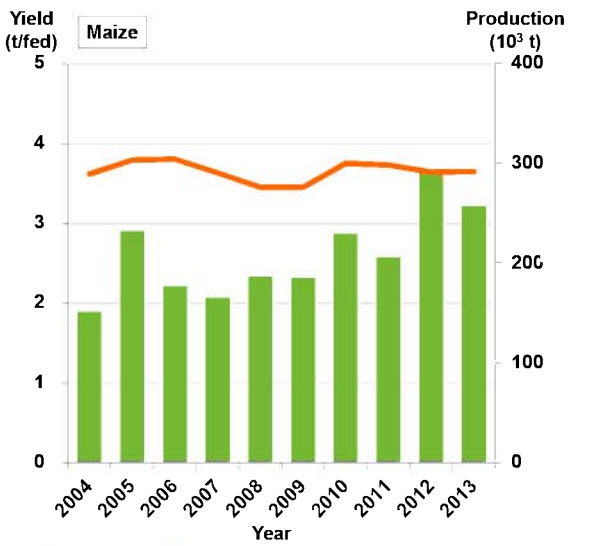


Figure 2.2.2-3 Maize Yield and Production in Kafr El Sheikh
Source: MALR Agriculture Statistics, 2004-2013

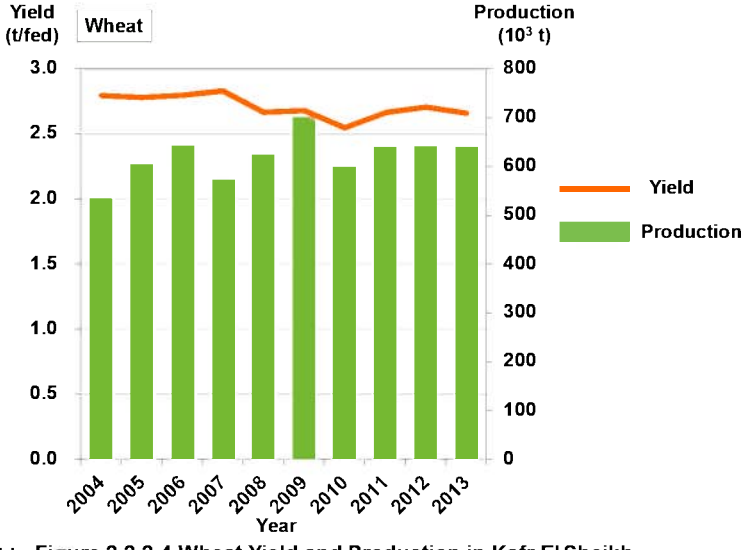


Figure 2.2.2-4 Wheat Yield and Production in Kafr El Sheikh
Source: MALR Agriculture Statistics, 2004-2013

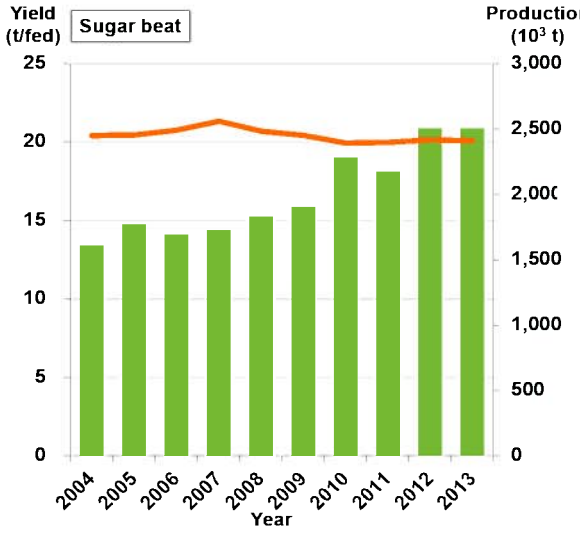


Figure 2.2.2-5 Sugar beet Yield and Production in Kafr El Sheikh
Source: MALR Agriculture Statistics, 2004-2013

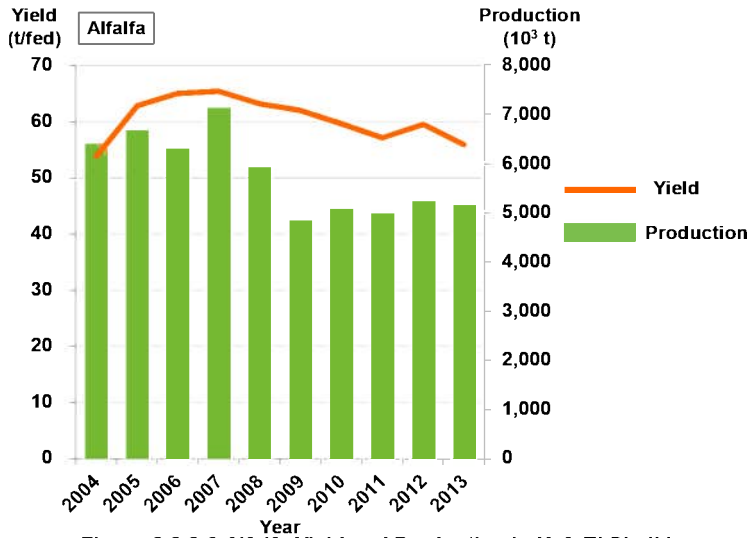


Figure 2.2.2-6 Alfalfa Yield and Production in Kafr El Sheikh
Source: MALR Agriculture Statistics, 2004-2013

2.2.4 Farm Income

(1) Questionnaire Survey at Head and Tail of the Irrigation Canal

The reuse of drainage water in the Project aims at supplementation for irrigation water shortage and agricultural production increase. Prior to the Pilot Project implementation, a questionnaire survey was carried out targeting the farmers whose farmland is located at head (upper part) and tail (lower part) of the irrigation canal to grasp the production situation in 2012, particularly stress by water shortage along the canal. The sample numbers were each 20 for upper part and lower part, at 10 canals (400 households in total). Moreover, at the Pilot Project sites, paddy and maize yield survey at upper and lower of the canals were implemented. Here to examine the farm economy, the data were analyzed by location, namely head and tail of the canal based on those surveys.

(2) Farm Size and Crop Area

Table 2.2.7 summarizes the farming area, cropping intensity, share of cropped area by crop of the sample households in head and tail of each irrigation canal. The average farming areas of all sample households in the head and tail are 2.70 feddan and 2.35 feddan, respectively. The average cropping intensities in the head and tail are both as high as 198%, however, the cropping intensity in the tail of W-6 is low, which may indicate the severe water shortage in the tail of the canal. In summer crop season, rice accounts for around 60%, and followed by cotton with around 30% and maize with 7%. In some canals, share of rice in the tail is higher than that in the head, but there is no significant difference between both sides. In winter crop season, wheat is a major crop with the share of 45% to 49%. Sugar beet has been prevalent in Kafr El Sheikh and the share accounts for around 27% of winter crop.

Table 2.2.7 Cropping Pattern of the Sample Households (by Site and Location)

Site	Canal and Length	Category	Ave. Area (fed)	Share of Crop (%) in 2011									% of sample re-using water
				CI (%)	Summer				Winter				
					Rice	Maize	Cotton	Other	Wheat	Berseem	Sugar beet	Nile Maize	
E-1	Marsa Al Gamal 17.0 km	Head	3.24	200	60	15	22	0	49	22	29	0	39
		Tail	2.54	199	66	11	23	0	46	13	41	0	
E-4	Mekhazan 5.2 km	Head	2.46	200	55	18	27	0	46	33	19	2	80
		Tail	1.73	199	49	19	40	0	48	18	30	4	
E-5	El Roken 1.7 km	Head	1.88	194	59	11	30	0	41	14	45	0	100
		Tail	1.68	195	69	5	26	0	48	23	27	2	
E-6	Ariamon 8.9 km	Head	1.58	197	86	7	7	0	32	11	57	0	20
		Tail	2.15	202	87	4	9	0	36	21	43	0	
W-5	M. Belshasha El Gharby 6.0 km	Head	2.19	199	52	7	40	0	43	18	39	0	50
		Tail	2.27	210	53	4	43	0	45	17	37	1	
W-6	Abo Hamar 3.5 km	Head	4.89	192	61	0	39	0	53	22	25	0	45
		Tail	2.98	165	65	4	31	0	38	29	33	0	
W-8	Manial Ismaeel 3.0 km	Head	3.48	197	58	8	34	0	66	26	1	7	48
		Tail	3.11	227	57	20	23	0	31	28	3	19	
W-9	El Sherkah El Mostagadah 5.6 km	Head	1.88	196	44	0	56	0	40	33	28	0	100
		Tail	2.13	201	66	2	32	0	45	23	32	0	
W-10	El Tarawy 5.0 km	Head	2.95	200	59	2	39	0	50	31	19	0	48
		Tail	1.84	192	70	0	30	0	58	36	6	0	
W-14	El Koniesah 9.7 km	Head	2.43	203	68	0	32	0	71	27	2	0	50
		Tail	3.03	193	61	0	39	0	59	28	13	0	
	Average	Head	2.70	198	60	7	33	0	49	24	26	1	58
		Tail	2.35	198	64	7	30	0	45	24	27	3	

Source: JICA Team, 2012 (interview to the farmers)

(3) Crop Yield

Average unit yield of the crops in the head and tail sample households are examined whether the water quality of reused drainage water would reduce productivity of the crops. It is assumed that the productivity at the head should be higher than that at tail since they could more easily secure irrigation water than the tail. Table 2.2.8 shows the average yield by crop in the head and tail of each canal (number of maize sample data is not enough). In the 6 canals out of 10, the average rice yields and wheat yield at the head showed higher than those at the tail. As for sugar beet, the yield in head is higher in 5 canals out of 9 and cotton shows the most significant difference as the yield of head was higher in 9 canals out of 10. For all crops, average yields in the head are higher than those in the tail. The differences of the yield between head and tail are 8%, 20%, 3% and 5%, for rice, cotton, wheat, and sugar beet, respectively. The results are consistent to the assumption that the difference may become higher in summer due to high water demand. As for rice, the yield gap between head and tail showed more than 20% in 4 canals.

There are some canals where the average yield in the tail is higher than the head, such canals are shorter than others, especially, the canal length in E-5 is only 1.7km, remarkably shorter. At E-5 the sample households practice re-use of drainage water, which contributes to higher productivity in the tail in this canal. As for E-6, the canal (Ariamon) has two intakes at both upper part and lower part from the main canal (Mit Yazed) and no water shortage was observed. On the other hand, water shortage was identified in the middle part of the canal, which was influenced the result of the survey.

Table 2.2.8 Unit Yield by Crop and Location

Site	Canal and Length	Category	Ave. Yield (2009 - 2011) (t/fed)				% of sample re-using
			Rice	Cotton	Wheat	Sugar beet	
E-1	Marsa Al Gamal 17.0 km	Head	2.68	1.03	1.73	15.89	39
		Tail	2.63	0.89	1.42	18.05	
E-4	Mekhazan 5.2 km	Head	2.13	1.00	1.51	17.12	80
		Tail	1.73	0.86	1.50	15.45	
E-5	El Roken 1.7 km	Head	2.01	0.84	1.07	12.94	100
		Tail	2.17	1.10	1.38	15.26	
E-6	Ariamon 8.9 km	Head	3.09	1.53	2.21	20.22	20
		Tail	3.13	1.43	2.42	20.55	
W-5	M. Belshasha El Gharby 6.0 km	Head	3.79	1.34	2.49	24.33	50
		Tail	3.10	0.98	1.94	19.56	
W-6	Abo Hamar 3.5 km	Head	2.48	1.17	1.49	20.10	45
		Tail	2.05	0.75	1.22	18.15	
W-8	Manial Ismaeel 3.0 km	Head	2.93	1.39	1.64	18.36	48
		Tail	2.70	1.12	1.68	20.17	
W-9	El Sherkah El Mostagadah 5.6 km	Head	2.15	1.08	1.42	16.78	100
		Tail	2.21	1.07	1.49	15.20	
W-10	El Tarawy 5.0 km	Head	2.75	1.21	1.75	17.90	48
		Tail	1.81	0.85	1.69	14.67	
W-14	El Koniesah 9.7 km	Head	2.88	1.25	1.38	-	50
		Tail	2.98	1.01	1.25	14.48	
	Average	Head	2.68	1.19	1.63	18.44	58
		Tail	2.48	0.99	1.59	17.62	

Source: JICA Team, 2012 (interview to the farmers)

The yields in Table 2.2.8 are much lower than statistic data by MALR. In addition to the household survey, the JICA Team implemented a series of yield surveys targeting paddy and maize at Pilot Project sites in 2014 and 2015 as shown in the following table. The yield survey is more accurate than interview to the farmers, and shows almost same value as the statistics data. In the yield survey, remarkable differences between upper and lower are identified. Mean paddy yields in upper and lower are 3.5t/feddan and 3.0t/feddan, respectively in 2014, while average paddy yields in upper and lower of stream are 3.5t/feddan and 2.9t/feddan, respectively in 2015. Moreover, mean maize yields in upper and lower of stream are 4.9t/feddan and 3.6t/feddan, respectively in 2014, while average paddy yields in upper and lower of stream are 5.3t/feddan and 3.5t/feddan, respectively in 2015.

Table 2.2.9 Rice yield with yield components in 2014 and 2015

Location*1	Variety		Estimated Yield (t/ha)*2		Estimated Yield (t/fed)*2		Yield components*3							
							Panicles/m^2		Spikelets /panicle		Ripening ratio		1,000 grains weight (g)	
Year*4	14	15	14	15	14	15	14	15	14	15	14	15	14	15
W5-U	Giza 178	Giza 178	5.9	8.3	2.4	3.5	554	568	98	127	80.0%	90.7%	23	22
W5-D	Giza 178	Giza 177	5.1	6.5	2.2	2.7	521	487	85	110	76.0%	82.7%	22	27
W4-U	Sakha 101	Sakha 101	9.9	9.6	4.2	4.0	558	605	110	115	86.0%	82.7%	27	27
W4-D	Sakha 104	Skha 104	5.4	5.4	2.3	2.3	420	435	95	113	84.0%	78.4%	26	26
W2-U	Giza 177	Sakha 104	9.0	7.8	3.8	3.3	491	532	108	128	91.0%	86.4%	28	28
W2-D	Giza 178	Giza 178	7.7	8.1	3.2	3.4	479	467	120	130	87.0%	83.7%	23	22
E1-U	Giza 177	Sakha 104	8.0	8.2	3.4	3.4	387	581	100	114	83.0%	91.2%	27	27
E1-D	Giza 178	Giza 178	9.2	7.7	3.9	3.2	714	459	105	128	80.0%	82.2%	22	21
E4-U	Sakha 101	Giza 178	8.9	8.0	3.8	3.4	593	632	92	134	89.0%	85.2%	27	21
E4-D	Giza 178	Sakha 104	8.3	6.3	3.5	2.6	789	684	80	103	85.0%	76.1%	22	27
Ave.-U	-	-	8.3	8.4	3.5	3.5	517	584	102	123	85.8%	87.3%	26	25
Ave.-D	-	-	7.1	6.8	3.0	2.9	585	507	97	117	82.4%	80.6%	23	24

Source: Dr. Abdallah, RRTC, 2014 and 2015
Note1: "U" and "D" stand for "Upstream" and "Downstream", respectively.
Note2: Rice yield is air-dried grain weight with hull.
Note3: Yield components were measured by the method commonly applied in Rice Research and Training center (RRTC).
Note4: "14" and "15" in the table are 2014 and 2015, respectively.

Table 2.2.10 Maize yield, no. of cobs /m^2, air-dried shoot weight and Harvest Index in 2014 and 2015

Location*1	Variety		Air-dried shoot weight (kg/m2)		No. of Cobs/m2		Estimated yield(t/fed)*2		Estimated yield (t/ha)*2		Harvest Index	
Year*3	14	15	14	15	14	15	14	15	14	15	14	15
W5-U	K-8	30K8	4.2	3.4	7	8	4.6	6.1	10.8	14.4	0.26	0.42
W5-D	K-8	30K8	3.0	1.7	6	6	2.8	3.4	6.6	8.2	0.22	0.47
W4-U	-	30-62	-	4.2	-	10	-	5.1	-	12.2	-	0.29
W4-D	Triple cross	30-62	3.0	1.9	7	6	1.8	3.5	4.3	8.3	0.14	0.43
W2-U	N-11	30-62	3.9	3.4	8	9	3.8	5.6	9.0	13.3	0.23	0.39
W2-D	Single cross-10	30-62	3.9	2.2	7	7	3.1	3.8	7.4	8.9	0.19	0.41
E1-U	Single cross-3062	30K8	5.3	3.9	11	10	4.4	4.8	10.0	11.4	0.19	0.29
E1-D	Triple cross	30K8	4.8	2.4	9	7	4.1	3.3	9.7	7.7	0.20	0.32
E4-U	Single cross-10	30K8	4.6	3.2	9	8	6.9	4.8	16.3	11.5	0.35	0.36
E4-D	Single cross-10	30K8	6.3	2.3	8	7	6.5	3.4	15.4	8.0	0.25	0.35
Ave.-U	-	-	4.5	3.6	8.8	8.8	4.9	5.3	11.5	12.6	0.26	0.35
Ave.-D	-	-	4.2	2.1	7.4	6.5	3.6	3.5	8.7	8.2	0.20	0.40

Source: Dr. Abdallah, RRC, 2014 and 2015
Note1: "U" and "D" stand for "Upstream" and "Downstream", respectively.
Note2: Maize yield is air-dried grain weight without cob.
Note3: "14" and "15" in the table are 2014 and 2015, respectively.

(4) Farm Income

Based on the farming area, the household survey in the head and tail of the canals, and yield survey by the JICA Team, the farm income at average farmland size in the upper and lower of the canals (2.4feddan/household) is estimated as shown in following table. The average annual net incomes of the sample farm households in the head and tail are estimated at LE15,301 and 12,254LE respectively. Net income per feddan is hence calculated at LE 6,375 and LE5,106 in the head and the tail, respectively. The income at the tail counts around 80% of the head.

Table 2.2.11 Estimated Average Farm Income in Downstream and Upstream

Crop	Cropped Area (fed)	Yield (t/fed)		Price (LE/t)	Gross Income (LE)		Cost (LE/fed)	Net Income (LE)	
		Downstream	Upstream		Downstream	Upstream		Downstream	Upstream
Summer Crop									
Paddy	1.44	3.00	3.50	2,000	8,640	10,080	2,290	5,342	6,782
Maize	0.24	3.50	5.10	1,500	1,260	1,836	2,888	567	1,143
Cotton	0.60	0.90	1.04	6,300	3,402	3,931	4,226	866	1,395
Other (melon)	0.12	13.22	15.34	697	1,106	1,283	2,764	774	951
Winter Crop									
Wheat	1.20	1.59	1.64	1,700	3,244	3,340	1,541	1,395	1,497
Berseem	0.36	39.02	40.19	55	773	796	279	673	696
Sugar beet	0.84	17.62	18.50	270	3,996	4,196	1,618	2,637	2,837
Total	4.80				22,421	25,468		12,254	15,301
					Net Income/feddan(LE/fed)			5,106	6,375
					Difference (LE/fed)				1,269

2.2.5 Inland Fishery

As mentioned above, inland fish farming with mainly tilapia and mullet has been prevalent in the north side of the Governorate. Mullet farming is typical in Egypt. Transformation of agricultural land into fish ponds has been increased, however, it is prohibited by the Fishery, Marine Wildlife, Aquaculture Law, namely Law No. 124 (1983) in terms of farmland conservation. The area, where transformation is admitted, is limited to the infertile land in view of agriculture. It means that most of land use transformation is illegal, however, it is not controlled properly. In the northern part of the Governorate,

the water quality issue has been serious, resulting in low crop productivity. Such situation has given further economic advantage to fish farming in the area. There is a large scale fish wholesale market in the area, which makes easier fish distribution. The table below shows the fish production of the Governorate.

Table 2.2.12 Production of Fish in Kafr El Sheikh Governorate

Year	Mediterrane-an sea (t)	El-Borullos Lake (t)	Fresh water (t)	Fish farms (t)	Rice fields (t)	Total (t)
2008	12,693	52,260	5,595	367,379	3,591	441,518
2009	14,365	53,401	6,308	363,815	3,730	441,619
2010	13,628	59,517	5,986	417,557	2,400	499,088
2011	11,632	45,544	5,896	494,343	2,363	559,778
2012	11,980	52,076	5,008	527,730	1,334	598,128

Source: CAPMAS

Production of fish in the fish ponds has been significantly increased from 2008 to 2012 and it reached 527,730 tons in 2012, which shares 54% of the national production in fish ponds. It is estimated that the total area of fish ponds in 2012 would be around 87,955 feddan, in calculation with the unit yield of fish[1]. On the other hand, the production from rice fields has been rapidly decreased since 2008 at peak. Paddy production in 2012 was 1140 thousand tons, which accounts for 78% of production in 2012, namely, 1470 thousand tons. It is also said that the fish pond expansion is accelerating water shortage in the area.

The JICA Team carried out a questionnaire survey targeting 10 aquaculture farmers. According to the survey, the major reason of fish pond expansion is high profitability. Due to the severe water shortage and water quality issue partly resulted by mixing the drainage water with irrigation water, the crop productivity in the northern Kafr El Sheikh is decreased, which enhances the advantage of aquaculture. However, since it needs a large amount of investment for start of aquaculture, it is difficult for small scale farmers to enter into it. Therefore, the majority of the fish farmers are large scale, and they operate fish ponds by themselves or rent out the fish ponds. Some fish farmers operate 10 feddan or more.

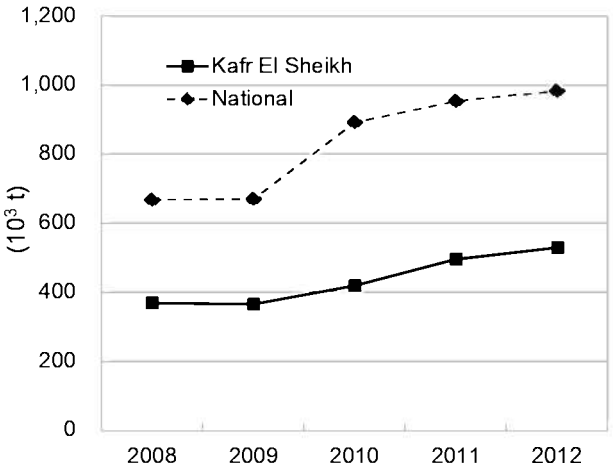


Figure 2.2.3 Production of Fish Farm
Source: CAPMAS

According to the survey, there are fish farmers who would like to return back to rice and other crop production, if the water quality is improved and water shortage is alleviated. Based on the survey, farmers normally cultivate tilapia and mullet at the same pond and the yields of tilapia and mullet on that condition are estimated at 5 tons/fed and 1 ton/fed respectively. They also face the risks that cold water or very dirty water can cause the loss of fish before the fish become mature. With such risks, the profitability of fish farming could be fluctuated but the net income of fish farming in the area is estimated at around 11,000LE/fed at their fish ponds or 7,900LE/fed by renting the ponds. According to the survey, unit yield of rice in the area is 2 to 3 tons/fed, which is quite lower than that in Egypt.

Table 2.2.13 Estimate of Income by Fish Farming

Basis	Ownership			Own			Rent		
	Harvest times / year			1			1		
	Farming season			March to November			March to November		
	Mix kinds or separate			Mix			Mix		
Cost (LE)	Item	Per		5 feddan		per		5 feddan	
		Amount	Unit	Unit Price	Price	Amount	Unit	Unit Price	Price
	Fish (Tilapia)	100,000	fish	0.05	5,000	100,000	fish	0.05	5,000
	Fish (Mullet)	10,000	fish	1.0	10,000	10,000	fish	1.0	10,000
	Fodder	50	ton	4,000	200,000	50	ton	4,000	200,000
	Operation labor	12	MM	1,000	12,000	12	MD	1,000	12,000
	Harvest labor	30	MD	50	1,500	30	MM	50	1,500
	Pumping cost				5,000				5,000
	Transportation				1,000				1,000
	Tools				1,000				1,000
	Depreciation of pond construction				9,450				-
	Rent	0	fed	5,000	0	5	fed	5,000	25,000
	Total				244,950				260,500
Sales (LE)	Item	Production	Unit	Unit Price	Gross Income	Production	Unit	Unit Price	Gross Income
	Tilapia	25.0	T	8,000	200,000	25.0	t	8,000	200,000
	Mullet	5.0	T	20,000	100,000	5.0	t	20,000	100,000
	Total				300,000				300,000
Income (LE)	Net Income				55,050				39,500
	Net Income per feddan				**11,010**				**7,900**

Source: JICA Study Team: Estimated based on the field questionnaire survey in 2012)

2.3 Irrigation and Drainage Water Reuse in Kafr El Sheikh Governorate

2.3.1 Irrigation System

(1) Irrigation Water Distribution System

The water sources for the Kafr El Sheikh Governorate are El Rayan El Monefy principal irrigation canal, which takes water at the upstream of the Mohamed Ali barrage on the Damietta branch (the Nile River), and El Rayan El Abbasy principal irrigation canal, which is branched off from upstream of the Zifta Barrage at the Damietta branch (the Nile River). Both canals run through the Gharbya Governorate, they provide water to the Kafr El Sheikh Governorate through four (4) main irrigation canals, namely, Bahr Tera, Meet Yazeed, Kasede, and El Kodaba. At the west of the Governorate, there is the Bahr El Saidi pump station, which takes water from the Rosetta branch to supplement for water shortage at irrigation peak season[1]. In addition, there are three (3) small-scale pump stations (Refer to Figure 2.3.1 in next page).

There are many branch canals which are diverted from the above main irrigation canals, and the total canal length is 1,061.3 km. Almost all of the canals are unlined in the cities to prevent from illegal dumping by the people except some short sections. The water level of the branch canals is kept at around one (1.0) m below of surface of farmland to prevent salt accumulation. The farmers can get irrigation water from Mesqa and convey it to their farm lands throughout Marwa.

The farmers previously take water from Mesqa by using mobile pump individually at their own risk. At present, the farmers shoulder O&M costs of a pump instead of the water charge. Since small-scale pumps are operated by the farmers privately, some problems such as water shortage, low irrigation efficiency, etc. have been raised. In order to solve such problems, a series of Mesqa improvement projects has been implemented under the financial assistance of the WB and so on. The Mesqa which has been improved are referred to as the "Improved Mesqa". The project has been implemented together with participatory water management project such as IIIMP by WB, WMIP and SWMT by GoJ. In Kafr El Sheikh, 118,000 feddan, which accounts for 23% of total cultivated area, has been already improved. Only farmers who have interest in the project have participated in the project, while some farmers have not.

[1] MWRI approve water take from Rosetta Branch (Nile River) only for May and June.

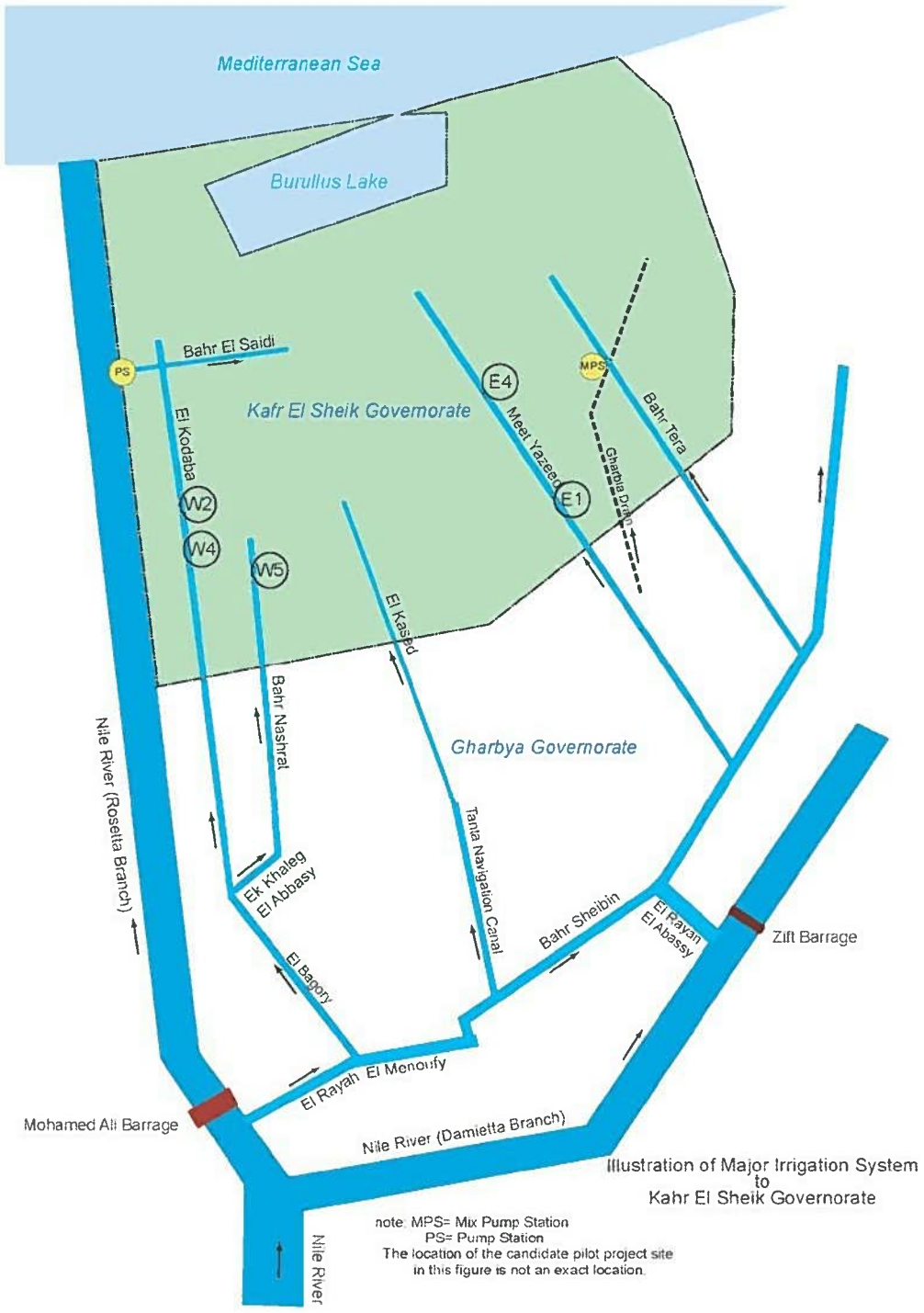


Figure 2.3.1 Illustration of Major Irrigation Systems to Kafr El Sheikh Governorate

Under the Improved Mesqas, an integrated pump is equipped at the start point of each Mesqa and the pipeline canal(s) (open lined canals at some places) and valves to feed water to farm land are established. These irrigation facilities are operated and managed by WUA which were organized under the Project. Each Mesqa serves irrigation water for 50 to 150 feddan (21ha to 63ha) of farmland.

As appurtenant structures, there is a sluice gate facility, intake gate facility, spillway, bridge and conduct, etc., which are managed by the MWRI. Usually, the MWRI maintains branch canals once or

twice per year depending on the extent of siltation in the canals, and the major maintenance works are dredging and weeding by using heavy equipment. In addition, since the inhabitants throw their daily garbage into the canals, the canal water is deteriorated. Even though operators are assigned, they cannot manage garbage sufficiently due to big amount of spoiled waste.

(2) Water Management Structure

Water Management of Main Irrigation Canals

The MWRI is in charge of water management of the whole country. At first, the MALR prepares a planting plan for following years and submits it to the MWRI. Based on the plan, a water distribution plan at Governorate level is prepared by using the unit of water quantity for each crop, which has been set by the MALR. Therefore, water distribution is adjusted at the boundary of some governorates, and water level and discharge of canals at the places are recorded every day. However, in many cases, water discharge within the governorate except main canals is not measured. At the main diversion works, adjustment of water level at the upstream and downstream has been implemented under the instruction of the Inspectors.

The Irrigation Department of Kahr El Sheikh Governorate divides the irrigation area into two zones for rotational irrigation. Based on the rotation schedule, Inspectors give instructions to Bahary for gate operation at water division works. Specifically, it is managed to distribute water for 4 days within a 10 day period from May to August, when water shortage becomes the most severe. Based on the past management record, the Inspectors give instructions regarding gate switching, valve travel and time. The gate operation records are kept at the district every day and it is reported to the Inspectors at the same time. The beneficiaries go to MWRI directly for problem solution, when any problems are identified.

The irrigation O&M system in the Kafr El Sheikh is operated in two districts, namely the East District and West District. Moreover, each district is divided into two engineering districts with Inspectors, who are assigned in the engineering district. They have responsibilities of water management and pump stations operation. Communication between the field and the office is done by using a mobile phone. The water management is done under the inspector's instruction since the engineers do not have rights to make decision by themselves. When the water shortage is observed at the field, surrounding farmers complain to the Inspector or higher staff from the irrigation department. The Inspectors are busy in summer cropping season for field inspection, confirmation, instruction, receipt of farmers' complains, etc. Service areas in the East District and West District are as follows:

Table 2.3.1 Irrigation Management by West and East

Area	Irrigation District
East	Kafr El-Sheikh, Seidy Ghazy, El-Riyad, Biala, El-Hamoul, El-Mansour, Baltim and El-Zahra'a (in total 8 Irrigation Districts)
West	Desouk, Fowa, Metoubas, West Seidy Salem, East Seidy Salem and Qilin (in total 6 Irrigation Districts)

Water Management of Irrigation Canals at Endpoint

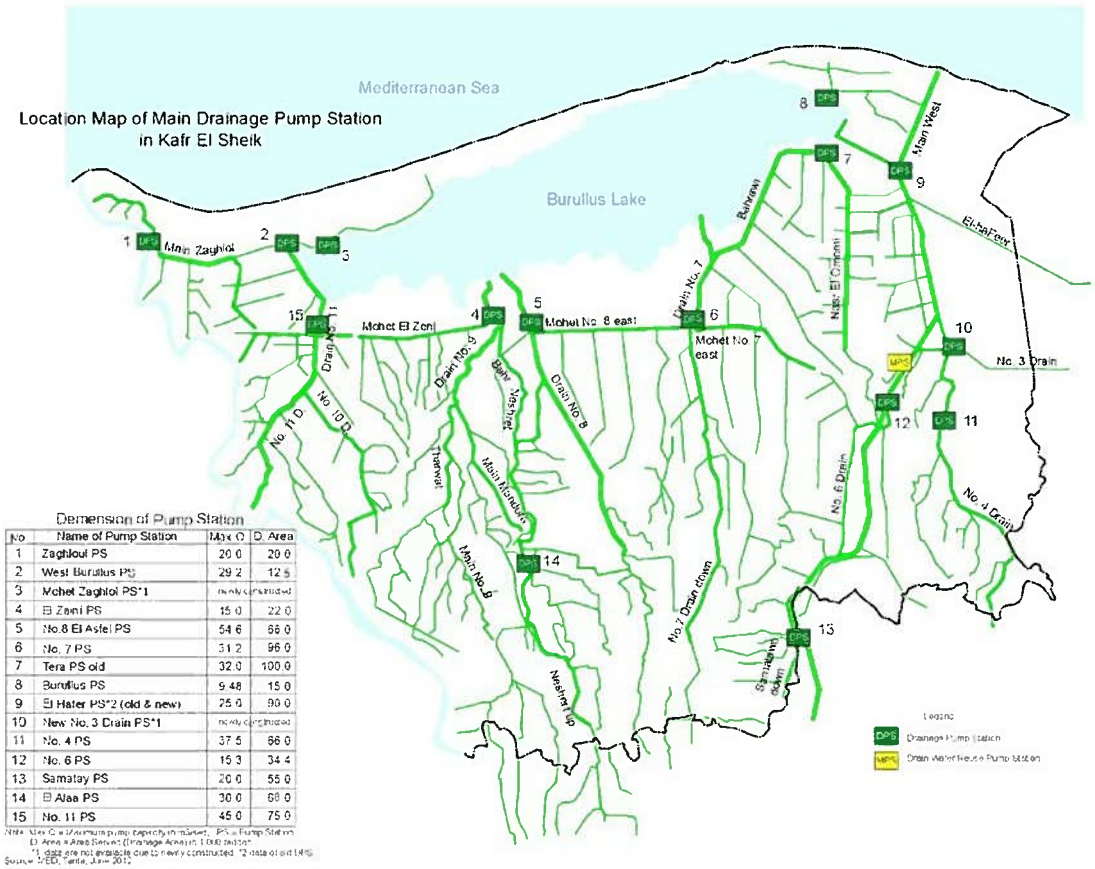
Until 20 years before, most of farmers had used "Sakia" (water wheel) for irrigation in Egypt, however, it was replaced by mobile small pumps with higher capacity, after price of the pump has become accessible for the farmers. However, water distribution to the endpoint of the canals becomes difficult, when the small pumps are operated simultaneously. Therefore, the Mesqa improvement project has been implemented in the whole Delta by IIP, IIIMP and so on. The project cost is redeemed by the beneficial farmers in 20 years. As mentioned before, organization of WUA and BCWUA has been promoted, and it is expected that even water distribution between upper stream and lower stream will

be done.

Improved Mesqa consists of an integrated pump station and common canals, and the canals are mainly pipeline system including intake valve and rarely open system with concrete protection. In general, water distribution system including command area and canal route has not been changed from the conventional one, and integration of beneficial area has been rarely done. Maintenance of the improved Mesqa is implemented by newly established WUA, while operation is done by board members (around 5 persons) and a pump operator. Pump is operated based on demand of individual farmers. Coordination among farmers is done by farmers themselves. When irrigation is needed, the farmers bring necessary fuel depending on their farmland size and crops, and they request the pump operator to distribute water. The farmers irrigate water to their field from the intake valve at the Mesqa. The turn of irrigation among the farmers is fixed by the pump operator.

2.3.2 Drainage System

As a drainage canal system in the Kafr El Sheikh Governorate, there are drainage pump stations, drainage canals, tile drain system and appurtenant structures. The drainage pump stations are classified into two (2) types, one is to drain surplus water to outside of the Governorate, and another is responsible for control of water level in a drainage. There are eight (8) large scale pumps to drain water directly, which are located in the northern part of the Governorate around the Mediterranean Sea and the Burullus Lake. In addition, there are two (2) drainage facilities, the former drains water to the Mediterranean Sea and the latter drains water to Damietta Branch (Nile River). In addition, another pump station is still under construction (refer to Figure 2.3.2). Since elevation of the farm land and water level in the drainage canal are lower than those of the Burullus Lake and the Mediterranean Sea, the gravity drainage system is not applicable. The drainage system by using pump is, therefore, used in the Governorate.



Demension of Pump Station

No	Name of Pump Station	Max Q	D. Area
1	Zaghloul PS	20.0	29.0
2	West Burullus PS	29.2	12.5
3	Mohet Zaghlol PS*1	newly constructed	
4	El Zeni PS	15.0	22.0
5	No.8 El Asfel PS	54.6	88.0
6	No. 7 PS	31.2	96.0
7	Tera PS old	32.0	100.0
8	Burullus PS	9.48	15.0
9	El Hater PS*2 (old & new)	25.0	80.0
10	New No. 3 Drain PS*1	newly constructed	
11	No. 4 PS	37.5	86.0
12	No. 6 PS	15.3	34.4
13	Samataay PS	20.0	55.0
14	El Alaa PS	30.0	68.0
15	No. 11 PS	45.0	75.0

Note: New Q = Maximum pump capacity in m3/sec., PS = Pump Station
D. Area = Area Served (Drainage Area) in 1,000 feddan
*1: data are not available due to newly constructed *2: data of old PS

Source: HED, Tanta, June 2012

Figure 2.3.2 Location Map of Main Drainage Pump Stations in Kafr El Sheik

There are five (5) large scale pump stations on the drainage canals, with the aim of controlling water level of the drainage canal. On the Drain No. 4 and No.6, four (4) drainage pump stations are located. One of them is under construction. Those drainage pump stations are operated and managed by the MED based on the designed water level at the pump station. The maximum lifting capacity of the pump varies from 9.48m3/s (= 568.8 m3/min) to 54.6 m3/s (=3,276 m3/min).

The total canal length of canal in the Kafr El Sheikh Governorate is 812.2 km and the cross section shape is non-lined trapezoidal with a side slope of 3 (H): 2 (V) or 1 (H): 1 (V). These drainage canals aim to control groundwater level of the farm land, instead of drainage for surplus rainfall water. The drainage canals are managed by the MWRI and not by the farmers. A drainage canal is maintained once or twice a year by using heavy equipment for weeding, side slope shaping and dredging. However, since inhabitants throw away their daily garbage to the drainage, the maintenance becomes more difficult. Recently, the MWRI, Drainage Authority, has constructed a box culvert in the dense populated area to prevent from garbage disposal of inhabitants. However, the total length of the box culvert is not enough. Even when the box culverts cover the drainage, the inhabitants throw their garbage at the entrance and exit points. Therefore, environmental awareness and garbage collecting systems are needed together with box culvert construction.

The drainage system of on-farm level has yet to be planned. Although some farmers, who cultivate paddy, have constructed farm ditches in their lands, they do not maintain the ditches properly; as a result, dried soil with many ditch cracks can cause water leakage.

In general, tile drain system is developed in the farmlands in the Kafr El Sheikh Governorate to prevent salt accumulation. EPADP had constructed the tile drain system to decrease groundwater level for salt leaching in the whole Nile Delta under the assistance of international donors. The system consists of polyethylene pipes, and drain pipes as a "collector" at the upstream and most of them are placed at around 1.0 m below farmland surface. The drain water in the tile drain pipe is discharged into the open drainage through a collector (pipe). At the exit point of the tile drain pipe, the pipe is set at 1.3 to 1.5 m below the farm land surface. The water level of the open drainage canal should be kept at 10 to 20 cm lower than the bottom of the drain pipe according to the EPADP standard. The tile drain system has no relief wells to control groundwater level and it drains surplus underground water into the drainage directly. In case there are some relief wells, it is possible to save irrigation water by adjustment of water level.

The monthly drainage discharge records by MED at four (4) major drainage pump stations for the past four (4) years, from 2007 to 2010, were analyzed. According to the result of the analysis, there is a big difference of unit discharges between winter and summer seasons. In case of the Tera drainage pump station, which covers 100,000 feddan, the unit discharge per 1,000 feddan in winter was 0.149 m^3/s, however that was 0.281 m^3/s in summer. The latter is 1.9 times of the former one despite of high evapo-transpiration in summer. It is probably due to wide rice cultivation area, which needs more irrigation water. Drain discharge from the tile drain system under rice cultivation, seepage loss from paddy farm ditches, distribution loss, etc. will cause increase drainage discharge at the drainage pump stations.

On the other hand, the specific discharge of the Zaghloul drainage pump station, which is located at the west end of the Kafr El Sheikh Governorate, varies from 0.249 $m^3/s/1,000$ feddan at minimum to 0.712 $m^3/s/1,000$ feddan at maximum. These figures are bigger than those of the other three (3) drainage pump stations in the Governorate. The reason for this is probably due to many fish ponds in the drainage area of the station.

2.3.3 Balance of Irrigation Water

(1) Demand of Irrigation Water

Irrigation water demand of major canals in the Kafr El Sheikh Governorate area was examined based on unit water requirement by crop and irrigation area by MWRI[2]. According to the study, the total irrigation demand is 5,158MCM as shown in the following table:

Table 2.3.2 Irrigation Water Requirement in Kafr El Sheikh

Name of Canal	Annual Inflow (MCM)	Annual Water Requirement (MCM)	Balance (MCM)	Remarks
Bahr Tera	1,172	1,413	-241	Hamoul Mix PS of 95 MCM/year excluded
Meet Yazed	1,488	1,476	12	Fuwa PS of 183 MCM/year excluding
El Qusad	280	227	53	No. 11 PS of 173 MCM/year excluded
Bahr Nashrat	180	166	14	
El Quadaba	691	1,016	-325	
El Bahr El-Sa'edy	349	249	100	
Main El Rashidya	176	159	17	
El Nil El Eslah	-	264	-264	264 MCM from El Garbia Main Drain
Ganabyad El Rashidy-Saedy Yousef	-	188	-188	from Nile River
Total	4,336	5,158	-822	Total annual inflow of 4,336 MCM + reuse pump discharge (95 + 183 + 173) + reuse water from El Garbia drain 264 + 188 from the Nile river = 5,239

Note: The above figures are recalculated by JICA Team using the original figures which are reported on "Rehabilitation of Water resources and Irrigation System of Kafr El Sheik, MWRI, 2012".

Based on the study (MWRI, 2012), area of farmland will be increased from 600,800 feddan to 680,700 feddan, if undeveloped area in northern part of the Governorate is developed[3]. In that case, future irrigation demand can be estimated as follows:

5,158MCM x (680,700 feddan /600,800 feddan) =5,844 MCM

In Egypt, farmers can select crops to be planted in next year, therefore, they tend to choose crops based on price of crops in previous year. Therefore, total water demand will be fluctuated depending on the situation in each year.

(3) Water Distribution

Water distribution is done by calculation of irrigation water demand based on the planting plan prepared by Governorate. However, cultivation area by tributary canal is not organized, which makes it difficult to calculate water demand and water balance by tributary canal. Fundamentally, it is needed to calculate water demand through data collection of cultivation area from the agricultural cooperatives which have relations to each tributary canal, and such method is very complicated. Therefore, in practice, water distribution is implemented following traditional measures. If the farmers complain about water shortage, temporarily, additional water is distributed by extension of opening hours of intake gates. The date of gate operation by tributary canal, water level at both upstream and downstream of control gate are recorded every day, however, discharge is not measured at all.

MWRI limits paddy cultivation percentage into around 50% of total farmland by tributary canal, and offender shall pay fine based on the regulation. However, this system is not practiced well due to the complicated procedure including examination of offenders, warning to the offenders, fine collection,

[2] Study of Rehabilitation of Water Resources and Irrigation System in Kahr El Sheikh, 2012, MWRI
[3] According to MALR statistics, farmland area is 566,024 feddan, however, data of MWRI is applied in this report.

trial and so on. Therefore, excessive paddy cultivation is done with the connivance of the authority, resulting from human resource shortage of Irrigation Directorate.

(4) Water Deficit at Irrigation Peak

The water balance study of the major irrigation canals in Kafr El Sheikh Governorate was carried out through the Study of Rehabilitation of Water Resources and Irrigation System in Kafr El Sheikh, 2012, MWRI. Prerequisite conditions are summarized as follows:

1) Cropped Area: The agriculture statistical data was referred. The dominant crop in the Governorate is paddy, which accounts for 71.1 % of total farmland in the Governorate, followed by cotton which accounts for 15.5%. Many farmers want to plant paddy, because basin irrigation for paddy cultivation is effective for salt leaching. It is generally known that higher production after salt leaching is expected. Moreover, benefit by paddy cultivation is same or more than those of other crops. In winter, wheat accounts for 50.3 % of total farmland area, which is dominant. Berseem is one of the animal feeds and its cultivation area accounts for 26.6%, while Sugar beet, which is widely planted as a recent source of sugar, and accounts for 17.9%. (Refer to Table 2.3.3)

Table 2.3.3 Cropped Area in Kafr El Sheikh Governorate Area (2009)

Crop Name	Cropped Acreage (feddan)	Ratio (%)	Remarks
Summer Crops			
Paddy	324,628	71.1	
Cotton	70,618	15.5	
Maize	52,682	11.5	
Tomato	8,846	1.9	
Sub-total	456,774	100.0	
Winter Crops			
Crop Name	Cropped Acreage (feddan)	Ratio (%)	Remarks
Berseem	135,445	26.0	
Wheat	261,818	50.3	
Linen	1,664	0.3	
Sugar Beet	93,094	17.9	
Beans	26,586	5.1	
Barley	1,824	0.4	
Sub-total	520,431	100.0	
Others			
Crop Name	Cropped Acreage (feddan)	Ratio (%)	Remarks
Fruits Garden	9,975	8.9	
Others	102,527	91.1	
Sub-total	112,502	100.0	
Total	1,089,707		

Note: Since the total farm land area of the Governorate is 577,600 feddan, the crop intensity is 198 %.
Source: Study of Rehabilitation of Water Resources and Irrigation System in Kafr El Sheikh, 2012

2) Water Requirement: The water requirement unit set by MWRI was applied.

3) Inflow Discharge: The data of actual canal discharge amount into the Governorate was used as inflow discharge.

Calculated water balance results at the major irrigation canals show almost same tendency. During the winter season of January and February, little water shortages were observed. However, in summer season, from July to September, severe water shortage was recognized. It was expected that water shortage in Kafr El Sheikh was observed mainly in May, puddling and rice planting season, and August to September, namely, booting stage. Water demand at the 1st peak in May is less than water

supply by 222.03 MCM, while deficit water of 515.70 MCM was identified at the 2nd peak in September[4] (Refer to Table 2.3.4 and Figure 2.3.3).

The water deficit is supplemented by reuse of drainage water through large scale pump station, 31 reuse pumps and private mobile small scale pumps. Operation of those pumps except the large scale pump station is not recorded, therefore, it is very difficult to identify the current conditions.

[4] In the calculation, paddy cultivation period is set from June to October, however, it is noted that the cultivation is done from May to August/September according to the interview to the farmers and field observation.

Table 2.3.4 Water Balance in Major Canals in Kafr El Sheikh

Name of Canal	Irrigation Area (feddan)		Jan. 18	Feb. 28	Mar. 31	Apr. 30	May 31	June 30	July 31	Aug. 31	Sept. 30	Oct. 31	Nov. 30	Dec. 31	Total
Bahr Tera Intake	125,123														
Unit Water Requirement (m3/feddan/day)			23.77	18.60	23.93	29.69	21.90	24.07	67.36	68.46	63.90	16.63	8.29	13.54	
- do - (MCM/day)			2.97	2.33	2.99	3.71	2.74	3.01	8.43	8.57	8.00	2.08	1.04	1.69	
- do - (MCM/month)		(a)	53.46	65.24	92.69	111.30	84.94	90.30	261.33	265.67	240.00	64.48	31.20	52.39	1,413
Inflow to Canal (MCM/day)			1.74	1.77	2.13	3.07	4.42	5.22	5.44	4.42	3.54	2.93	2.76	1.75	
- do (MCM/month)		(b)	31.32	49.56	66.03	92.10	137.02	156.60	168.64	137.02	106.20	90.83	82.80	54.25	1,172
Balance (MCM/month)		(b-a)	-22.14	-15.68	-26.66	-19.20	52.08	66.30	-92.69	-128.65	-133.80	26.35	51.60	1.86	-241
Meet Yazid	130,698														
Unit Water Requirement (m3/feddan/day)			23.77	18.60	23.93	29.69	21.90	24.07	67.36	68.46	63.90	16.63	8.29	13.54	
- do - (MCM/day)			3.11	2.43	3.13	3.88	2.86	3.15	8.80	8.95	8.35	2.17	1.08	1.77	
- do - (MCM/month)		(a)	55.98	68.04	97.03	116.40	88.66	94.50	272.80	277.45	250.50	67.27	32.40	54.87	1,476
Inflow to Canal (MCM/day)			2.24	2.86	3.07	4.13	5.91	6.36	6.36	5.65	3.71	3.67	3.37	2.46	
- do (MCM/month)		(b)	40.32	80.08	95.17	123.90	183.21	190.80	197.16	175.15	111.30	113.77	101.10	76.26	1,488
Balance (MCM/month)		(b-a)	-15.66	12.04	-1.86	7.50	94.55	96.30	-75.64	-102.30	-139.20	46.50	68.70	21.39	12
El-Qased	20,085														
Unit Water Requirement (m3/feddan/day)			23.77	18.60	23.93	29.69	21.90	24.07	67.36	68.46	63.90	16.63	8.29	13.54	
- do - (MCM/day)			0.48	0.37	0.48	0.60	0.44	0.48	1.35	1.38	1.28	0.33	0.17	0.27	
- do - (MCM/month)		(a)	8.64	10.36	14.88	18.00	13.64	14.40	41.85	42.78	38.40	10.23	5.10	8.37	227
Inflow to Canal (MCM/day)			0.46	0.67	0.70	0.60	0.92	1.24	1.29	1.14	0.80	0.58	0.61	0.38	
- do (MCM/month)		(b)	8.28	18.76	21.70	18.00	28.52	37.20	39.99	35.34	24.00	17.98	18.30	11.78	280
Balance (MCM/month)		(b-a)	-0.36	8.40	6.82	0.00	14.88	22.80	-1.86	-7.44	-14.40	7.75	13.20	3.41	53
Bahr Nashrat	14,753														
Unit Water Requirement (m3/feddan/day)			23.77	18.60	23.93	29.69	21.90	24.07	67.36	68.46	63.90	16.63	8.29	13.54	
- do - (MCM/day)			0.35	0.27	0.35	0.44	0.32	0.36	0.99	1.01	0.94	0.25	0.12	0.20	
- do - (MCM/month)		(a)	6.30	7.56	10.85	13.20	9.92	10.80	30.69	31.31	28.20	7.75	3.60	6.20	166
Inflow to Canal (MCM/day)			0.25	0.40	0.38	0.42	0.53	0.90	0.81	0.80	0.51	0.29	0.39	0.34	
- do (MCM/month)		(b)	4.50	11.20	11.78	12.60	16.43	27.00	25.11	24.80	15.30	8.99	11.70	10.54	180
Balance (MCM/month)		(b-a)	-1.80	3.64	0.93	-0.60	6.51	16.20	-5.58	-6.51	-12.90	1.24	8.10	4.34	14
El Quodaba	89,933														
Unit Water Requirement (m3/feddan/day)			23.77	18.60	23.93	29.69	21.90	24.07	67.36	68.46	63.90	16.63	8.29	13.54	
- do - (MCM/day)			2.14	1.67	2.15	2.67	1.97	2.16	6.06	6.16	5.75	1.50	0.75	1.22	
- do - (MCM/month)		(a)	38.52	46.76	66.65	80.10	61.07	64.80	187.86	190.96	172.50	46.50	22.50	37.82	1,016
Inflow to Canal (MCM/day)			0.89	1.38	1.66	1.98	3.42	2.20	2.95	2.27	1.87	1.58	1.58	1.26	
- do (MCM/month)		(b)	16.02	38.64	51.46	59.40	106.02	66.00	91.45	70.37	56.10	48.98	47.40	39.06	691
Balance (MCM/month)		(b-a)	-22.50	-8.12	-15.19	-20.70	44.95	1.20	-96.41	-120.59	-116.40	2.48	24.90	1.24	-325
El Bahr El-Sa'edy	22,061														
Unit Water Requirement (m3/feddan/day)			23.77	18.60	23.93	29.69	21.90	24.07	67.36	68.46	63.90	16.63	8.29	13.54	
- do - (MCM/day)			0.52	0.41	0.53	0.65	0.48	0.53	1.49	1.51	1.41	0.37	0.18	0.30	
- do - (MCM/month)		(a)	9.36	11.48	16.43	19.50	14.88	15.90	46.19	46.81	42.30	11.47	5.40	9.30	249
Inflow to Canal (MCM/day)															
- do (MCM/month)		(b)	24.50	22.40	31.00	33.00	38.20	36.65	32.60	38.50	27.90	28.25	35.70		349
Balance (MCM/month)		(b-a)	15.14	10.92	14.57	13.50	23.32	20.75	-13.59	-8.31	-14.40	16.78			79
Main El Rashidya	9,886														
Unit Water Requirement (m3/feddan/day)			23.77	18.60	23.93	29.69	21.90	24.07	67.36	68.46	63.90	16.63	8.29	13.54	
- do - (MCM/day)			0.23	0.18	0.24	0.29	0.32	0.36	0.99	1.01	0.94	0.25	0.25	0.25	
- do - (MCM/month)		(a)	4.14	5.04	7.44	8.70	9.92	10.80	30.69	31.31	28.20	7.75	7.50	7.75	159
Inflow to Canal (MCM/day)															
- do (MCM/month)		(b)	15.50	14.00	15.00	15.00	15.50	19.00	18.60	19.00	0.00	4.65	24.00	15.50	176
Balance (MCM/month)		(b-a)	11.36	8.96	7.56	6.30	5.58	8.20	-12.09	-12.31	-28.20	-3.10	16.50	7.75	17
El Nil El Eslah	25,963														
Unit Water Requirement (m3/feddan/day)			23.77	18.6	23.93	29.69	21.9	24.07	67.36	68.46	63.9	16.63	8.29	13.54	
- do - (MCM/day)			0.62	0.48	0.62	0.77	0.32	0.36	0.99	1.01	0.94	0.94	0.94	0.94	
- do - (MCM/month)		(a)	11.16	13.44	19.22	23.10	9.92	10.80	30.69	31.31	28.20	29.14	28.20	29.14	264
Inflow to Canal (MCM/day)								not available							
- do (MCM/month)		(b)						not available							-
Balance (MCM/month)		(b-a)													0
Ganabyad El Rashidy-Saedy Yousef	21,033														
Unit Water Requirement (m3/feddan/day)			23.77	18.6	23.93	29.69	21.9	24.07	67.36	68.46	63.9	16.63	8.29	13.54	
- do - (MCM/day)			0.50	0.39	0.50	0.62	0.32	0.36	0.99	1.01	0.94	0.25	0.25	0.25	
- do - (MCM/month)		(a)	9.00	10.92	15.50	18.60	9.92	10.80	30.69	31.31	28.20	7.75	7.50	7.75	188
Inflow to Canal (MCM/day)								not available							
- do (MCM/month)		(b)						not available							-
Balance (MCM/month)		(b-a)													0
Water Balance															
Inflow (MCM)			140.44	234.64	292.14	354	524.9	533.25	573.55	500.18	340.8	313.45	321	207.39	4,336
Water Requirement (MCM)			196.56	238.84	340.69	408.9	302.87	323.1	932.79	948.91	856.5	252.34	143.4	213.59	5,158
Balance (MCM)			-56.12	-4.20	-48.55	-54.90	222.03	210.15	-359.24	-448.73	-515.70	61.11	177.60	-6.20	-823

Source: Basic figures are based on the report of "Rehabilitation of Water resources and Irrigation System of Kahr El Sheik, MWRI, 2012".

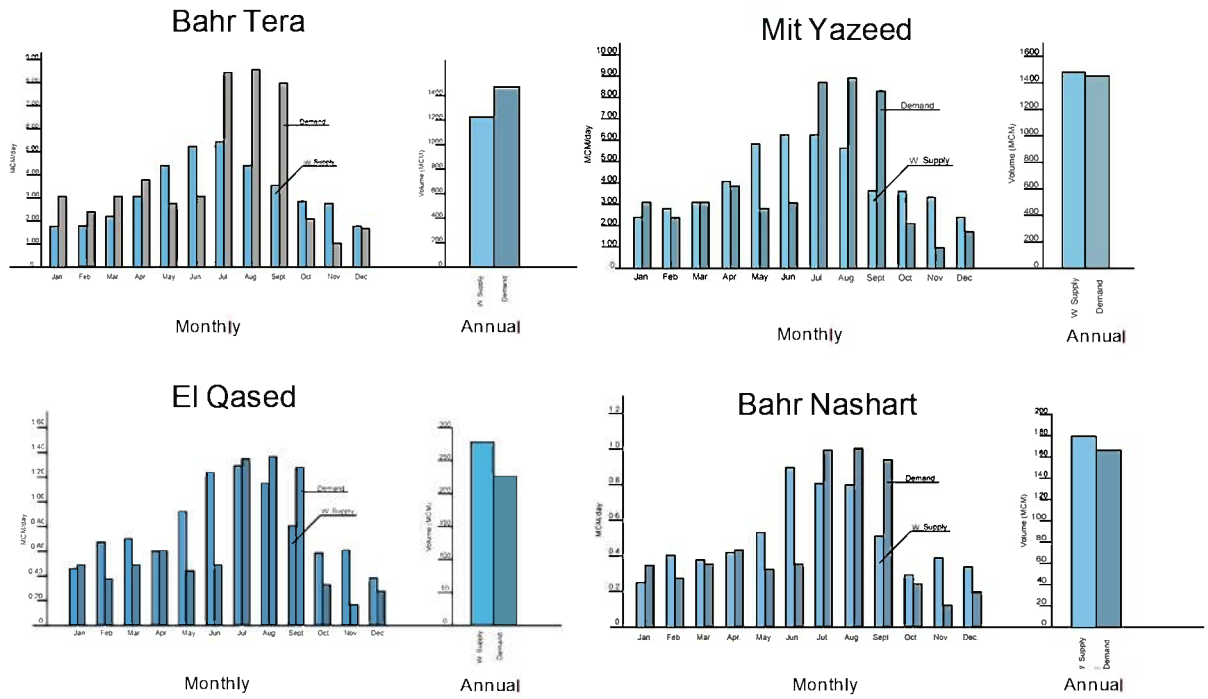


Figure 2.3.3 Water Balance for Major Canals in Kafr El Sheikh Governorate

2.3.4. Reuse of Drainage Water for Irrigation

(1) Drainage Water as Irrigation Source

Farmland of Kafr El Sheikh is located on final endpoint of irrigation canals in the Delta, and the farmland cannot receive sufficient water from the Nile River, which causes large amount of irrigation water shortage in summer, especially, paddy cultivation season. Irrigation system in the area has been developed, therefore, large scale change of irrigation system is almost impossible in terms of land acquisition.

Groundwater is one of alternatives as irrigation water source, however, it contains high salinity which is not suitable for drinking and farming. The people do not use groundwater as well as the Government does not encourage the people to use ground water. Rainfall is very limited and irregular, it cannot be considered as water source.

Under the situation, only reuse of drainage water from farmlands can solve the water shortage issue. Such drainage water is discharged through tailed drains and levees. Therefore, the pollution level is low, and it is possible to reuse the drainage water as irrigation water. However, untreated drainage water from households is also discharged into the drainage in the farmlands. It means it is expected that pollution risk of drainage water will be increased due to population increase in the future.

(2) Facilities for Reuse of Drainage Water

Drainage water pump station is one of facilities for reuse of drainage water for irrigation. Such pump stations can be categorized into two (2) groups; one of them is a large scale pump station e.g. Zahara'a, No.11 and Hamoul Mixing Pump Station (MPS). The Hamoul MPS has been operated since 1962, and it lifts up water from Garbia Drainage to Bafr Tera Irrigation canal. The station has three pumps with the capacity of $10m^3/s$, however, the capacity has been deteriorated year by year. Water quality of

Garbia Drainage is worsen as expansion of population in the cities upstream, even after mixing with clean water 1:1, the water quality is not suitable for reuse, and water quality improvement is an urgent issue. Furthermore, Botate MPS had lifted up water from Gharbya drainage to El Saweia irrigation canal since 1991. However, the operation is suspended at present due to highly deteriorated water quality.

Another one is a small scale pump station. There are 31 pump stations in Kafr El Sheikh Governorate and they are operated and maintained under the MWRI. The pump capacity at the stations is 0.5 to 1.0m^3/s, and operation period is 1,000 hours per year. The stations are operated directly by Mushel (pump operator) based on instruction by the inspectors or request from the farmers. During the operation period, the Mushel stays at the quarter neighboring the pump stations for operation all the time. The maintenance cost of the pump stations is shouldered by MWRI.

Table 2.3.5 Existing Drainage Water Reuse Pump Stations

No.	Name of Station	Installation Year	Name of Irrigation Canal	Command Area of Irri. Canal (fed)	Name of Drain	Command Area of Drain (fed)	No. of Unit	Major Crop in Summer Season	Pump Capacity (m^3/sec)	Pump Type	Pump Diameter (mm)	Driving System	HP or PS	Working hours (hrs)	Pump Type	Remarks
{East Kafr El Sheik}																
1	Kom el Tiin	1997	Kom el Tiin	n.a	M. KM 7 Ayema	n.a	2	Rice	1.00	Vertical	750	Electric	120	1,000	KSB	Extra unit needed
2	Ashrya Ebshan	2007	Ebshan KM 11	n.a	Gharbya M.	n.a	1	Rice	0.50	Vertical	500	Electric	65	1,000	SZ50-55	OK
3	Bahr Bila	1992	Bahr Bila	n.a	Nemra 4	n.a	1	Rice	0.96	Vertical	600	Diesel	121	1,000		electric drive
4	Sharfy	2007	Teroa el Sharfa	n.a	Nemra 4	n.a	1	Rice	1.00	Vertical	700	Diesel	120	1,000	SZ60-65	electric drive
5	Abu Mostafa	2003	Abu Mostafa KM 14	n.a	Masraf 7 KM 1	n.a	1	Rice	1.0	Vertical	750	Diesel	120	1,000	KSB	OK
6	Wzaria	2003	Basis KM 17	n.a	M. abu Khahaba KM 2.2	n.a	1	Rice	0.96	Vertical	600	Diesel	121	1,000		electric drive
7	Naseria	1997	Basis KM 17.2	n.a	M. abu Khahaba KM 1.2	n.a	1	Rice	1.0	Vertical	750	Diesel	120	1,000	KSB	electric drive
8	Saayda	2006	Basis KM 17.4	n.a	M. abu Khahaba KM 2.0	n.a	1	Rice	0.96	Vertical	600	Diesel	121	1,000		electric drive
9	Gmeza	1994	Gmiza	n.a	M. Gharbya	n.a	1	Rice	0.96	Vertical	600	Diesel	121	1,000		electric drive
10	Meshreki	1997	Teret el Adma	n.a	M. Gharbya	n.a	1	Rice	1.0	Vertical	750	Diesel	120	1,000	KSB	OK
11	Manawfa	1997	Teret el Adma	n.a	Gharbya	n.a	1	Rice	1.0	Vertical	700	Electric	120	1,000	SZ60-65	OK
12	Marbat	2007	Nhayet Teret el Mahbt	n.a	M. No. 7	n.a	1	Rice	1.0	Vertical	700	Electric	120	1,000	SZ60-65	OK
13	Farsh El Gnayn	1994	Sant	n.a	Farsh el Ganayen	n.a	1	Rice	0.96	Vertical	600	Diesel	121	1,000		electric drive
14	Kom el Roz	1997	Kom el Roz el Koklima	n.a	Ghanabya	n.a	1	Rice	1.0	Vertical	750	Diesel	120	1,000	KSB	electric drive
15	Al Gdyah	2008	Nhayet Tret el Gdyah	n.a	M. Naser	n.a	1	Rice	0.96	Vertical	600	Diesel	121	1,000		electric drive
16	Khalig	2009	Khalig 15.8 Ayman	n.a	M. Abu Khashba	n.a	1	Rice	0.96	Vertical	600	Diesel	121	1,000		electric drive
17	Rokn	2010	Rokn	n.a	Abu Khashba KM 1	n.a	1	Rice	0.5	Vertical	500	Diesel	65	1,000	KSB	electric drive
18	Daramally	2010	Daramally	n.a	Farsh el Gnayen	n.a	3	Rice	1.0	Vertical	900/600	Electric	120	1,000		OK
{West Kafr El Sheik}																
1	El-Sath	1990	End of El-Sath Canal	600	Bahr Nashart Drain	n/a	1	Rice	0.96	Vertical	700	Diesel	125	1,000	Agrofill	
2	Domro	1990	Imtedad Shalma	400	Drain No. 8	n/a	1	Rice	0.96	Vertical	700	Diesel	125	1,000	Agrofill	
3	El-Misk	2005	End of El-Misk Canal	700	Drain No. 8	n/a	1	Rice	1	Vertical	600	Diesel	120	1,500	Willer	Electricity conversion due
4	Dil Rewaina	2011	End of Dil Rewaina	300	Drain No. 8	n/a	1	Rice	0.5	Hydro-flow	300	Diesel	n/a	n/a	Hydro-flow	
5	Shalma	2005	Imtedad Shalma	1,000	Drain No. 8	n/a	2	Rice	2	Vertical	600	Diesel	120	2,800	Willer	Electricity conversion due
6	Youssef Afandy	2005	End of Youssef Afandy canal	500	Drain No. 10	n/a	1	Rice	1	Vertical	600	Diesel	125	300	Willer	
7	El-Henawy	2005	El-Henawy Canal through a mesqa	500	Bahr Nashart Drain	n/a	1	Rice	1	Horizontal	650	Electric	n/a	n/a	KSB	
8	Shalma (addt'l)	2012	Imtedad Shalma	1,000	Drain No. 8	n/a	2	Rice	2	Horizontal	650	Electric	n/a	n/a	Fahim Ragab	under Construction
9	Um Dokhan	2012	End of Um Dokhan canal	600	Bahr Nashart Drain	n/a	1	Rice	1	Horizontal	600	Electric	n/a	n/a	Willer	under Construction
10	Moftah	2012	End of Moftah Canal	500	Bahr Tharwat Drain	n/a	1	Rice	1	Horizontal	600	Electric	n/a	n/a	Fahim Ragab	under Construction
11	Sath (addt'l)	2012	End of El-Sath Canal	600	Bahr Nashart Drain	n/a	1	Rice	1	Horizontal	n/a	Electric	n/a	n/a	Agrofill	under Construction
12	El-Khamseen	2011	End of Moheet Belshasha El-Gharby	n/a	Salem Drain	n/a	1	Rice	1	Hydro-flow	600	Diesel	n/a	n/a	Hydro-flow	installed & operational
13	El-Ghamria	2012	End of El-Ghamria Canal	n/a	Salem Drain	n/a	1	Rice	1	Hydro-flow	600	Diesel	n/a	n/a	Hydro-flow	Necessary actions for operation are ongoing

Note: M. means "masraf" (= drainage canal), KM means Kilometer (distance from the beginning point).
Source: Irrigation Department of Kafr el Sheik Governorate

(3) Available Drainage Water for Irrigation

It is difficult to grasp actual amount of drainage water reuse in whole the Kafr El Sheikh Governorate due to no record of operation except major pumps. Based on the operation record of major pumps and actual water intake amount, approximate amount of drainage water reuse is estimated at 669.5MCM. The value does not consider the amount of drainage water reuse through engine drive mobile small pumps, which is commonly used in whole area of Egypt, due to difficulty of data collection. It is not needed to get permission from EPADP in case of utilization of this type of pump, and farmers operate as they like. The annual total amount of drainage water reuse at 31 pump stations under the General Integrated Directorate of Water Resources and Irrigation of East of Kafr El Sheikh is estimated at 108.5MCM considering the pump capacities and 1,000 hours operation (See Table 2.3.6).

Table 2.3.6 Estimation of Amount of Drainage Water Reuse

Name of Reuse Pump Station	Annual Amount (MCM)	Remarks
1. Hamoul PS:	95	
2. Zahara'a District	293	
3. Mix PS No. 11	173	
Total	561	
4. 31 PSs under ID	108.5	
5. Private Pump	N.A.	There are many private mobile pumps in the area. And no data are available as of now.
Grand Total	669.5	

Source: Basic figures are based on the report of "Rehabilitation of Water resources and Irrigation System of Kahr El Sheik, MWRI, 2012"

(4) Unit Discharge of Available Drainage Water

During the water shortage period in summer, no rain is recorded, and almost all of drainage discharge is brought from irrigation. At the Pilot Project sites, the actual velocity of discharge water ranges from 0.05 m/s to 0.3 m/s in a drainage canal. When the drainage pump station is operated, the velocity becomes high, and when the drainage is stopped, velocity becomes zero or low. Under this condition, the result of discharge measurement does not show exact tendency. Therefore, specific discharge based on actual discharge at the drainage pump station is calculated, and available drainage discharge is estimated by the specific discharge and drainage area at proposed drainage reuse pump.

However, in summer, there are so many small pumps along the drainage canal, and these pumps are individually operated by the farmers as they like. Considering these phenomenon, the safety ratio of 0.7 is applied to calculate the available amount of reuse drain water from the drainage canal. Statistical data of the reuse of drainage water by the farmers are not collected.

The actual discharge records of the above four (4) drainage pump stations were examined. According to the results, the specific discharges of three (3) pump stations, except for the Zaghluol drainage pump station, showed almost the same amount. Therefore, the average value was applied as specific discharge for the Pilot Project. The specific discharge in May and June, when water shortage is the severest due to land preparation and paddy transplanting, is calculated. One in August is used as a reference, since if we apply the month of maximum drain discharge, it may lead to over estimation of the available drainage water for reuse. The discharge of 0.131 lit/s/feddan measured in May was applied as the specific discharge for the Pilot Project. The unit available reuse water amount was calculated as follows:

Table 2.3.7 Estimation of Unit Available Drainage Water Reuse

Month	Actual Specific Discharge	Design Specific Discharge
May	0.188 lit/s/feddan	0.131 lit/s/feddan
June	0.233 lit/s/feddan	0.161 lit/s/feddan
July	0.252 lit/s/feddan	0.176 lit/s/feddan
August	0.258 lit/s/feddan	0.181 lit/s/feddan

(5) Available Reuse Drainage Water

It is needed to estimate available drainage water reuse amount based on drainage area and location of drainage by site. Referring actual situation at the 5 Pilot Project sites, available reuse of drainage water was estimated. The conditions for estimation are as follows:

1. Drainage area: it is calculated based on the 1/50,000 topographic map and field observation.
2. Unit of available drainage water reuse: 0.131 lit/s/feddan was applied based on examination in the previous page.

Following figures are available drainage water for reuse at the Pilot Project sites. Available reuse was estimated by multiplication of drainage area and the unit amount of available drainage water for reuse as shown below.

Table 2.3.8 Estimation of Available Drainage Water for Reuse

Proposed Pilot Site	Drainage Area (feddan)	Available Re-use Drain Water (m^3/s)
E1	11,000	1.441
E4	2,110	0.276
W2	56,850	7.447
W4	11,300	1.480
W5	9,100	1.192

Source: JICA Project Team

2.4 Water Quality of Drainage in Kafr El Sheikh

2.4.1 Water Quality of Drainage

A series of water quality surveys was conducted every month from June to August in 2012. Basic items included in water quality standards such as nitrogen were measured. The results of the survey for the main irrigation and drainage canals are attached as an Appendix C.

Water quality shows the worst levels in June, which is the beginning of irrigation in most irrigation canal, and it becomes slightly better in July and August. Table 2.4.1 shows the summary of the major items in drainage water.

Table 2.4.1 Water Quality Test Results (Drain, 2012)

Item		EC (mS/cm)	DO (mg/l)	TSS (mg/l)	COD (mg/l)	BOD (mg/l)
Water quality standards		4.0	-	1000	80	30
June	Min	0.5	0.1	10	20	9
	Max	6.5	3.6	717	97	36
July	Min	0.9	0.6	11	17	7
	Max	11.7	2.4	3.7	53	34
August	Min	0.8	0.1	7	14	6
	Max	7.7	3.2	646	106	28

Source: JICA Study Team, 2012

The water quality survey results and the Article 65 of Law 48 were compared, and the characteristic of

water quality at the sites are summarized as follows:

- Only one sample in June satisfied the standard of DO.
- 32 samples out of total 75 samples for 3 months satisfied the standard of BOD.
- 9 samples out of total 75 samples for 3 months satisfied the standard of COD.
- 17 samples out of total 75 samples for 3 months satisfied the standard of E.Coli.

2.4.2 Pollutants and Load of Contamination

As mentioned above, BOD of the Nile water will reach from 1.2mg/l at the point of High Aswan Dam to 5.0mg/l at the south edge of the Nile Delta traveling through Cairo. This contamination is mainly caused by the domestic and industrial wastewater from the populated city of Cairo. The main sources of drainage pollution in Kafr El Sheikh are agricultural waste, industrial wastewater, domestic wastewater, and livestock wastewater. Also it seems that household garbage and illegal dumping of livestock excreta are the cases of contamination; however, it is difficult to estimate the amounts. Category of pollution sources in Kafr El Sheikh Governorate is estimated as follows:

Table 2.4.2 Pollutant and its Ratio(BOD)

	Livestock	Agriculture	Rural Sewerage	Urban Sewerage	Industry	Total
Waste (t/year)	13,200	14,850	20,350	2,750	3,850	55,000
Ratio (%)	24	27	37	5	7	100

Source: outline Design Study Report on the Re-use Water Quality Improvement of Agricultural Water Nile Delta JICA (Draft)

2.4.3 Waste as Pollutants

The weight of Municipal Solid Waste (MSW) generated in Kafr El Sheikh Governorate is estimated at 2,500 tons per day (=912,500 tons/year) (SWEEP NET, 2010)5; while, the amount of the domestic garbage is 811,200 tons/year. This means that most of the garbage in the governorate is produced from general households, and organic garbage accounts for 65% in the whole amount of garbage as shown in Figure 2.4.1. This data indicates that effective organic garbage disposal is important.

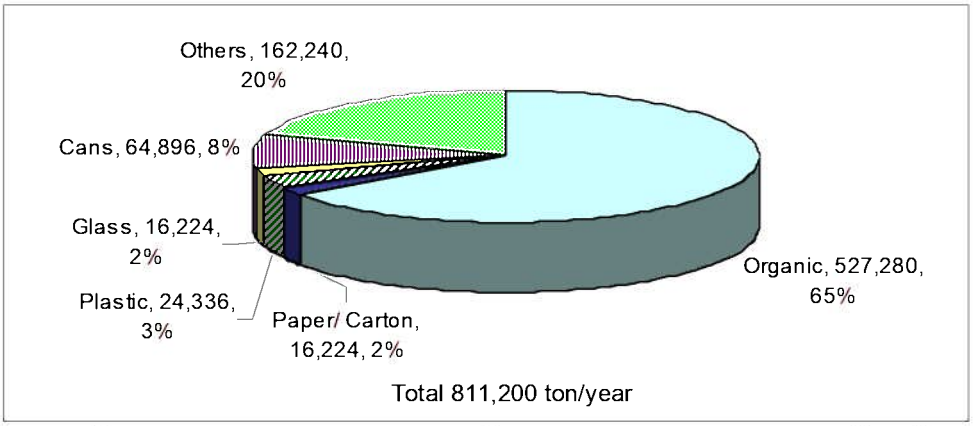


Figure 2.4.1 Annual Domestic Garbage in Kafr El Sheikh Governorate (tons)

Source: "Kafr El Sheikh Governorate, "A study on the qualitative composition of the waste of Kafr El Sheikh governorate" (1996, revised in 2011)

On the other hand, according to the Kafr El Sheikh Environmental Sector, around 1,600 tons of garbage is collected and disposed per day in the Governorate only. In other words, around 900 (=2,500 to 1,600, 36% of total garbage) tons of MSW is dumped every day without collection and disposal.

[5] The Regional Solid Waste Exchange of Information and Expertise network in Mashreq and Maghreb countries (SWEEP NET), 2010, "Country Report on the Solid Waste Management, Egypt"

There is one dumpsite in the Governorate; however, it has not been operated yet. MSW collection coverage percentage in the rural and urban area of Egypt is 0-35% and 40-90% respectively (SWEEP NET, 2010). This means that regular garbage collection in rural areas is not functioned well. Actually, according to the Social Condition Survey (JICA,2012), there are many cases showing that domestic garbage are left outside of houses or dumped in the canals.

There are three recycle factories in Kafr El Sheikh Governorate, namely, Beila Factory, Sidi Salem Factory, and Kafr El Sheikh Factory. However, Kafr El Sheikh Factory is not operated at the time being since they did not pay the rental fee to the Governorate. The daily recycle capacities of Beila Factory and Sidi Salem Factory are around 100 tons per day and 130 tons per day respectively. Concerning the latter, the actual disposal amount is only 30 tons per day due to the insufficient garbage collection system (interview result to the factory, 2012). The factory does not have a collection system or transportation means such as trucks to collect solid waste on their own. They can dispose only the waste which the Governorate brings to the factory. This situation shows that the amount of recycled garbage is very minimal, in comparison to that of generated garbage.

In some areas of the Integrated Irrigation Improvement and Management Project (IIIMP) in Kafr El Sheikh Governorate, the beneficiaries have established the garbage collection system through monthly payments of collection fees. In addition, they follow their internal rules so as not to throw away waste in the canals. However, in general, due to the dysfunction of official collection system, the residents have no option but to dispose their MSWs in the canals. The people understand that it is not good to throw out garbage in the canal in terms of sanitation; however, they do not have any place to dispose them, which leads to water quality deterioration of the canal.

2.4.4 Urban and Rural Sewerage System

Ratio of sewerage cover rate in Kafr El Sheikh is 44% as a whole, while urban sewerage rate and rural sewerage rate are 100% and 35%, respectively. The city sewerage systems are as follows: activated sludge and oxidation ditches (79%) waste stabilization ponds being (11%) trickling filters (5%) and others (5%). In addition, low-cost sewerage systems in rural areas are UASB method and grade-up of septic tank, and so on, and it is possible to examine installment of those systems. After the confirmation of the performance, it is needed to introduce processing system with low construction cost and easy maintenance.

2.4.5 Disposal of Agricultural and Livestock Waste

The straw (rice, wheat) is worked to burn up without being reuse, or it is used as fodder, fuel for domestic cooking, and organic fertilizer (compost). Some farmers apply domestic animal waste (cow, water buffalo) as compost in their farmlands, and others may purchase domestic animal waste even if they do not own a domestic animal. The domestic animal waste is put in a weather-beaten state along the canal or farm neighborhood for a long term until they throw it in the farm. There are many cases such dumped livestock waste falls down to the canal, which causes water quality deterioration.

A national project to promote the organic fertilizers utilization is going-on since 2012 by MALR. Furthermore, lectures to promote organic matter by university staff, sale of the organic material including microbe material and so on were implemented by the agricultural extension officer. According to the farmers at E-3, one of the Pilot Project site, only 5% of whole farmers use organic materials, which are recommended by the agriculture extension office. Majority of farmers think that chemical fertilizer is more effective than organic fertilizer and they are relatively conservative, which leads to low dissemination percentage of compost application.

Chapter 3 Constraints of Drainage Water Reuse for Agriculture Development in Kafr El Sheikh

Based on the situation analysis of the governorate, constraints of agriculture in terms of drainage water reuse for irrigation are discussed in this chapter. One of the constraints is stagnant agricultural productivity. As reason for the productivity decline, irrigation water shortage, reuse of drainage water and water quality issues are listed up for examination. Issues regarding water quality of drainage water reuse and its utilization have a relation with facility construction and participation of the people.

3.1 Constraints for Agriculture Development in terms of Irrigation

3.1.1 Decrease of Agricultural Productivity

According to the statistics of MALR, the unit yields of the major crops in Kafr El Sheikh have been decreasing in recent years as illustrated in Table 2.2.5 in Chapter 2. Figure 3.1.1 shows average yields of major crops from 2009 to 2013, under the premise that average yield from 2004 to 2008 is 1.0. The figure indicates all of mean yields of the major crops have been declining. Especially, such trend is remarkable for summer crops like cotton and paddy. Not only summer crops but also winter crops show the same tendency, therefore, the reasons for the yield decrease could be various. However, most often heard opinions from the farmers at the field are the serious water shortage especially in summer crop season and irrigation water quality.

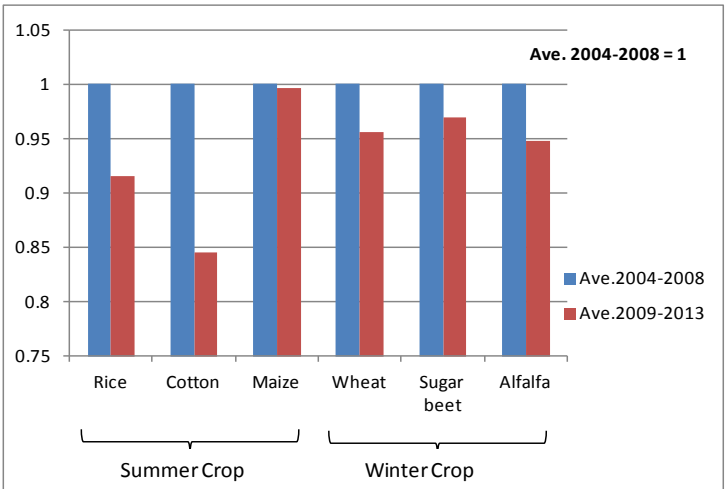


Figure 3.1.1 Yield Trend of Major Crops in Kafr El Sheikh

Some farmers cultivating land at the tail of the irrigation canal claim that they have to reuse drainage water, since the fresh water from the irrigation canal does not reach to the tail, and the deteriorated drainage water gives damage to the crops. Drainage water is supposed to be mixed with fresh water, but the portion of drainage water at the tail is getting much higher, as the fresh water does not reach to the tail of the canal. After all, the farmers in the tail are forced to use bad quality water without mixing it with fresh water. The farmers' complaint indicates that the severe water shortage consequently results in worse water quality for irrigation.

Bad water quality as well as water shortage results in low productivity of agricultural land and decrease of farm income. The situation also makes some farmers to transform their agricultural lands into fish ponds especially in the area of El Hamoul District, in which the drainage water from Garbia's main drain is mixed with fresh water of the Bahr Tera irrigation main canal at the upstream reaches of the irrigation command area. In this area, the drainage water is already mixed at the upstream reaches, so the quality of irrigation canal water is already deteriorated to some extent. Expansion of fish ponds is significant in this area. Shifting farmland to fish ponds means not only the loss of the summer crop production but also the winter crop, which includes wheat, the most important grain for people's staple food in Egypt. According to the local farmers, there is a rumor that crops in the area are damaged by the deteriorated water quality, which risks the reputation of the crops. Improvement of water quality and thereby maintaining the productivity of crops are crucial in this area in terms of securing agricultural land.

3.1.2 Shortage of Irrigation Water and Reuse of Drainage Water as a Solution

Water shortage in Kafr El Sheikh is remarkable in booting stage, namely, August to September. According to the water balance estimation, 515.7MCM of water shortage is calculated in September, irrigation peak period. Results of water balance estimation at the major canals in Kafr El Sheikh show the similar tendency. A little water shortage in January and February (winter season) is recognized, while severe water shortage in July to September is observed.

Farmlands in Kafr El Sheikh are located on endpoint of the irrigation canals, which give disadvantage, namely, insufficient irrigation water distribution from the Nile River to the area. Since it is difficult to change ancient and existing irrigation network system among the Nile Delta, increase of water from the Nile River cannot be expected. Ground water is one of alternatives, however, it contains high concentration of salt, which is not suitable for irrigation.

Under the circumstances, the reuse of drain water is regarded as the prospective water source. Most of the drainage water is flowing into drain from the agricultural land through a tile drain system and/or paddy ditches. The drainage water does not contain harmful elements such as heavy metals, and it is applicable for farming. MWRI advocates using such less contaminated drainage water, as so called “intermediate reuse”.

3.1.3 Contamination of Drainage Water

The population increase and industrialization have resulted in water contamination of the Nile, especially the delta region located most downstream. Therefore water quality in the drain should be conserved so as to increase the amount of reuse. The following are the main issues of water quality of drainage water for reuse:

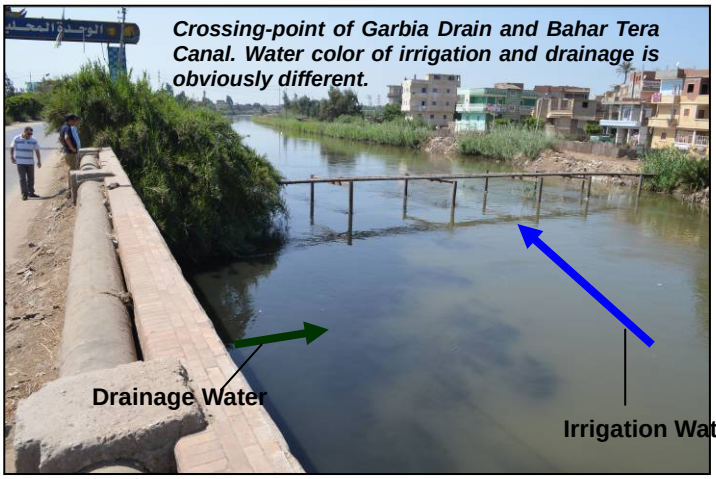
- The main source of organic matter (BOD, COD and DO) of the drainage water is domestic and animal waste.
- Nutrients ($N\text{-}NO_3$, $N\text{-}NH_4$, T-N, T-P) in the drainage water come from chemical fertilizers applied in the farmlands and domestic wastewater.
- Salts (EC as an indicator), which is originally contained in soil and aquifer, is accumulated at surface due to evaporation, and flows into drainage with drainage water.
- Pathogens (Total coliform, as an indicator) are mainly originated from domestic wastewater.

As mentioned in the previous chapter, main pollutants of the drainage are industrial waste water, domestic waste water, animal waste, and agricultural waste water. In addition, raw waste from the households is one of the causes of contamination of drainage water. The largest pollutant in Kafr El Sheik comes from domestic waste water in the rural area, which accounts for 37% of whole pollutants, followed by agricultural waste water, animal waste, industrial waste water, and domestic waste water in the urban area. If sewerage system, that can reduce 90% of pollutant, is established, and compost making facilities, that can reduce 95% of pollutants from agricultural waste, are constructed, 60% of total pollutants in the governorate can be reduced. Moreover, if water improvement in the upper stream of the Nile River is promoted, water quality at downstream will be also improved.

According to result of the Social Condition Survey (JICA Team, 2012), there are many cases that the people leave their waste outside of their houses, or they throw away the waste to the canals. In general, governmental garbage collection system in the rural area does not function well, the farmers do not have spaces and measures to manage the waste. Consequently, they have no options except illegal dumping of waste to the water ways.

3.1.4 Water Quality and Drainage Reuse of Garbia Drain

Drainage water quality is expected to be improved through rehabilitation of the sewerage plant. However, mismanagement of the treatment plant causes further water deterioration. This is because drainage water from a number of villages comes into the treatment plant, and the collected drainage water discharges into the drain without proper treatment. In this case, water quality becomes even worse. Therefore, proper management of the sewerage plant is one of the conditions for promoting drainage water reuse. Water quality in Kafr El Sheikh Governorate is the worst in the country; nevertheless, drainage water from Garbia Drain is mixed in irrigation canals. Water deterioration of Garbia Drain is described in the following sections because it is one of the most urgent matters in Kafr El Sheikh.



Garbia Drain extends east part of the Governorate. The main drain collects sewage from Tanta and Mahala Kobra (Garbia Governorate, upper side of Kafr El Sheikh Governorate), and collected sewage is discharged into red sea from east side of Lake Burulus. Garbia Drain is cross over Bahar Tera Drain at Hamoul city (Kafr El Sheikh Governorate). Hamoul Reuse Pump Station was constructed in the 1960s. The purpose of this reuse pump station is to mix drainage water of Garbia Drain into Bahar Tera irrigation canal. Population of Tanta city and Mahala Kobra city is increasing rapidly, and water quality of Garbia Drain is deteriorating year by year. According to the population census, population of Tanta city and Mahala Kobra city is estimated 486,000 people and 509,000 people in 2014 respectively[1]. The following diagram shows water degradation in Garbia Drain.

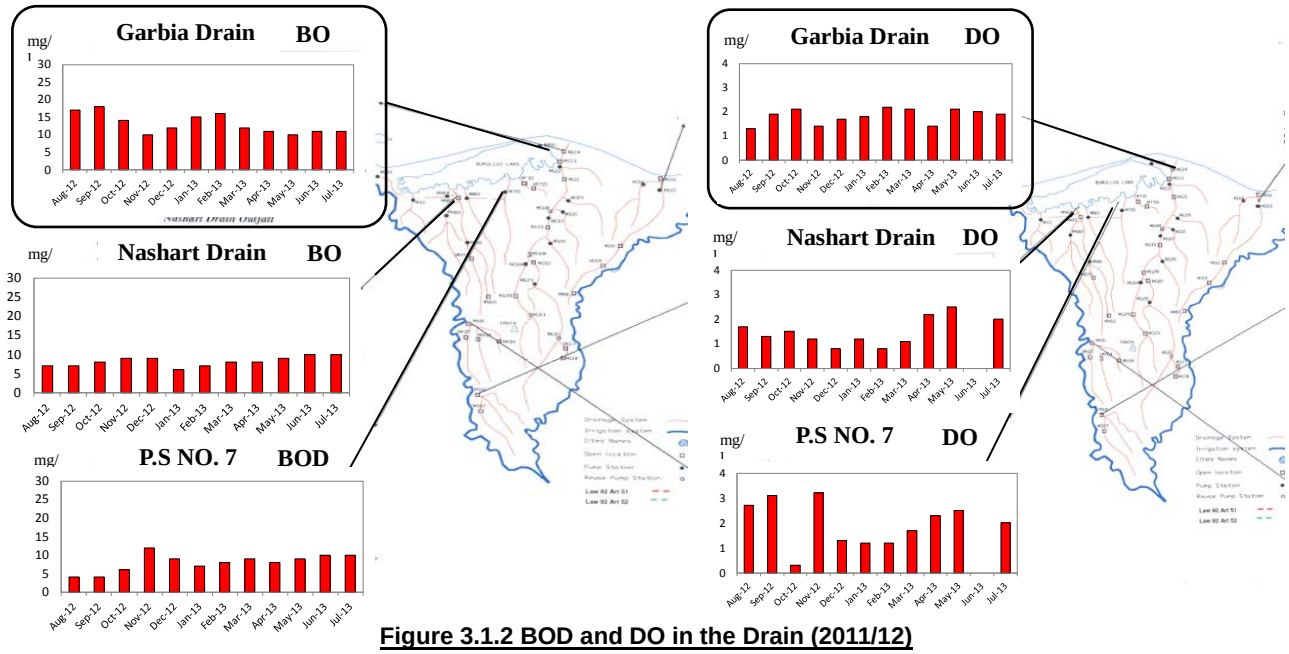


Figure 3.1.2 BOD and DO in the Drain (2011/12)

Source: Drainage Research Institute Year Book 2011/12, July 2013

[1] According to the Population Census, population in Tanta is 422,854 and population in Mahala Kobra is 442,958 in 2006. Population of Garbia Governorate in 2014 was increased by 115% from population in 2006. This increase rate applied for estimating population of Tanta and Mahala Kobra.

Water quality of Bahar Tera irrigation canal is deteriorated after mixing drainage water from Garbia Drain. Particularly, water quality degradation affects the downstream area of Bahar Tera irrigation canal. In fact, aquafarming is promoted in this area because crop productivity became low compared to other areas. Some farmers complain that quality of agricultural production became low because of water degradation. Some other farmers pointed out that there is a rumor that crops produced in this area are unhealthy. For these reasons, crop price is declining. This downstream of Bahar Tera irrigation canal is only the area that drainage water is mixed into upstream of the irrigation canal.

There are various size of villages along Garbia Drain. Rural residents in small hamlets discharge household sewage directory into the drain with pipes. In larger villages, a small tractor with a tank visits each house and collects sewage from septic tanks. And then, the small tractor discharges collected sewage into the drain without treatment. This situation could cause water deterioration in the drain; however, these pollution sources have still limited impacts. One of the most significant pollution sources is Mahala Kobra sewerage plant (treatment capacity 90,000 m^3/day) because a large volume of untreated sewage is discharged into the drain from the plant.

Household sewage is discharged into the drain directly

Sewage discharge from a tractor with tank. This sewage is collected from septic tanks at each

Mahala Kobra Sewerage Plant: Rehabilitation is necessary. Some of the facilities do not work after the revolution.

Sewage from Mahala Kobra Sewerage Plant. The Plant does not work and untreated sewage was discharging when the Study Team visited the Plant.

Mahala Kobra city is well-known as an industrial city. There are many cotton-spinning companies. Mahala Kobra sewerage plant was constructed in 1982. This plant treats both domestic and industrial sewage from Mahala Kobra city and surrounding eight villages. Most of the facilities, however, are getting old, and the amount of sewage inflow is over the capacity of the facilities. The sewerage plant only operates from 6am to 2pm so that untreated sewage water is discharging between 2pm and 6am.

Rehabilitation and enhancement of function of Mahala Kobra sewerage plant were once planned by IWASP funded by EU; however, the sewerage plan was excluded from IWASP after political situation became unstable in Egypt. There are around 20 staffs working on operation. According to the EU's rehabilitation plan, the number of staff was to increase up to 150, and treatment capacity was to strengthen 120,000m^3/day. In addition, purification facility was under construction to treat industrial waste water; however, the construction has stopped. This purification facility has capacity with 45,000m^3/day of industrial waste water.

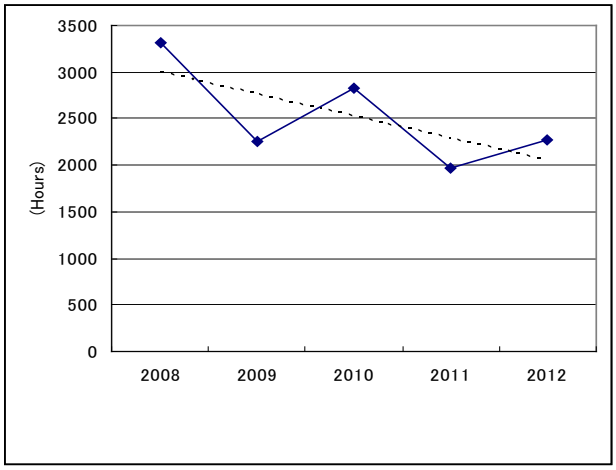


Figure 3.1.3 Operation Hours of Hamoul Reuse Pump Station

Source: MED

Hamoul Reuse Pump Station (maximum capacity 10m^3/s) pumps up drainage water from Gariba Drain and put it into Bahar Tera irrigation canal. Drainage mixed irrigation water supply for the area of 84,800 feddan (35,600 ha). It is important to prevent from water degradation and avoid any influence on crop production. Therefore, rehabilitation of sewerage plants along Garbia Drain is urgently necessary. Figure 3.1.1 shows annual operation hours at Hamoul Reuse Pump Station. This graph indicates that pump operation hours is decreasing. According to the MED staff, drainage water is too deteriorated to mix with irrigation water. Therefore, the pump station often stops its operation.

3.2 Challenges of Community Organizations in Rural Area

Water Users Associations (WUA) are organized to improve water use efficiency in rural areas. Also, a CDA (Community Development Association) is willing to be involved in environment related activities. A CDA is also a common community organization in rural areas. It is important to consider how to involve these organizations in drainage water reuse. In this section, major challenges of community organizations are summarized as follows:

3.2.1 Water Users Association

(1) Initiatives and Constrains of Farmers' Organization

Mesqa WUAs are organized based on Law No. 213 of 1994, and their main activities are management of pumps, water distribution in mesqas, and cropping adjustment. On the other hand, legal framework of BCWUA is still under discussion and has not been approved yet. Although the direction of the Ministry is to promote irrigation management transfer to BCWUA, transfer has not been progressed yet, and activities of BCWUA are limited. The main activities of BCWUA are conflict management, problem solving, and water distribution management. Some of the BCWUAs negotiate with the government to change the schedule of the gate operation.

Although activities of BCWUA are limited, some BCWUAs implement some activities with collecting service fees from members. These BCWUAs got approval from MWRI, and some other BCWUAs are registered to the Ministry of Social Solidarity as a NGO in order to open a bank account. As mentioned in Chapter 2, the agricultural cooperative also involves in community activities.

These cases are still not common; yet, some villagers started garbage collection and maintenance of irrigation canals voluntarily with farmers' initiatives. These villages could be a model village for other

villagers and farmers. Also, study-visit will be a good opportunity to exchange information and experience among these villages.

(2) Lack of Communication Skills

Communication skill of staff members who are engaged in establishment of WUA is one of the important aspects depending on whether WUA becomes active or not. This is because if farmers do not understand the purpose of associations and activities properly, they do not continue their activities voluntarily. Also, if staffs who are engaged in establishment process are transferred to other areas, it could affect follow-up activities for farmers' organizations.

(3) Lack of Leader and Leadership

Also, leadership is a key for success to establish active WUA, especially having active leaders. For example, mesqa WUA in Nesher El Quaeema canal is one of the active WUAs established under IIIMP. The leader of this WUA paid salary to a guard and pump operator from his own money when the WUA was established. At the beginning, most members refused to pay money because they did not understand the benefit of these activities. However, members gradually understood the necessity of paying for a guard and pump operator and finally all the members agreed to pay. The leader showed his own willingness and effort to take initiative; as a result, his attitude had other members active as well.

In addition, the active BCWUA in Kafr El Sheikh Governorate has a meeting regularly, and some of their board members spend their own money to manage the BCWUA. If a leader takes an action and show strong leadership, other members will follow the leader. This process makes a farmers' group active. Therefore, a strong leader and leadership are key to organize active groups.

(4) Clarification of Major Activities and Constraints

Major problems of WUA include strong influential aspect on their activities. The main activities of WUAs are based on the priority of their needs. For example, if the condition of canals is very bad and there is not much that farmers can do, their activity will just request from the government and their attitude will be rather passive. By contrast, if the canal condition is not so bad, but they need small repairs or works on it. Probably, they will be able to work vulnerary rather than just requesting and demanding from the government because their problem is solvable by themselves.

The result of the Social Condition Survey (see Appendix) also shows that active BCWUAs have different situation between farmers in tail areas and farmers in upper areas, and their main activities are conflict management and problem solving. On the other hand, inactive BCWUAs are in relatively small canals compared to active BCWUAs and they do not have regular meetings and specific activities. In these BCWUAs, they do not have specific problems which need to be addressed and solved. Besides, IAS staff in Kafr El Sheikh mentioned that one of the reasons of inactive BCWUAs is small canals and they do not face water shortage or any other specific problems. Therefore, they do not need to be active as associations.

3.2.2 Farmers' Involvement in Environmental Conservation

In some areas, BCWUAs collect money for their specific activities. In these cases, BCWUAs have to register as a NGO or they get special permission from the Ministry. For example, Bahr Nemra BCWUA, which was established in 2006 under IIIMP, collects 30LE from each member to conduct cleaning operation for the canal. They also collect the money to buy garbage collection vehicle and operate garbage collection activities. In another case, a BCWUA collected money from members and bought a car for cleaning. They actually collect 2LE from each member to conduct garbage collection. These cases are still limited at branch level: yet, they could be models for other areas.

3.3 Interests of Development Partners regarding Sewerage System Improvement and Issues

As described in Chapter1, a lot of development partners have been implemented the installation of waste water treatment and rural sewerage facilities. This section summarizes the issues obtained from the experiences of other development partners.

3.3.1 Site Acquisition and Legal Regulation

DWMP supported by GIZ constructed rural sewerage facilities in seven (7) villages and ISSIP by World Bank is now working on the construction of rural sewerage facilities. Those who were involved in the construction work pointed out the difficulty in site acquisition. It is hard to acquire the land for facility construction, due to high population density in rural area in Egypt. In addition, in case of rural sewerage facility, which can cause odor problem, it is required to construct the facility 500m away from the hamlet in order to meet EIA. However, this requirement is very difficult to be satisfied in rural area in Egypt.

There are some measures to solve the problems with regard to site acquisition, e.g. to bury the facility under service road along the drain, or to use drain side slope, which is public land. Burying the facility under the service road will not interfere with function of service road. Furthermore, it would solve its odor problem, which leads to satisfy the EIA requirement.

Another legal issue is the ownership of facility. According to the current principle of HCWW, HCWW will not have ownership of small-scale rural sewerage facilities. Therefore, the rural sewerage facilities' ownership may be transferred to the local government organization or local unit. The organization to which facility ownership is transferred should be the organization with legal registration, and it cannot be the private organization. Hence, private organization in the village should be organized as CDA in order to get the qualification to legally own the facilities.

3.3.2 Trial of Rural Sewerage Facility

HCWW has been set the cluster approach in principle, i.e. it has been installed sewerage pipelines connecting the large-scale sewerage facilities to expand the site where sewerage can cover. ISSIP proposes 3 alternative approaches to the cluster approach, while it also takes an advantage of the cluster approach. First one is Decentralized System installing the rural sewerage facility independently in a village and the second one is to install septic tank for remote small hamlet. The Decentralized Systems are under implementation in 13 villages as a result of continuous and tenacious negotiation with HCWW. With regard to the rural sewerage facilities, most of them were just trials of facility installment by many donors. Through ISSIP implementation etc., HCWW has started to participate in the Decentralized System. There are following issues, e.g. facility scale, with the expansion of the rural sewerage facilities' installment.

The rural sewerage facilities with sand filtration system, constructed with the support from USAID, require a lot of manpower for its maintenance, resulting in the difficulty in maintenance activity by inhabitants around the facility. On the other hand, the simplified system supported by Netherland was easy to maintain but its treated water cannot meet the water quality standards. HCWW support with regard to rural sewerage facility is only up to the technical part. Hence, the role of local unit is seriously crucial in the operation and management of the facility. Therefore, it is required to design the facilities meeting the qualifications; e.g. to maintain treated water quality following water quality standard, to keep maintenance cost not high and to make operation work not complicated.

According to the social survey carried out by the Project Team, it was indicated that it would be possible to get consensus among the inhabitants as long as the payment to sewerage is under LE 10. It is required to design the facility which can be operated under the financial condition assumed based on

the willingness to pay of the inhabitants.

3.3.3 Operation and Maintenance of Facility

The following issues were obtained from the rural sewerage facility installed by DWMP implemented by GIZ. The sewerage facility constructed with support from GIZ is designed to make O&M minimal, or say maintenance free. It seems such specification may set a lower target for water quality improvement due to the technological limitation. It was observed that the O&M of the pump station has been well maintained, while the treatment function seems to rely heavily on self-purification. The evaluation report of GIZ indicates the translation of this situation, as saying that residents are satisfied as long as their surrounding environment is improved and indifferent in the quality of the final effluent.

Pump station for GIZ Mufty Site

Oxdiation pond (GIZ KoleeahSite)

On the other hand, the facility is designed as if “Maintenance Free”, but this may accelerate the deterioration of the facility. In general, it is not possible for facility to be entirely maintenance free. O&M is still required no matter how minimal it is. It might be paradoxical but too little burden could reduce the motivation of people for O&M, i.e. “Since it is too little, we do not have to take care.” Also the project side might calculate that people would volunteer as it is a little burden.

From this viewpoint, it could be said that a certain level of O&M burden would facilitate people to work for it. Facilities, which need regular O&M, will force to clarify the role and responsibility of people concerned and the neglect of O&M will cause defects. For this case, the cost of manpower for O&M should be taken into account. It needs to thoroughly exercise the collection of service fee and pay salary for the operators. It may be more risky for facility deterioration to depend on voluntary work because it is a tiny work.

3.4 Summary of the Issues: Problem Tree

The issues with drainage water reuse for irrigation regarding agricultural development in Kafr El Sheikh Governorate are summarized as follows. Kafr El Sheikh governorate is located in the most downstream reaches of Nile River, therefore, the Governorate is in disadvantage condition from the view point of irrigation water distribution. Furthermore, the Governorate is exposed to the salinity damage because it is near to the coast. Therefore, cultivation of paddy, which consumes large amount of water compared to other crop, occupies huge farmland in the Governorate, as the measure to prevent salinity damage. The rice production of the Governorate counts for 20% of the total national production. This situation induces the shortage of irrigation water at the peak period of irrigation water demand.

While the shortage of irrigation water has been mitigated by improvement of irrigation efficiency, as IIP proceeds, it is still necessary to supply additional water in order to address the issue of chronic water shortage. It is impossible to take ground water as alternative water resource due to salinity problem. Therefore, drainage water is the only alternative water resource. However, the waste water

treatment facility is not working sufficiently, particularly in rural areas, due to rapid population growth at 2.2 % annually. There are industrial cities such as Mahala Kobra and also big cities like Tanta with population of a million in the upstream reaches in Kafr El Sheikh Governorate. Those cities are a part of the causes of the deterioration of drainage water quality. The deterioration of drainage water makes usable drainage water reduced. The issues are summarized in Figure 3.4.1 and 3.4.2.

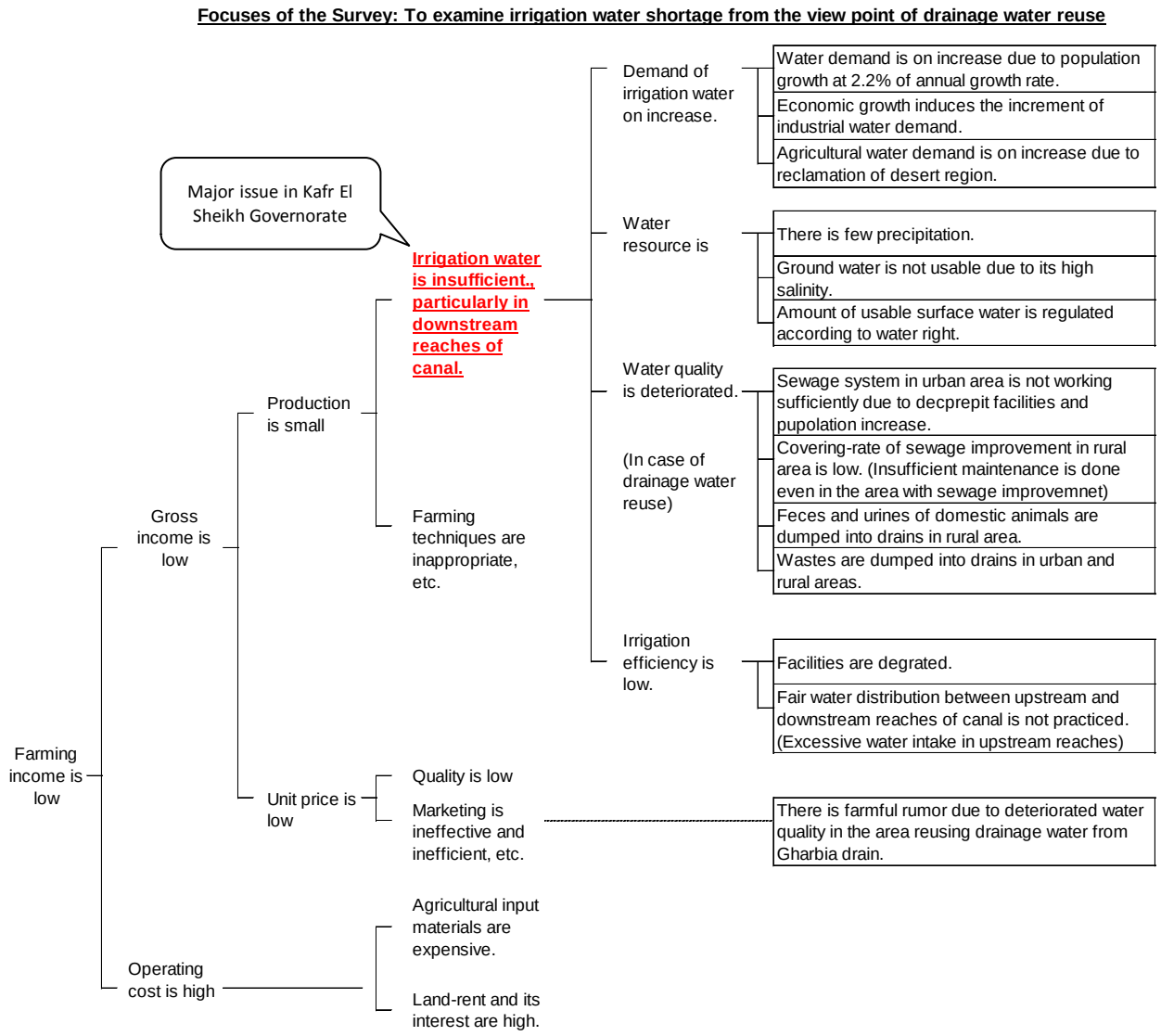


Figure 3.4.1 Problem tree summarized from the view point of drainage water reuse and agricultural development in Kafr El Sheikh Governorate

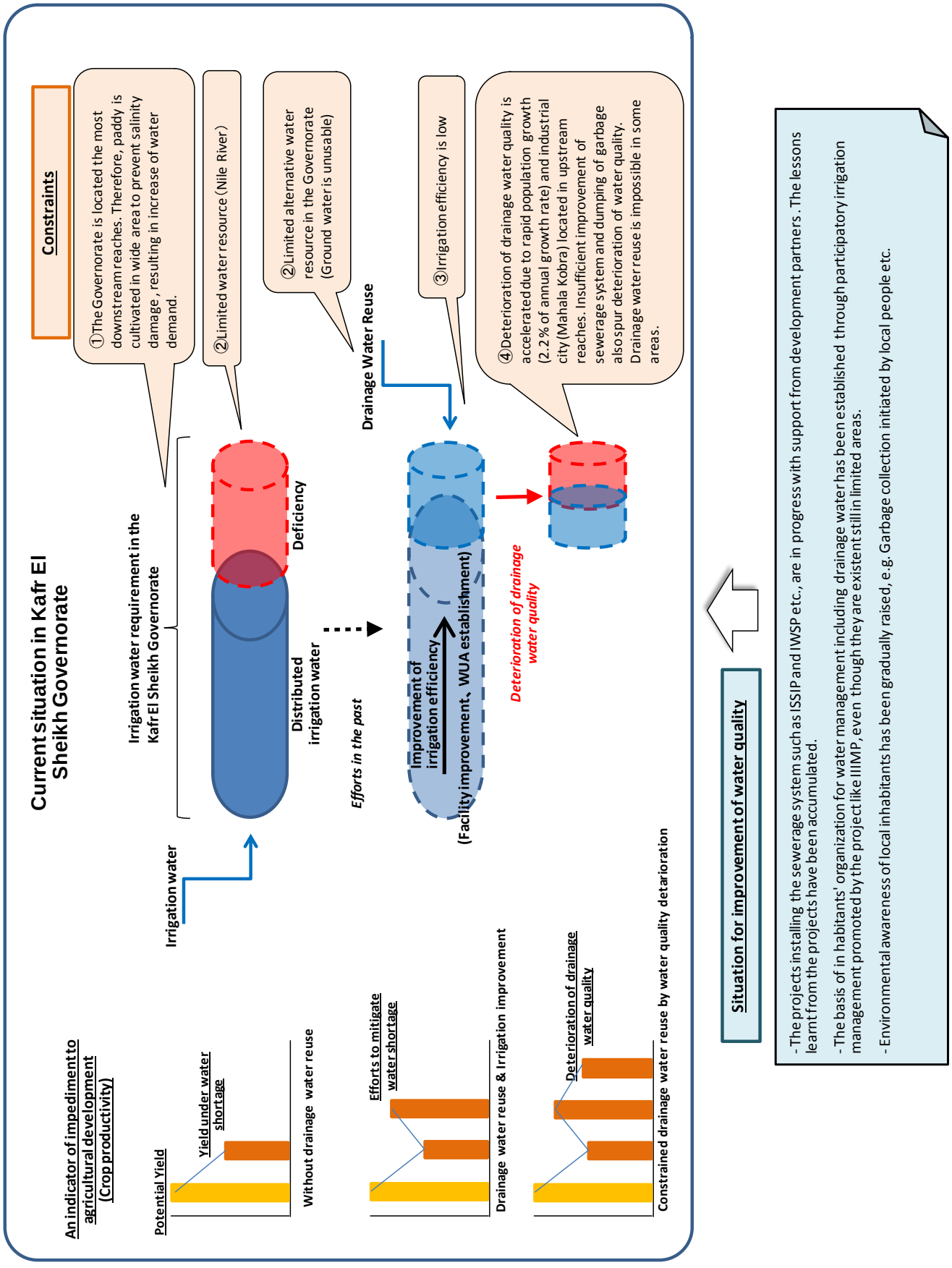


Figure 3.4.2 Constraints and Opportunities Related to Drainage Water Reuse in Kafr El Sheikh Governorate

Chapter 4 Drainage Water Reuse Plan

4.1 Objective and Formulating Process of Drainage Water Reuse Plan

4.1.1 Development Objective

The Ministry of Water Resources and Irrigation (MWRI) took the initiative to develop the National Water Resources Plan 2017 (NWRP 2017) as a countermeasure for the increasing water demand with the following strategies; 1) Development of new water resources using underground water, 2) Water saving of existing cultivated field, and 3) Reuse of drainage water. However, drainage water quality is generally deteriorated because of the contamination by untreated black water discharged from industry and households, animal feces / urine and dumping of waste materials and so on. Therefore, in order to accomplish the strategies above, it is required to establish the method for drainage water reuse keeping it at allowable level as agricultural irrigation water.

The project site is Kafr El Sheikh Governorate in the middle Nile delta. The project aims to formulate drainage water reuse plan and make it contribute to the agricultural development in the project site through supplementing irrigation water by drainage water reuse, while maintaining drainage water quality. The drainage water reuse plan formulated in the Project plans to propose the method of maintaining drainage water quality and reuse which can be applied to other sites in Nile delta under similar condition to that of the Project site.

4.1.2 Formulating Process of Drainage Water Reuse Plan

The previous chapter organizes the issues on drainage water reuse for irrigation in Kafr El Sheikh Governorate. Following that, the approaches were sorted corresponding to the issues above, examining the consistency with national policies. Then, the implementation strategy was formulated to make each approach practical and realizable. The draft plan of drainage water reuse plan was formulated consisting of the projects embodying the implementation strategy. Based on the draft plan of drainage water reuse plan, the pilot project was planned and implemented during phase 2 in the Project. The formulation process of drainage water reuse plan was examined based on the information and lessons obtained from the implementation process of pilot project. Then, the drainage water reuse plan was finalized through reflecting the outcomes and learnt lessons of the pilot project.

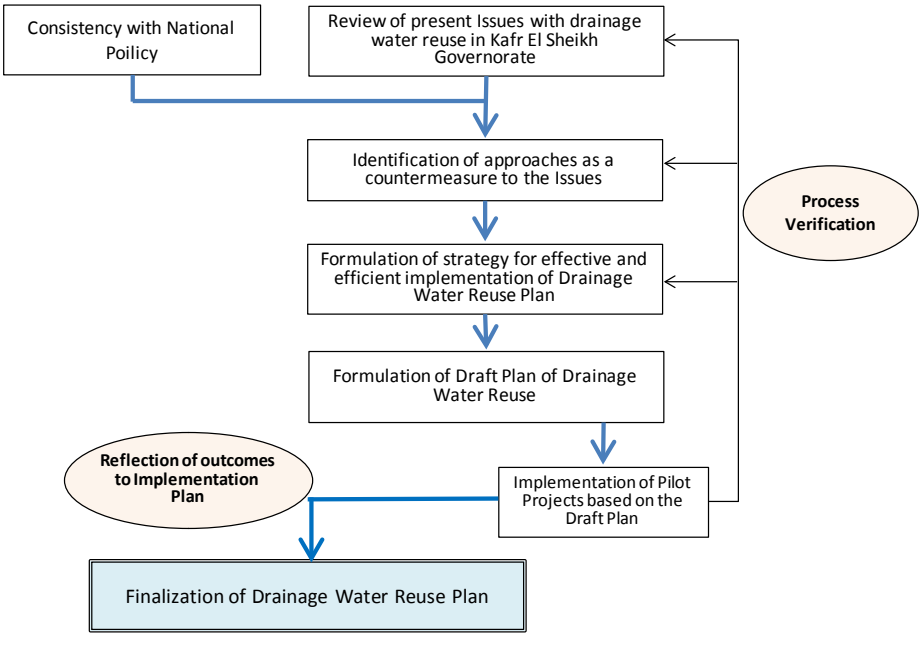


Figure 4.1.1 Formulation Process of Drainage Water Reuse Plan

4.2 Framework of Drainage Water Reuse Plan

In keeping with the issues on drainage water reuse in Kafr El Shekh Governorate and the consistency with national policies, the basic approaches of drainage water reuse plan (Master Plan) were organized and implementation strategy of the drainage water reuse plan was set up under its time frame. Based on the implementation strategy, the projects for drainage water reuse are to be proposed in the following section as short or mid-long term countermeasures.

4.2.1 Consistency with National Policies

MWRI together with relevant ministries have formulated the "National Water Resources Plan 2017 (NWRP)" with the objective of "To support the socio-economic development of Egypt on the basis of sustainable resource use (surface water and groundwater), while protecting and restoring the natural environment". The Plan predicts the future water demand as the challenge and defines the strategy for facing the challenge. The Strategy mainly addresses two approaches: "developing additional resources" and "making better use of existing resources". Reuse of drainage water falls under the latter approach. This Drainage Water Reuse Plan will be formulated based on the policy frame of the NWRP.

Augment of drainage water reuse is considered as one of the measures to accelerate effective use of existing resource. The basic strategies for the augment of drainage water reuse in NWRP are as follows; 1) "appropriate mixing drainage water in main drainage canal with irrigation water" and 2) "intermediate drainage water reuse". In addition, NWRP also guides the acceptable salinity level of water for irrigation after mixing considering the view of increasing demand for irrigation water, which will be up to 1,600 ppm. NWRP points out that increment of drainage water reuse also requires that pollution levels in the drainage water be controlled. The Drainage Water Reuse Plan will be formulated in line with NWRP approach.

(1) Large-scale Drainage Water Reuse from Main Drain

There are two levels of reuse: one is a large-scale reuse and another is intermediate reuse. NWRP describes the reuse of drainage water as reducing loss by mixing it with fresh canal water. NWRP further explains that the drainage water reuse already has been practiced at large-scale using water from main drains pumped into main canals. However, it has been recognized that the deteriorating water quality in the drains polluted from municipal and industrial sources threatened other water users located downstream of the mixing points. NWRP highlights that in the past a number of main drain reuse stations had to be closed for that reason.

Therefore, NWRP makes a point of necessity to mitigate pollution of drainage water and drainage water reuse from main drain under such water quality control is required. Table 4.2.1 and 4.2.2 show the drainage water reuse plans of delta region and Kafr El Sheikh Governorate described in NWRP. The upper-level plan is applied to the drainage water reuse plan in the Project. The volume of drainage water reuse from main drain in Kafr El Sheikh Governorate is planned to be maintained as same as that in 2007.

Table 4.2.1 Drainage Water Reuse Plan in Delta Region (NWRP)

Pump Stations	1997 MCM/yr	2007 MCM/yr	2017 MCM/yr
Eastern Delta	1,774	2,699	3,639
Middle Delta	808	2,659	3,159
Western Delta	637	1,070	1,670
Total	3,219	6,428	8,468

Table 4.2.2 Drainage Water Reuse Plan of Main Drain in Kafr El Sheikh Governorate (NWRP)

Pump Stations	From drain	To canal	1997:MCM/yr	2007:MCM/yr	2017:MCM/yr
East Menufeya P.S.	Menufi	Bahr El Abbasy	57	57	57
Mahallet Ruh P.S.	Upper Garbia	Meet Yazid	77	77	77
Hamoul P.S.	Garbia end	Tera, El Nil etc	390	390	390
Garbia outfall	Garbia end	Tera, El Nile etc	0	970	970
No.11 P.S.	No.11	El Nour + Abo Ismiel	0	178	178
Nashart drain	Nashart		0	236	236
Total			524	1,908	1,908

(2) Intermediate Drainage Water Reuse

NWRP suggests an alternative for the reuse of drainage water from larger drains, namely shifting the reuse to smaller less polluted drains in the upper part of the system. The alternative is called "intermediate reuse", which would pump drainage water to lower order irrigation canals where it does not have harmful impacts on downstream domestic water intakes. NWRP also cautions that the area where groundwater is vulnerable for pollution in the absence of a protecting clay cap should be taken into consideration.

4.2.2 Approaches as Countermeasures to the Issues in Kafr El Sheikh Governorate

The approaches are organized here, which are to address the issues such as a shortage of irrigation water in Kafr El Sheikh Governorate. The figure below shows the countermeasure approaches dealing with the issues. Increment of water demand is one of the causes resulting in a shortage of irrigation water. It is one of the possible approaches to suppress the water demand and the Government practices it by limiting paddy cultivation, which consumes much amount of irrigation water, and promoting sugar beet cultivation instead of sugar cane. To deal with the problem that water resources are limited ("there is no alternative water resource"), drainage water reuse can be one of approaches. With regard to drainage water reuse, deterioration of drainage water quality threatens the workability of drainage water reuse. Therefore, the improvement of drainage water quality is regarded as an important approach and countermeasures to decrease pollutant or to directly purify water within canals are considered to be practiced in both of urban and rural areas. To address the issue of inefficient irrigation, there are some approaches such as renovation of facilities and coordination of water allocation among farmers, which have been practiced through many projects like IIP.

Out of those approaches above, the Drainage Water Reuse plan has "Promotion of drainage water reuse" and "Improvement of drainage water quality" as its basic approaches. In the latter approach, "Improvement of drainage water quality", there are some specific activities planned to address the current issues. For example, "non-polluting" activity, concretely speaking, sewerage improvement in urban and rural areas or prevention of livestock waste or garbage disposal into drain. The activity for "Improvement of drainage water quality" also one of the specific contents planned. In addition, nitrogen remaining in drainage water can be utilized as supplemental nutrient to field crops under water quality control by preventing pollution due to livestock waste. It can be the adherent approach of the Plan, which can result in reduction of the cost for agricultural input.

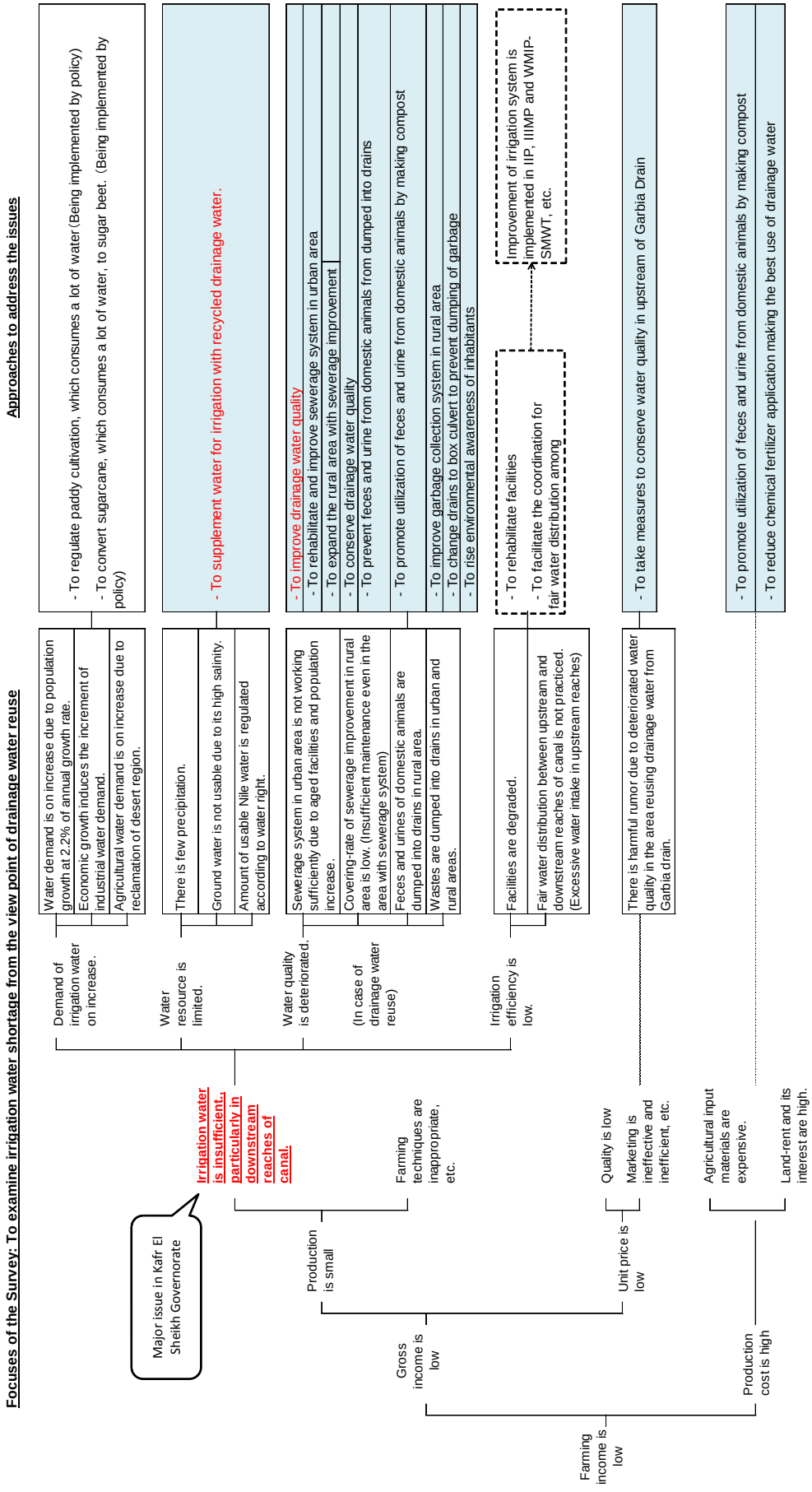


Figure 4.2.1 Countermeasure Approaches to the Issues

4.2.3 Strategies for Water Quality Conservation and Drainage Water Reuse for Irrigation

The following sections show the implementation strategies to facilitate effective operation of the countermeasure approaches to address the issues in Kafr El Sheikh Governorate.

(1) Implementation Combining Measures for Conservation on Water Quality and Drainage Water Reuse

The Drainage Water Reuse for irrigation is to be planned combining several measures at different points from upstream to downstream of water flow. The plan will consist of the countermeasures from Water Quality Control (preventive measures of water quality) → Water Treatment (treating contaminated water)→ Water Reuse (recycling drainage water). Non-polluting measure is the most effective to maintain water quality at the applicable level as irrigation use. That is, the measure taken at upstream to control water quality just after or nearby pollution source is the most effective and also low in cost. From this point of view, the measure for conservation on water quality should be considered to be important. Following that, quality improvement of drainage water quality coming from pollution source is worked out. Then, at the downstream point where drainage water comes after it is treated through the measures taken from upstream, the pump station to use the treated drainage water for irrigation is set up. The series of measures from the treatments at upstream to pump station set-up at downstream is the whole plan of drainage water reuse.

(2) Public Investment and Users' Organization

The proposed facilities are basically considered as public investment as they deal with public goods, namely water, and public interest. Then the uses of the facilities should be involved in its planning, operation and maintenance, as it should be significant for the users in their lives. The sustainable use of the facility would be insured when the users can feel its significance in their life. At the same time of public investment, capacity development of the users, i.e. farmers or residents in the target village should be an important component of the Plan for sustainable operation and management of the facilities. The policy of the facility development plan is therefore proposed as the one option where the beneficiaries can sustain the operation and maintenance, persistently considering economic efficiency and ability of inhabitants (beneficiaries).

(3) Water Quality Standard Setting for Drainage Water Reuse and Utilization of Water Quality Monitoring

When it comes to examine how to combine the drainage water reuse and the measures for conservation on water quality, water quality standards should be stipulated first and the corresponding countermeasures is organized according to the standards. The water quality for drainage water reuse should be adapted into the standards stipulated in Law No. 48. Article 64 in Law No.48 describes particularly the items with regard to human health and Article 62 gives the reference values of water quality for irrigation. The Drainage Water Reuse plan should comply with those stipulations. According to the legal regulation above, the following prerequisites were set for the selection of the sites where drainage water reuse is to be implemented.

Table 4.2.3 Set-up of Water Quality Standards for Drainage Water Reuse

Judgement	Water quality standard	Applicable condition
Unnecessary of treatment	Comply with Low No. 48.	Applicable without any treat
Necessary of treatment	EC≦4ds/m and no harmful heavy metals	Applicable after in-stream treatment and rural sewerage
Inappropriate for reuse	EC＞4ds/m, or contains harmful heavy metals	Inapplicable

1) Sites without necessity of water treatment

The sites with unnecessary of rural sewerage or in-stream treatment facilities is where water quality complies with all of the required water quality standards.

2) Sites which can be selected under water treatment

The water quality items such as SS, BOD and COD can be removed with inexpensive physical or biological treatment, e.g. sedimentation or screen, which is easy to maintain. The site is where only those water quality items exceed those reference values. In case of such sites, rural sewerage or in-stream treatment facilities composing the irrigation complex of the Project can be applicable.

3) Sites with difficulties

It is necessary to spend a large amount of money for construction and O&M of the treatment facility, if the costly water treatment is required. As a result, unit price of treated water should be high so that farming cannot be profitable. Such items of water quality which costly treatment is required to remove are heavy metals and salinity concentration.

Heavy metals can cause adverse effects on human health through the crops grown at the field where heavy metals have been accumulated. Expensive chemical treatment is necessary to remove heavy metals. The membrane and electric treatment, which are required to decrease salinity concentration, is costly so that unit price of water becomes expensive. Tide gate to prevent salinity intrusion is effective to decrease salinity concentration. However, it would take long time to decrease salinity concentration in the areas where soil contains accumulated salinity.

Water quality conditions should be checked in each target site. The water quality monitoring data which MWRI regularly collects can be utilized for the check. The implementation strategies include the measures that facilitate the efficient and effective implementation of the countermeasure, such as utilization of existing monitoring data to prioritize candidate sites.

(4) Effective Use of Drainage Water for Farming

The deterioration of drainage water quality is current issue. However, conversely it would be possible to utilize good points of drainage water reuse. Drainage water contains nitrogen, which is essential for crop growth. In other words, drainage water can provide complementary nitrogen supply to field. Therefore, it would lead to improvement of farming reducing chemical fertilizer input. In its practical application, the measures of water quality conservation are required to maintain BOD or DO at allowable level, while to keep usable nitrogen left in the drainage water.

4.2.4 Implementation Method and Proposed Projects

The projects and those implementation methods are proposed according to the implementation strategy of the Plan, i.e. “Combination of countermeasures”, and two concepts described in the national policies, i.e. “Intermediate drainage water reuse” and “Large-scale drainage water reuse”. “Measures for conservation on water quality and drainage water reuse at branch canal level” is proposed as the implementation method corresponding to “Intermediate drainage water reuse”. Whereas, “Formulation of the project covering from upstream to downstream of main canal” is proposed corresponding to “Large-scale drainage water reuse”. The projects are proposed according to those categories. The former is called “Irrigation Complex” and the latter is called “Wide-area application project”, and the details are described in the following section. Furthermore, projects to strengthen the utilization of water quality monitoring system and to promote crop cultivation improvement with drainage water reuse are proposed as “technology development and foundation making” for promoting drainage water reuse.

Table 4.2.4 Proposed Projects in accordance to Implementation Strategy and National Policy

Implementation Strategy	National Policy	Implementation method	Project
Combination of measures for conservation on water quality and drainage water reuse facility Combination of public investment and users' organization	Intermediate drainage water reuse	Countermeasures at branch canal level (Irrigation Complex)	Establishment of Irrigation Complex (Rural sewerage facility, In-stream treatment facility, drainage water reuse pump, composting facility, local unit organization and environmental campaign)
	Large-scale drainage water reuse	Wide-area application Project	Water quality conservation of Garbia main drain, installation of large-scale reuse pump stations, and covering drains by box culvert
Water quality monitoring and effective use of drainage water	Intermediate / large-scale drainage water reuse	Technology development and foundation making to promote drainage water reuse	utilization of water quality monitoring and improvement of agricultural techniques using drainage water

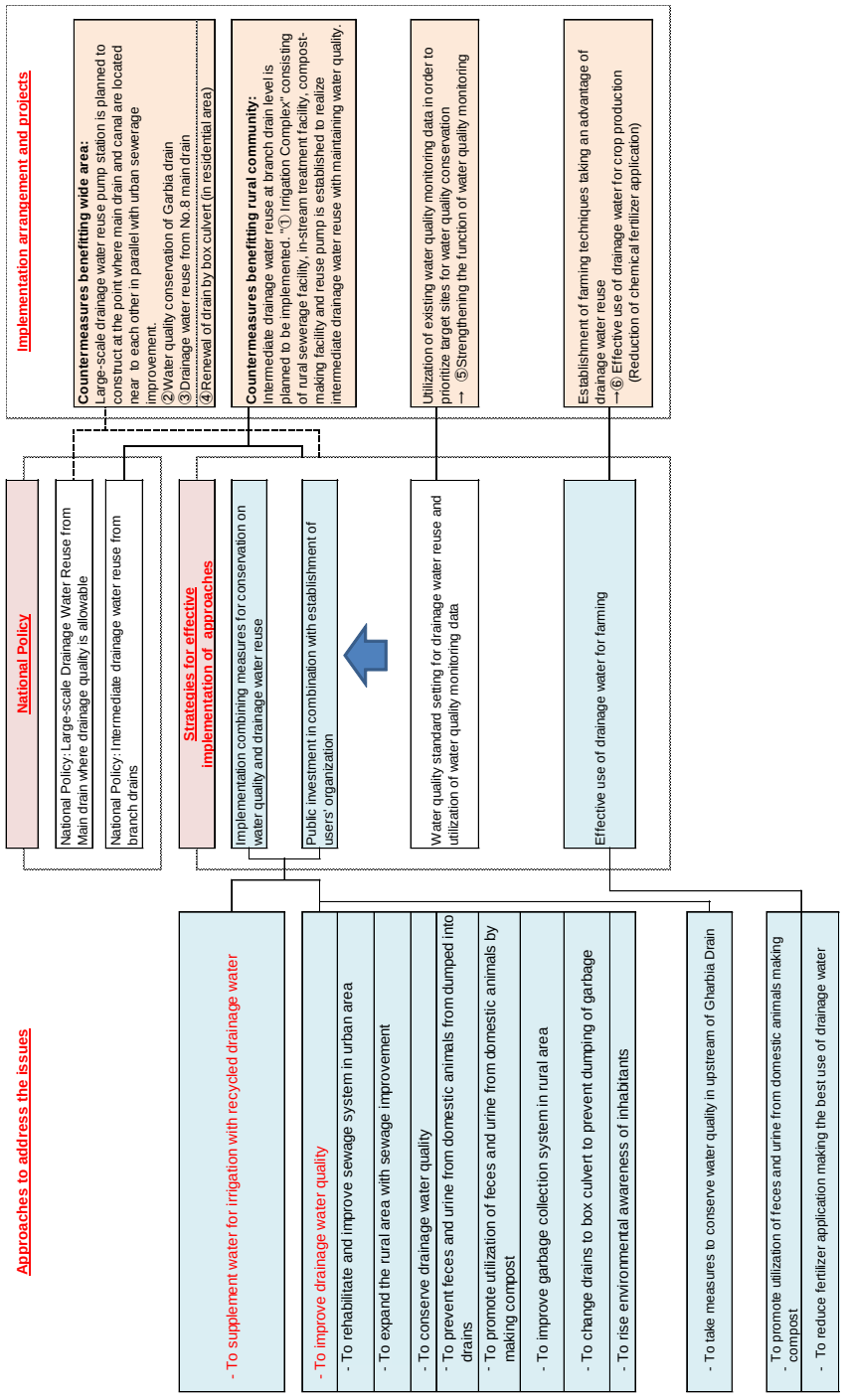


Figure 4.2.2 Drainage Water Reuse Plan according to Implementation Strategies and National Policy

4.3 Implementation arrangement of the Drainage Water Reuse Plan

The Drain Water Reuse Plan proposes the implementation of the project consisting of several facilities, namely "Establishment of Irrigation Complex", as the measures for the conservation of drain water quality and for the promotion of drainage water reuse in rural area. Furthermore, the Plan also proposes the project targeting wide area from downstream to upstream, namely "Wide-area project". Those two categories of the projects proposed here compose the Drain Water Reuse Plan.

4.3.1 Package of Water Quality Conservation and Drainage Water Reuse: Irrigation Complex

Raising the awareness of local people is important to promote water quality conservation. One of the strategies for this is to make physical distance between the people who discharge wastewater and who use that water closer. In this strategy people will realize that their position can easily change one another, from discharge to reuse, which produces peer-to-peer pressure with each other. In other words, they will be able to have a strong sense of unity in the same water environment area. To begin with formulating a complex, one area sharing the same water environment is identified as a water environment unit, and a package of activities in the unit is planned.

Considering the water environment unit, causes of water pollution in the drainage canal are categorized into two: 1) direct causes from the area (e.g. direct sewage inflow, seeping from animal waste and direct disposal of animal waste), and 2) indirect causes from outside of the area (e.g. industrial waste water from upstream and agricultural drain with fertilizers and chemicals). Regarding the direct causes, it is possible to remove these causes effectively in closed areas because those are delivered from point, and these are important for water quality improvement. It seems reasonable to suggest construction and installment of facilities such as rural sewerage facilities and agricultural waste treatment facilities.

On the other hand, it is difficult to identify specific areas of indirect causes. Hence, it appears to be effective if water quality in the whole drainage canal is improved (e.g. installment of direct water purification system in drainage canal). Also, it is possible to formulate a reuse system of local resource by combining drainage water reuse facilities which promote improved drainage water usage. Environmental awareness activities are also included in this package so that each activity is connected organically as a water environmental improvement package.

This package is applied for other governorates as "Complex of Water Quality Improvement and Drainage Water Reuse (Irrigation Complex)". One unit is identified by the territory of a local unit and branch canal system and contiguity of residents are also considered so that local government unit at village level can be involved to the unit.

4.3.2 Project Targeting Wide Area: Wide-area Application Project

The countermeasures within the limited area, namely the same water environment area are considered as described above, whereas, it is also necessary to target wide areas (riverine system at main canal level). In wide areas, people are dispersed far from each other in the upstream to downstream reaches. The distance between people who discharge wastewater and people who reuse that drainage water is huge. Therefore, it is necessary to consider water quality conservation in the upstream reaches of the canals for the sake of people living in the downstream reaches. Large-scale investments are necessary for this kind of countermeasure because of the wide scale target area. Also the size of the cities in the upstream reaches should be taken into consideration. Wide-area application project would have to include the construction and rehabilitation of the facilities (e.g. large-scale municipal sewerage plant and large-scale pump station for drainage water reuse settled in main drainage canal) benefitting wide area from upstream to downstream.

4.3.3 Implementation of Irrigation Complex and Wide-area Application Project

The project implementation is planned following the categories, i.e. "Establishment of Irrigation Complex" and "Wide-area application project". In the Irrigation Complex, the drainage water pumped up from drain is mixed with fresh water at tail or middle point of irrigation canal within command area of branch irrigation canal. Measures for drainage water quality improvement are also implemented by installing rural sewerage facility or in-stream treatment facility in drain. Irrigation Complex is planned to be established at the point where irrigation canal and drain are located near to each other, in other words, the project is targeting tight area. Therefore, increment in number of the Irrigation Complex leads to the expansion of the Irrigation Complex to broader area.

"Wide-area application project" will be implemented after clarifying which sites and components should be prioritized. The project regarding agricultural techniques will be extended basically along with the expansion of the Irrigation Complex establishment, and it should be a part of Wide-area application project because it would be disseminated using experimental results. Although the project regarding agricultural techniques is planned to be extended in parallel with the expansion of the Irrigation Complex, its responsible organization will not be only MWRI but also MALR, therefore, it was not incorporated into the Irrigation Complex.

Table 4.3.1 Categories of the Drainage Water Reuse Plan

Category	Contents
Irrigation Complex	It is implemented within tight area in branch canal command area. The facilities will be installed within a block around the point where irrigation canal and drain are located near to each other. It is expanded to wide area by increasing the number of the Irrigation complex.
Wide-area application project	It is the project benefiting the wide area mainly by the construction or rehabilitation of large-scale facilities.

The Irrigation Complex can be established with some or all of the components according to the circumstances in the target site. Each component of Wide-area project can be implemented individually.

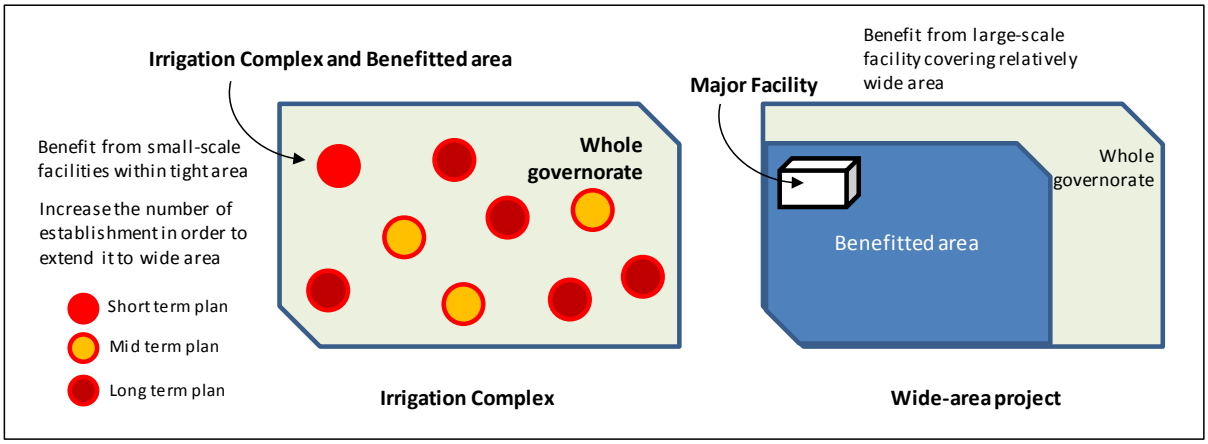


Figure 4.3.1 Basic Concept of "Irrigation Complex" and "Wide-area Application Project"

4.3.4 Time Frame of the Drainage Water Reuse Plan

The timeframe of the Drainage Water Reuse Plan is set in the short term (1-3 years after the completion of this project), the mid-term (3-5 years) and the long term (5-10 years). The key of the short term plan is to create a package of activities for water conservation and drainage water reuse in a branch canal level, namely "Irrigation Complex" based on the result of the Pilot Project implementation in the process of the master plan formulation. Also in the short-term plan, the basis of the extension of the package from the pilot to all over the governorate will be made. First step is to

assess the candidate sites identified in the Plan and second step is to carry out feasibility study for those sites, followed by the conclusive identification of the target sites for the project implementation including prioritization of those sites.

Irrigation Complex would include a reuse pump, in-stream treatment facility, rural sewerage system and compost making facility, etc. Since it should be difficult for farmer beneficiaries alone to establish these facilities, public investment in such facilities will be required, but with the participation of the farmer beneficiaries for operation and management for the sustainable use of the facilities. From the sustainability point of view, the activities of strengthening water users' association and environmental awareness creation are incorporated in establishing the Irrigation Complex.

In the mid and long term plan, it is planned to expand the package to other governorates based on the results of feasibility study above. Wide-area project is implemented targeting wider riverine system in parallel, which would require relatively large-scale investment. It appears to be possible to involve the components without facility construction (e.g. environmental education activity) to maximize the effectiveness and efficiency of the investment. The mid and long term plan is planned to incorporate expansion of the package in a branched water area and wide-area projects.

As described above, the components (the projects) of the Drainage Water Reuse Plan are categorized into Irrigation Complex (No.1 in the table below), wide-area application projects (No.2 to 4) and promotion and foundation making projects (No. 5 and 6). Table 4.3.2 and Figure 4.3.2 show these projects in classification from the upstream-downstream point of view, namely the "Water quality control", "Water treatment" and "water reuse".

With regard to Irrigation Complex, its implementation from possible components should start from short-term at the same time of conducting F/S. Then the Irrigation Complex will be implemented in the number of sites based on the result of F/S in mid and long-term. Regarding wide-area application projects, which require relatively large-scale investment, the feasibility study is implemented in short term then the project implementation is commenced in mid to long term. The table below shows the countermeasures categorized into short and mid-long terms of each project.

Table 4.3.2 Components for Drainage Water Reuse and Countermeasures in Short and Mid to Long Term

No.	Project	Short term	Mid to long term
1	Establishment of Irrigation Complex	Implementation of F/S and implementation in priority sites.	Extension to other governorates
2	Water quality conservation in Garbia drain	Implementation of F/S	Facility construction
3	Construction of drainage water reuse pump station	Implementation of F/S	Facility construction
4	Change drain to box culvert	Facility construction based on the requirement from the government	Facility construction based on the requirement from the government
5	Utilization of water quality monitoring	Review and improvement of existing system	Activity continuation, M&E
6	Agricultural techniques utilizing drainage water	Baseline investigation and field experiment	Establishment of the technique and its dissemination

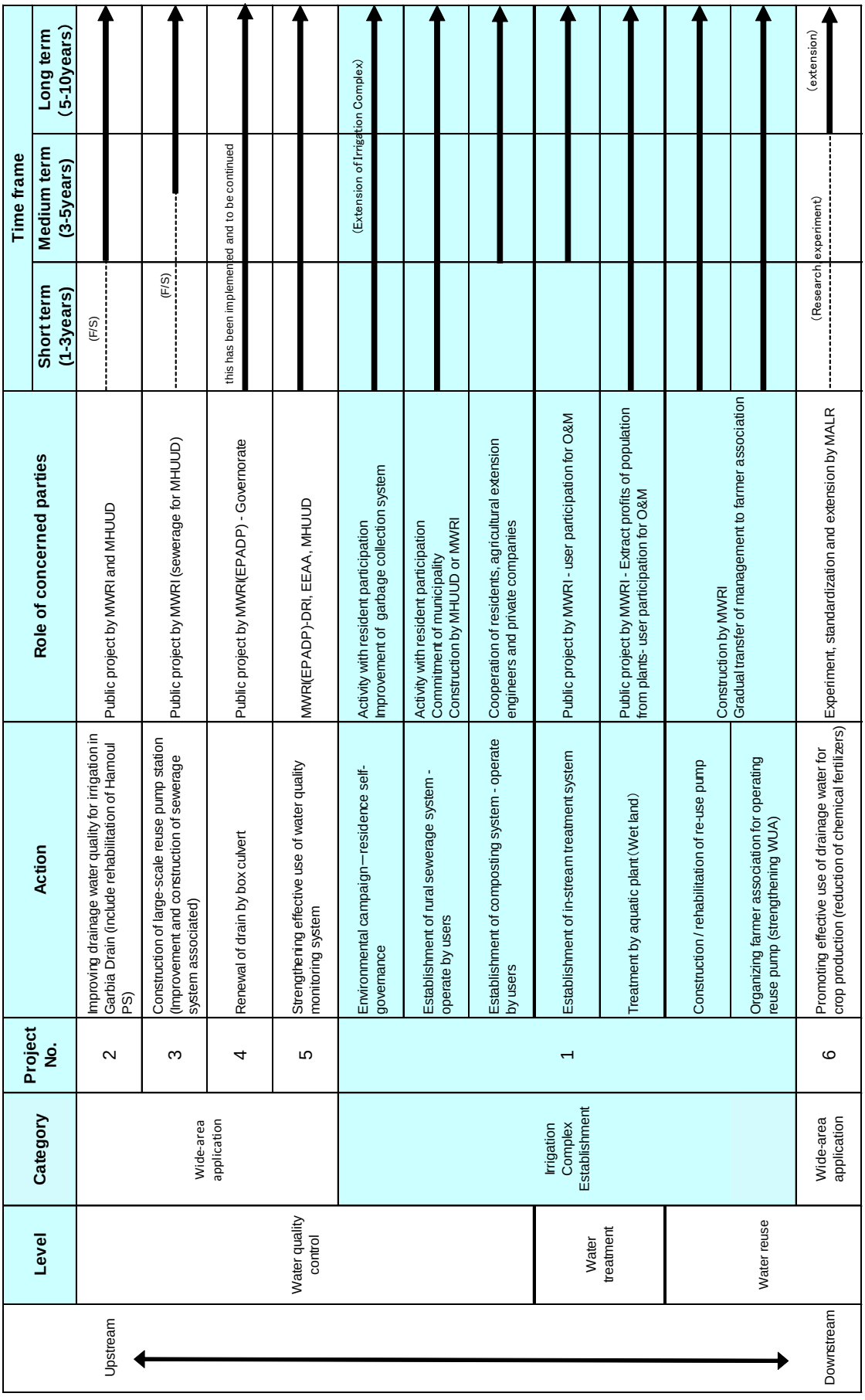


Figure 4.3.2 Components and Time Frame of Drainage Water Reuse Plan

4.4 Verification through Pilot Project

In the Drainage Water Reuse Plan, the draft plan was firstly formulated based on the field survey, and then the Pilot Project was implemented following the draft plan. The Drainage Water Reuse Plan was finalized after the learnt lessons from the Pilot Project were reflected to the Plan. This section marshals the implementation process, outcome and lessons of the Pilot Project, which were reflected to the Plan.

4.4.1 Implementation Process of Pilot Project

23 candidate sites were proposed by Irrigation and drainage departments in Kafr El Sheikh Governorate during phase 1, and field survey was conducted in those sites. Then, 5 sites shown in the table below were conclusively selected for the pilot project implementation based on the evaluation with the criteria such as “if there is a shortage of irrigation water”, “if the water quality of drainage is at applicable level to irrigation”, “if the water quantity of drainage water is enough during irrigation period”, and “if the local inhabitants are willing to reuse drainage water”. The detailed implementation process is described in Appendix J. The project components implemented in each site are shown in the table below.

Table 4.4.1 Implemented Project Components in the Pilot Project Sites

Code	Drain	Irrigation Canal	Component
Kafr El Sheikh East			
E-1	Farsh Al Ganaen	Marsa Al Gamal	Reuse pump (1.0m^3/s), Strengthening WUA, Environmental Campaign
E-4	Mekhazan	Mekhazan	Reuse pump (0.5m^3/s), Strengthening WUA, Environmental Campaign
Kafr El Sheikh West			
W-2	No. 11	Kbreet	Reuse pump (1.0m^3/s), Strengthening WUA, Environmental Campaign
W-4	Faranon	El Karadwah	Reuse pump (0.5m^3/s), Strengthening WUA, Environmental Campaign
W-5	Sandela	El Moheet El Gharby	Reuse pump (1.0m^3/s), Rural Sewerage system (500 people), In-stream system, Compost yard, Strengthening WUA, Environmental Campaign

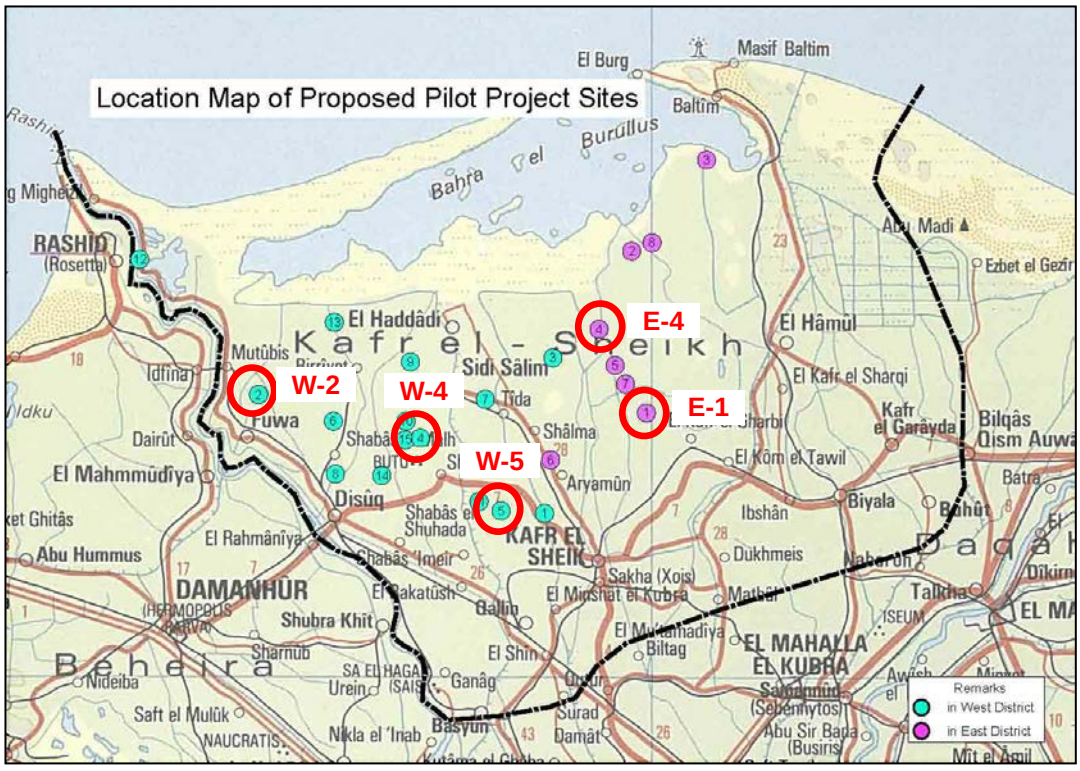


Figure 4.4.1 Location Map of the Pilot Project Sites

The Pilot Projects were implemented basically as “Irrigation Complex”. All of the facilities to form “Irrigation Complex” were established in W5, whereas, only drainage water reuse pump was installed in other 4 sites. Establishment of WUA working for O&M activities of pump and environmental education activities through the implementation of environment campaign were implemented in all of 5 sites. The components of “Irrigation Complex” are explained in detail in 4.5.1.

4.4.2 Results of Pilot Project

The effect verified through the operation of the water treatment facilities established in the Pilot Project. The water treatment facilities were in-stream and rural sewerage treatment facilities set in W5.

The in-stream treatment facility is constructed as a part of the irrigation complex facilities to improve water quality by direct treatment in the drain. Effectiveness of in-stream treatment is expected to reduce organic matter and nutrients load, as well as increasing dissolved oxygen, in the drain. As actual improvement rate figures of water quality items on average, dissolved oxygen (DO) was increased 0.50 mg/l, Chemical Oxygen Demand (COD) removal ratio was confirmed as 37%, Total Nitrogen (T-N) removal ratio was confirmed as 11%, Total Phosphorous (T-P) removal ratio was confirmed as 45%.

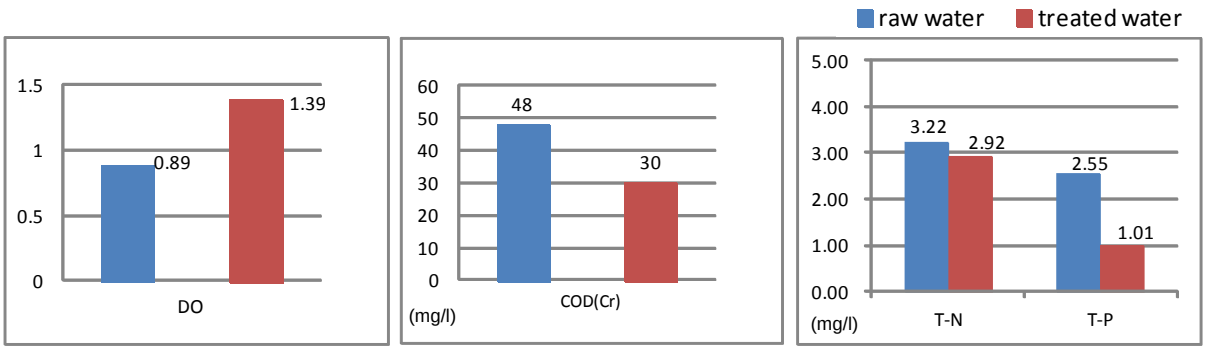


Figure 4.4.2 Comparison of Water Quality before/after the Treatment (In-stream treatment facility)

The rural sewerage treatment facility gathers domestic waste water from the village beside drain to purify it and releases treated water into drain. The rural sewerage treatment facility is one of the countermeasures for water pollution of the drain, and to prevent the deterioration of drain water quality. Accordingly, proper sewerage treatment by the facility contributes to drain water quality improvement.

Figure 4.4.3 shows the treatment effect observed at the rural sewerage facility in W5. The raw water is sewage water comes from Hamseen village in W5. COD and BOD removal ratios were confirmed as high as 85 % and 99 %, respectively in comparison between raw water and treated water quality. Besides, COD and BOD values of treated water quality were low (COD: 60 mg/l, BOD: 5mg/l respectively), which indicates treatment was well done.

In terms of the nitrogen and phosphorus compounds, removal ratios of total nitrogen (T-N) and total phosphorus (T-P) were confirmed 14% and 43&, respectively. In addition, total coliforms and fecal coliforms were also properly treated and those numbers were reduced to less than 100 MPN/ml. Although DO value was slightly out of the range of the drainage water quality standard, other water quality items (e.g. COD, BOD, total coliforms and fecal coliforms) fully complied with the drainage water quality standards, which indicates treated water has fairly good quality.

Although the scale of rural sewerage treatment facility constructed by the Pilot Project was as small as 30 m^3/day, future dissemination to other villages along the drain, and increasing the number of rural sewerage treatment facilities, will be effective for water quality improvement of the entire drain.

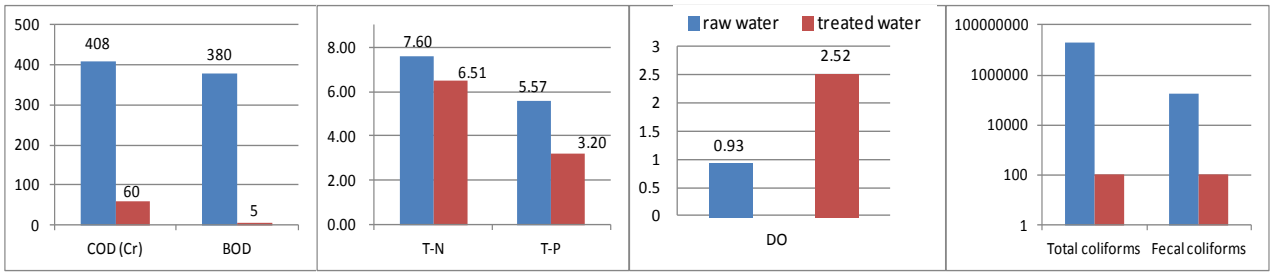


Figure 4.4.3 Comparison of Water Quality before/after the Treatment (Rural sewerage facility)

There is no direct governmental organization which is in charge of environmental conservation regarding open drainage. Therefore, the Project Team and EPADP organized a workshop at Kafr El Sheikh Directorate to discuss the matter involving various sectors. This workshop resulted in DAS (drainage department) and GDIAS (irrigation department) staff's participation in the Environmental Campaign playing major role in the activity. DAS has been working on enlightening activities for the users of culvert drain, whereas, GDIAS has been working targeting WUA in irrigation sector. Both of those organizations have been usually working with farmers, therefore, it is expected for those organizations to play an important role in the environmental education activities involving local inhabitants. In fact, the Environmental Campaign was carried out in corporation with DAS and GDIAS in the Pilot Project and the environmental education activity was regarded as a part of those organizations works.

When it comes to the implementation of the environmental education activity in the Pilot Project, the Project asked for other relevant agencies' cooperation for the environmental awareness sessions, not only MWRI, namely, The Ministry of Education, The Ministry of Youth and Sports, The Ministry of Awqaf (Religious Affairs). Every agency of them expressed high level of interest and understanding and very cooperative, which enabled the implementation of the Environmental Campaign, environmental enlightening speech by Imams (Mosque leaders), clean-up activity along the canal. The Project implementation seemed to have contributed the awareness-raising of staffs' in those concerned agencies. It is expected that DAS and GDIAS lead the cooperation among the relevant agencies.

4.4.3 Lessons learnt from the Implementation of Pilot Project

(1) Lessons on the Implementation Arrangement

The Drainage Water Reuse Plan will be implemented based on the plan reflecting the lessons learnt from the implementation of the Pilot Project. The Pilot project was implemented under the implementation regime in cooperation with various stakeholders at the Governorate and village levels, which was arranged based on the agreement among the authorities concerned at central level. Some relevant organizations newly joined the Pilot Project at the Governorate and village levels. For instance, the Ministry of Education at Governorate level arranged a series of environmental campaigns at the schools with sincere cooperation. IAS (Irrigation Advisory Service) and Drainage Advisory Service (DAS) are not included in the direct C/P organizations of the Project, however, the official personnel of the organizations participated in the environmental campaigns.

Various stakeholders, not only EPADP, would be involved to the implementation of the Drainage Water Reuse Plan. Hence, the coordination with those stakeholders would be essential. The followings show the major lessons learnt from the Pilot Project, and those lessons will be basis of the implementation plan.

- Central level: Consensus formation on implementation plan and regime in JSC at central level and periodical progress reports are necessary to facilitate smooth instruction and handling from

central organization to cope with issues on the ground.

- Governorate level: In case of facility construction related to several governmental jurisdictions, it is crucial to conclude a protocol among the authorities concerned, especially at the government level. The protocol clarifies where the responsibility lies, which leads to the awareness of responsibility raised among the authorities concerned. In this coordination process, the role of the governorate is important, especially the role of Secretary of General is important as a coordinator.
- Village level: When new resident organization is planned to be established for facility maintenance, it is effective to cooperate with the experienced local organization such as existing local NGOs not only with the local unit, which is a terminal governmental organization. For example, existing local organizations might be able to support a new resident organization through sharing their experience of organization management such as how to make an activity plan and manage a bank account. Also, existing local organizations are expected to cooperate with a new resident organization providing physical materials such as T-shirts and cleaning tools for environmental campaigns. In environmental education activity, it would be necessary to ask for the cooperation of the stakeholders deeply rooted in the site, e.g. Imams or elementary schools in the village. Therefore, it is essential to organize the explanatory workshop to the local stakeholders including existing organizations such as local NGOs at initial stage of the facility construction plan.
- The concept of the Irrigation Complex is new to most of the stakeholder. Therefore, in-depth explanation targeting both governmental staff and the people is necessary. Stakeholder meeting should be held in cooperation with local government at early stage to facilitate the understanding of the project concept shared promptly among the stakeholders.
- The farmers in downstream reaches are accustomed to manage their farmland under limited available irrigation water, compared to those in upstream reaches. This circumstance may induce the farmers in downstream reaches to be blind to insufficient amount of irrigation water application For the improvement of agricultural productivity in downstream reaches, it is necessary to raise the farmers' awareness regarding appropriate irrigating way (proper amount / timing) in parallel with the installation of drainage water reuse pump.

(2) Lessons on Designing and Construction Works

Construction works of the pilot project were done by the local contractor based on Japanese facility design. As the result, the period of actual construction works needed longer time than planned one because of various aspects. Lesson learned on the designing and construction works which project team experienced from pilot project is shown as follows;

- The facilities should be constructed in public land as much as possible because land acquisition of private land is difficult. Under the pilot project, the problem of land acquisition was avoided by constructing the reuse pump facilities on irrigation canal, constructing the rural sewerage treatment facility under the administration road of drainage canal and constructing the in-stream treatment facility in drainage canal.
- Design of the facilities should adapt local technical level as much as possible. Appearance of the structure should also adapt other facilities in Egypt. Progressing of technical level from the existing is important. However, adapting design to existing technical level is required so as to introduce a new system easily and to ensure the continuity of operation.
- Capacity of the facilities should be decided carefully for avoiding excess scale. Sufficient discussion is necessary among stakeholders. As its characteristic of pilot project, planned design

year should be set up considering several years.

- Construction period should be set sufficiently taking into account the process of design modification and inspection / handover. Generally, contractors consider material procurement, worker procurement, fund procurement, etc. in each construction process and accordingly adjust of construction schedule comes up frequently. Besides, concerning authority's approval also tends to take a long time. Therefore, it is necessary to allow the certain days for these procedure
- Construction management generally consists of the schedule management, the work process management, the cost management and the safety management. In case of local contractor's work, it would be important to allocate the construct supervisor for managing local contractor's work, based on the capacity of local contractor.
- In the handing over process of the facilities after completion of the construction work, additional work and betterments are supposed to be requested after the joint inspection among concerned parties. Affordability of construction schedule and cost including this process is required.

4.5 Projects Composing the Drainage Water Reuse Plan

4.5.1 Project 1: Establishment of Irrigation Complex

(1) Components to Form Irrigation Complex

The Irrigation Complex can be established with either some or all of the components. How to incorporate the components depends on the situation of the target site. Each component to form the Irrigation Complex is described below.

1) Rural Sewerage System

Promoting the rural sewerage system is to maintain the drainage water quality. The fact that the sewerage accounts for 40% of all pollution, rural sewerage plays a vital role in water quality conservation. The rural sewerage system is planned to improve the water quality of drainage canals discharging from domestic wastewater of the village considering easy operation and maintenance, economical efficiency, good water quality, and so on. The scale of the rural sewerage system is to cover around 500 to 1,000 people per unit.

In case the target number is under 500 persons, simple way of treatment such as a septic tank can be applied tentatively and prioritized other sewerage project because its sewerage volume is small and does not significantly affect to drain pollution. In case the target number is more the 1,000 persons, th MHUUD and HCWW should undertake the project in planned manner. Accordingly, the target number of irrigation complex – rural sewerage treatment facility is set between 500 persons and 1,000 persons.

2) In-stream Treatment

The in-stream treatment facility is planned inside the drainage canal to improve DO and COD value of drainage water quality. The facility could enlighten the inhabitants by showcasing a model of water quality improvement facility in Egypt. The facility consists of sedimentation zone, vegetation zone, transition zone and aerating zone with plastic contact media.

3) Agricultural / Livestock Disposal / Compost Facility

Generally in the village, domestic animal waste and crop residues such as rice straw left in the open air beside the canal fall into canals directly, which result in water pollution. The compost facility is planned to prevent animal feces and urine, and crop residues from being dumped into the drain and also to prevent the materials coming from those waste infiltrating to underground. The compost produced in the facility can be utilized as a fertilizer.

4) Drainage Water Reuse Pump

The drainage water reuse pump is at a subsequent place of the treatment facilities. The layout of the drainage water reuse pump station is the same as the one that has been constructed in Egypt. Installation of reuse pump is to promote drainage water reuse with improved water quality.

5) Establishment of Users' organization

Through the operation and maintenance of the facilities described above, the establishment and strengthening capacity of users' organization will be carried out. The Government basically has the ownership of facilities. It is because the facilities will be constructed within public land. Furthermore, the Government may not be able to support facility repairing and rehabilitation if the facilities are owned by inhabitants. Drainage water reuse pump and in-stream treatment facility are owned by MWRI, whereas, rural sewerage facility and composting facility are owned by local unit. The users' organization is planned to participate in operation and maintenance activities of those facilities. Therefore, users' organization will be newly established in the site having no existing organization, and in the sites having existing organization, its function will be strengthened. The ownership and form of users' organization of each facility is shown in the table below.

Table 4.5.1 Ownership and Users' Organization of Each Facility

Facility	Ownership	Users' organization working on facility O&M
Rural sewerage facility	Local unit	Existing or newly established CDA in the beneficiary village
Treatment of agricultural and livestock waste / Composting facility	Local unit	
In-stream treatment facility	MWRI (Drainage department)	Drainage water reuse pump committee (Its form will be slightly different depending on whether there is existing WUA)
Drainage water reuse pump	MWRI （Irrigation department）	

CDA in the village will basically participate in the O&M activities of rural sewerage and compost-making facilities. In the village having no existing CDA, new CDA establishment by inhabitants following NGO law is required. With regard to drainage water reuse, strengthening function of WUA is crucial because the farmers in the site will be direct beneficiaries. Particularly, the role of BCWUA, which organizes branch drains where drainage water reuse pumps are to be installed, would be very important. In fact, MWRI mentions the importance of WUA in NWRP, and describes its principle to transfer facility maintenance, which has been practiced by the Government, to WUA in future. MWRI is now taking the concrete measures following the principle, through IIP such as IIIMP (WB) and SWMT (JICA) with supports from development partners. It is ideal that BCWUA, in the future, can take responsibilities on O&M of the facilities for drainage water reuse.

As described above, the drainage water reuse pump committee is established on the assumption that BCWUAs will be established for all of branch canals, and will be in charge of entire water management including drainage water reuse in the future. However, the circumstances of the sites vary currently, and there are the sites not having BCWUA and the sites only with WUA at Mesqa level. Hence, the approach for each condition of establishment and function strengthening of users' organization is summarized in the table below.

Table 4.5.2 Basic Approaches of Establishment & Strengthening of Drainage Water Reuse Pump Committee

Items	With BCWUA	Only with WUA at Mesqa level	With no WUA
Organization	Establishing the group consisting of the drainage water reuse pump users under the existing association	Establishing the group of the drainage water reuse pump users, through the representatives from Mesqa WUA	Establishing the users association of drainage reuse pump, through the identified powerful person in the area.
Main role of the Committee	・Guard and cleaning of the pump ・Discuss and decide the operating schedule.	・Guard and cleaning of the pump ・Discuss and decide the operating schedule.	・Guard and cleaning of the pump ・Discuss and decide the operating schedule.
Main role of the Government	・Provision of operators and operating activities / burden of operating cost / maintenance, inspection and repairing, and bearing those expenses	・Provision of operators and operating activities / burden of operating cost / maintenance, inspection and repairing, and bearing those expenses	・Provision of operators and operating activities / burden of operating cost / maintenance, inspection and repairing, and bearing those expenses
Function Strengthening of the Committee	・Carrying out activities to raise awareness of water quality conservation (Cleaning campaign etc.) ・Hold training to transfer O&M in future	・Clarifying the activities for O&M of drainage water reuse pump ・Carrying out activities to raise awareness of water quality conservation	・Clarifying the activities for O&M of drainage water reuse pump ・Carrying out activities to raise awareness of water quality conservation
Others	—	The users' group of drainage water reuse pump can become a part of BCWUS or itself.	The users' group of drainage water reuse pump can become a part of BCWUS or itself.

The issues and approaches with regard to farmers' organization, particularly BCWUA, are summarized in the table below. The issues were already mentioned in Chapter 3.

Table 4.5.3 Main Issues / Consideration and Approaches of BCWUA

Main issues / consideration	Approach
No legal framework for BCWUA	・Approval of Undersecretary to activities ・System preparation for activities after legal reform
Insufficient communication between government staffs and farmers	・Training of staffs for BCWUA establishment ・Establishing BCWUA involving various stakeholders such as irrigation and drainage inspectors
Absence of leader with appropriate leadership	・Discovering talent such as locally influential persons, religious people and progressive farmers ・Establishing the organization having those people as the center
Clarification of issues to address and main activities of BCWUA	・Clarifying WUA activities when it comes to establishing ・Raising awareness of main issues and challenges

There are examples that BCWUA collect money from its members for the activities of BCWUA. There are some currently realizable measures, with the prospect of the activities after legal reform, e.g. to establish the committee handling the matters of drainage water reuse or water quality conservation in BCWUA, or to facilitate farmers' group activities, which can be the basis of future association.

6) Environmental Campaign

In the Irrigation Complex, a component of environmental campaign will be incorporated. As mentioned before, waste dumping into canals is a big issue in the Project area, it is necessary to promote people's awareness of environmental conservation. There will be varieties of activities on the campaign and such activities will be programmed according to the circumstances of the site.

As a way of deepening their understanding, it is recommended to organize a study visit for the villagers to learn from some advanced sites, which have active organizations for proper garbage management, canal cleaning and so on. Based on their observation, if the tour participants can prepare and action plan describing what they can do, who are responsible for activities, how much cost they can afford and so on, it would lead to carrying out realizable and practical activities.

There are some good examples of garbage collection systems established by local people. For instance,

one of BCWUA in IIIMP area, namely, Mafroza East & West BCWUA, or El Rash El Gharbi BCWUA, which had been supported by WMIP phase 2 by JICA, exchanged the contracts with NGOs for the regular garbage collection, and each household shoulders LE 2-3 LE monthly. Bahr Nemra BCWUA purchased one truck to collect garbage themselves. It is worth taking into consideration to establish such a new system managed by the people mainly after the visit to such advanced areas mentioned above.

In addition, the waste separation at the household level will make it possible to reduce amount of garbage in the long run, which leads to decreasing the time, labor cost, and transportation fee and so on for garbage collection. Making compost by using raw garbage from kitchens is effective to reduce whole amount of garbage, at the same time, compost is useful for soil fertility increase. Concerining plastic bottles, cans, and cartons etc. can be transported to the recycle factory in the governorate. In addition, it is recommended that the governorate acts as bridge between NGO & the recycle factories and the people for effective garbage collection and disposal.

It would be necessary to involve stakeholders from various sectors for the effective implementation of the environmental education activities. The Pilot Project gained the cooperation of various agencies, namely, local units, The Ministry of Awqaf (Religious Affairs), The Ministry of Youth and Sports and The Ministry of Education, not only MWRI. Imams (Mosque leaders) give speeches about environmental awareness every Friday at Mosques in the Pilot Project sites. Moreover, environmental cleaning activities by the Youth Society in W5 (Sandela Village) have triggered the local unit to start the garbage collection. Water quality conservation is not only a matter for MWRI, since water quality deterioration is related to insufficient morals and low education. Therefore, for expansion of environmental conservation awareness, various agencies have to be stakeholders, along with the MWRI.

7) Other Possible Component: Sub-surface Drain Reuse

Sub-surface drains have been installed in the farmlands in the Delta. When sub-surface drains are installed, it is possible to consider the introduction of lock gates and gutters. The sub-surface drains are connected to the main collector of the drainage water underground and there is an outlet to discharge the drainage water into an open channel drain. If this drainage water is not contaminated with salt, it could be reused before it gets into a larger drain and become deteriorated. It would be possible to install gutters to catch the drain water from the sub-surface collector and reuse it at the farm downstream. Or if the farmers can control the discharge of this outlet e.g. by installing a lock gate at the outlet of the sub-surface drain, they could control the underground water level to retain moisture of farmland for crops, which is one of the methods to reuse irrigation water.

Drainage water coming from sub-surface collector

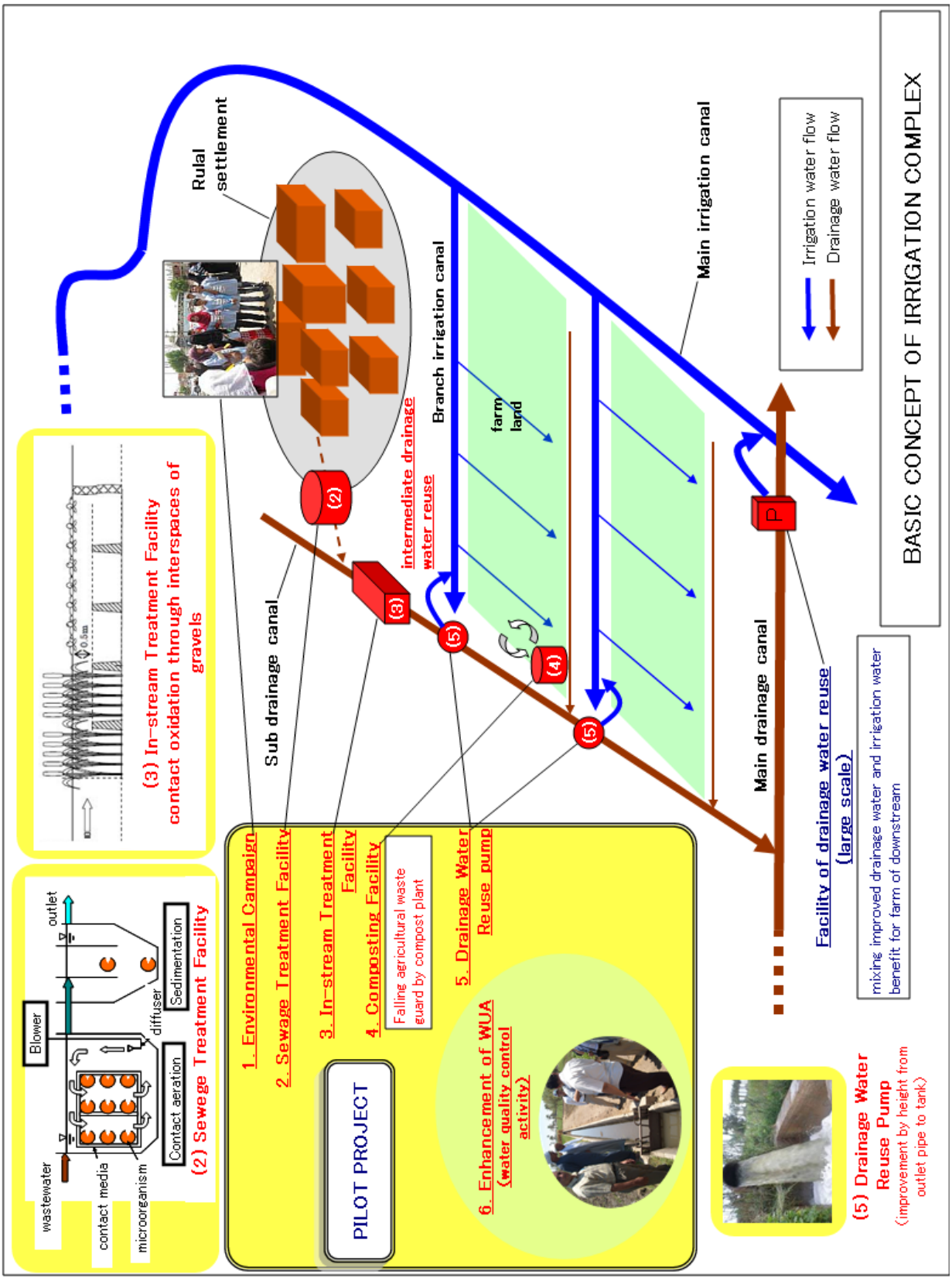


Figure 4.5.1 Illustration of Irrigation Complex

(2) Implementation by Making Use of the Pilot Project Experience

The Pilot Project to establish the Irrigation Complex has been implemented during the master planning period and has been showcased in the vicinity of Kafr El Sheikh City. Through the Pilot Project the system of public investment with the participation of farmers in operation and management has been designed. The key point of the Drainage Water Reuse Plan in the short term is to commence the expansion of the "Irrigation Complex Package" from the Pilot Project to a full-scale one. In the short term plan, the concerned authorities continue monitoring the Pilot Project and encourage the beneficiaries' participation to the operation and maintenance of the facilities. The followings are the preparations and methods to enhance the prospect for the short term plan by the government after the completion of the Pilot Project.

- To identify candidate sites which suite for the expansion of irrigation complex.
- To carry out the feasibility study including prioritization of the sites.
- To increase the people who understand the effectiveness of the Irrigation Complex, through study tours and workshops.
- To commence the budget-wise easy launching components such as environmental education and improvement of the monitoring system.

(3) Extension of the Irrigation Complex

In the mid and long term plan, it is planned to expand the Irrigation Complex all over the governorate where it is necessary. In order to help identify and manage the information for the possible sites for establishing the Irrigation Complex, GIS maps have been prepared with the layers of drains, irrigation canals and villages, using the topographic maps of Kafr El Sheikh Governorate with the scale of 1 : 50,000. The output maps of GIS are attached as Appendix-F. The potential sites for the Irrigation Complex will be the area where the villages, irrigation canals and drains are close to each other.

These potential sites where the irrigation canals and drains are close to each other are picked up from the 1 : 50,000 geographical map and conclusively 89 sites were selected. These 89 sites include the site proposed by the governorate irrigation and drainage departments as the candidate sites for the Pilot Project, which were conclusively identified based on the field survey. Among the proposed sites for the Pilot Project, the sites where drainage water quality is not suitable for the drainage water reuse, for instance due to its high salinity, were excluded from the candidate sites for future plan. Furthermore, as a result of consultation with EPADP, additional 2 sites (Al Nil and AL Sheikha) located at the downstream of Garbia main drain where drain water quality is heavily deteriorated were selected, then 91 sites in total were selected as candidate sites. (See Figure 3.3.3 and Table 3.3.2) Basically these candidate sites are not overlapped with the plan of MHUUD for the wastewater treatment plant construction. Hence it needs coordination with MHUUD in constructing rural sewerage system in these candidate sites.

In the Pilot Project implemented through the formulating process of the Plan, Irrigation Complexes were established in 5 sites. Among them, 1 site (W5) has all of the main facilities to form Irrigation Complex, whereas, other 4 sites have only drainage water reuse pump accompanied with environmental campaign carried out. Hence, the latter 4 sites can be the candidates for further developed Irrigation Complex. Then, the total number of the candidate sites becomes 95. The list of potential sites is shown in Table 4.5.5.

However, the information of the potential sites is limited, i.e. only the location, names of irrigation canal and drain, and nearby villages / hamlets are obtained from this inventory. Also the situation on the field can change from time by time and therefore following procedure will be required in actually

establishment of the Irrigation Complex:

1. Provisional prioritization of the sites from the inventory
2. Field investigation / Feasibility Study of the priority sites. Through this investigation, the intension of inhabitants, the condition of water shortage and water quality of the drain and status of sewerage etc. are to be collected.
3. Implementation

With regard to the prioritization of the potential site, the sites where the drainage water reuse pumps have been already installed is promising, i.e. the Pilot Project sites of the Project (4 sites) and the priority project areas where MWRI has commenced the establishment of the pump in its own budget. The following table shows the sites where the construction of the drainage water reuse pumps have already commenced.

Table 4.5.4 Drainage Water Reuse Pumps Constructed by MWRI (Nov, 2015)

ID of the target site	District	Canal	Drain	PS Discharge	Progress
R-3	Reyad (East of Sidi Salem)	Al-Monsha'a	Al-Monsha'a	2 m^3/sec.	70%
Ke-3	Kelin	Al-Kharaba	Nashart Drain	1 m^3/sec.	41%
F-3	Fowa	Al-Suada'a	No. 11	1 m^3/sec.	30%
D-10	Desouk	Lasefer	No. 9	1 m^3/sec.	0%
-	Motobas	Khaleeg Brembal	Tharwat	1 m^3/sec.	50%
F-4	Fowa	Bahr Al-Qasaby	No. 11	1 m^3/sec.	11%
Ka-1	Kelin / Kafr El Sheikh	Al-Ghamria	Bahr Nashart	1 m^3/sec.	32%
D-11	Fowa / Desouk	Nahr Kushk	Tharwat	1 m^3/sec.	40%

Source: Irrigation department in West Kafr El Sheikh Governorate

Note: IDs in the table are same as those of the potential sites of Irrigation Complex, shown in Table 4.6.1. The Pilot Projects were implemented starting from the sites which had been a part of the plan formulated by Irrigation department of Kafr El Sheikh Governorate.

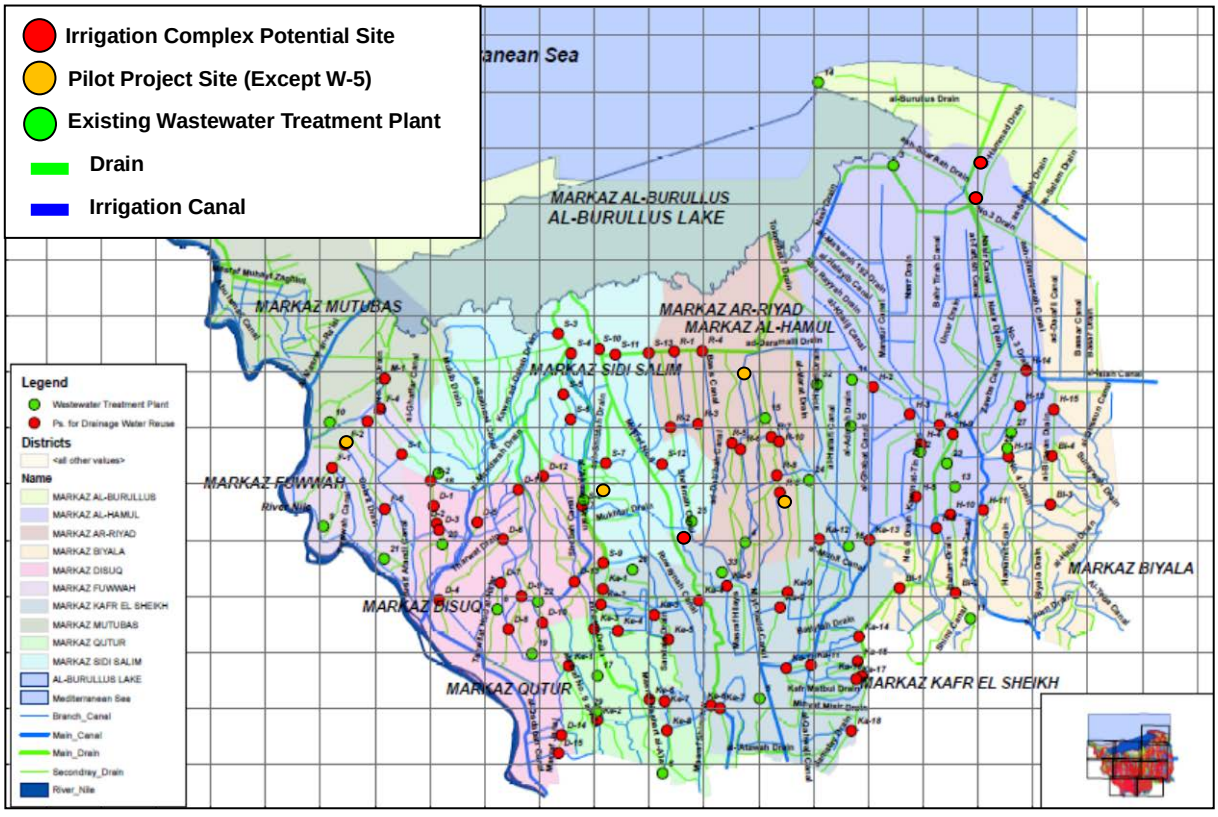


Figure 4.5.2 Potential Sites of Establishing the Irrigation Complex Identified from the Geographical Map

Table 4.5.5 List of Potential Irrigation Complex Sites Identified from Geographical Map

No.	District	ID No.	Irrigation Canal	Drain	No.	District	ID No.	Irrigation Canal	Drain
1	El Hamoul	H-1	Al Hallafi	Kaum at-Tin	49	Sedi Salem	S-5	West Sid Salim Side (branch)	Al-Wastani
2	El Hamoul	H-2	Al Ghabat	Kaum at-Tin	50	Sedi Salem	S-6	Bahr Sheikh Ibrahim (branch)	Al-Wastani
3	El Hamoul	H-3	Siyaq	No.6 - Kaum at-Tin	51	Sedi Salem (PC)	S-7	Mit Yazeed (PC: W-7)	Ash-Shibtah(Nashart al Asfal) (PC: W-7)
4	El Hamoul	H-4	ad-Dayir	No.6 - Kaum at-Tin	52	Sedi Salem	S-8	Al-Afir	Narshat
5	El Hamoul	H-5	Az-Zawiyah (Branch)	No.6	53	Sedi Salem	S-9	Umm Dukhan	Al-Ajuzayn (or Nashart)
6	El Hamoul	H-6	ad-Dayir (Branch)	Abu Hamad	54	Sedi Salem	S-10	Mit Yazeed	No.8
7	El Hamoul	H-7	Ibshan	Gharbia	55	Sedi Salem	S-11	Shalimah	Tolombat 8
8	El Hamoul	H-8	Az-Zawiyah (Branch)	Gharbia	56	Sedi Salem	S-12	Shalimah	Taftish Minshat Abbas
9	El Hamoul	H-9	ad-Dayir (Branch)	Gharbia	57	Sedi Salem	S-13	Shalimah	Tolombat 8
10	El Hamoul	H-10	ad-Dayir	Ibshan	58	Sedi Salem (PC)	S-14	Ariamon (PC: E-6)	Erin (PC: E-6)
11	El Hamoul	H-11	Bahr Nour	Ash Sharqawiyah	59	Fowa	F-1	Fuwwah	No.11
12	El Hamoul	H-12	Bahr Tirah (Branch)(Abu Uwaydah)	No.4	60	Fowa (IS)	F-3	Yusif Afandi (Al-Suada'a)	No.11
13	El Hamoul	H-13	Raghib	No.4	61	Fowa (IS)	F-4	Al-Qassab	No.11
14	El Hamoul	H-14	Bahr Al-Binwah	No.3	62	Fowa	F-5	Yusif Afandi	Kbreet
15	El Hamoul	H-15	Al-Bashmah	Al-Binwan	63	Kelin	Ke-1	Al-Kardy	No.9 al-A'la
16	El Reyad	R-1	Al-Minshah	Tolombat 8	64	Kelin	Ke-2	As-Salamuniyyah	Qunah
17	El Reyad	R-2	Al-Minshah (branch)	Taftish Minshat Abbas	65	Kelin (IS)	Ke-3	Al-Hinawi (AL Khrabaha)	Bahr Nashart (Nav.)
18	El Reyad (IS)	R-3	Al-Minshah (branch)	Al-Minshah	66	Kelin	Ke-4	Ash-Shuqqah	Mit ad-Dibah ash-Sharqi
19	El Reyad	R-4	Basis	Tolombat 8	67	Kelin	Ke-5	As Safti	Sandera
20	El Reyad	R-5	Ad-Dabbah	Abu Khashabah	68	Kelin	Ke-6	Bahr Nashart	Ar-Rawdah
21	El Reyad	R-6	Abu Muatafa	Abu Khashabah	69	Kelin	Ke-7	As Safti	Ar-Rawdah
22	El Reyad	R-7	Al-Hasfar	No.7	70	Kelin	Ke-8	As Safti	Ar-Rawdah
23	El Reyad	R-8	Al-Mallahah	No.7	71	Kafr EL Sheikh (IS)	Ka-1	Al-Amiriyyah (Al Ghamalia)	Nashart
24	El Reyad	R-9	Abu Rayyah	No.7	72	Kafr EL Sheikh	Ka-2	Muhayt Shabah al-Gharbi	Nashart
25	El Reyad (PC)	R-10	As-Santah (PC: E-7)	Farsh Al-Ganayin (PC: E-7)	73	Kafr EL Sheikh	Ka-3	As Safti	Sandera
26	Biyala	Bi-1	Damaqash	Gharbia	74	Kafr EL Sheikh	Ka-4	Ash-Shaburah	No.8
27	Biyala	Bi-2	Shimi	Ibshan	75	Kafr EL Sheikh (PC)	Ka-5	Ash-Shakirlyyah (PC: W-1)	Hillays (PC: W-1)
28	Biyala	Bi-3	Musayri (cross)	AL-Binwan	76	Kafr EL Sheikh	Ka-6	As Safti (branch)	No.8
29	Biyala	Bi-4	Musayri (end)	AL-Binwan	77	Kafr EL Sheikh	Ka-7	Al-Qasid	Waqi Uthman
30	Desouk	D-1	(Small canal from Nile)	No.10	78	Kafr EL Sheikh	Ka-8	Umm Inan	No.7
31	Desouk	D-2	(Small canal from Nile)	No.10	79	Kafr EL Sheikh	Ka-9	Maris al-Gamal	No.7
32	Desouk	D-3	Yusif Afandi (branch)	No.10	80	Kafr EL Sheikh	Ka-10	Al-Qahwagi (branch)	Mabtubl
33	Desouk	D-4	Sanbur al-Kabirah	Tharwat	81	Kafr EL Sheikh	Ka-11	Al-Qahwagi	al Tayifah
34	Desouk	D-5	Umm Barakah (branch)	Al-Mandurah No.9	82	Kafr EL Sheikh	Ka-12	Kadlah	Al-Ganayin
35	Desouk (PC)	D-6	Umm Barakah (Koniesah) (PC: W-14)	Tharwat Howd el-Hagar (PC: W-14)	83	Kafr EL Sheikh	Ka-13	Az-Zawiyah	An-Nashadi
36	Desouk	D-7	Sanhur as-Sughra	Tharwat Howd el-Hagar	84	Kafr EL Sheikh	Ka-14	As Shamariqah	Gharbia
37	Desouk	D-8	Sanhur as-Sughra	Sanhur al-Gharbi	85	Kafr EL Sheikh	Ka-15	As Shamariqah (branch)	Kahalaf Allah
38	Desouk	D-9	Al-Asfar	Sanhur al-Gharbi	86	Kafr EL Sheikh	Ka-16	Matbul	Ash Shamariqah
39	Desouk (IS)	D-10	Al-Asfar (Lasefer)	No.9 (branch)	87	Kafr EL Sheikh	Ka-17	Kafr Matbul	Kafr Matbul
40	Desouk (IS)	D-11	Al-Kunayyisah (Nahr Kushk)	Tharwat	88	Kafr EL Sheikh	Ka-18	Al Ramadi	Samatay
41	Desouk	D-12	Shabah	Masraf 9 al=Bahr as-Saghir	89	Motobas	M-1	Khalij al-Quni	Zaghlul
42	Desouk	D-13	Shabah	Firawn	90	Baltim	B-1	Al Nil	Gharbia Main
43	Desouk	*D-14*	*Sanhur al-Kabirah (branch)*	*Janai*	91	Baltim	B-2	Al Sheikha	Gharbia Main
44	Desouk	*D-15*	*Sanhur al-Kabirah (branch)*	*Janai*	92	El Reyad (PS)	E-1	Marsa Al Gamal (PS: E-1)	Farsh Al-Ganayin (PS: E-1)
45	Sedi Salem	S-1	Yusif Afandi	No.10	93	Sedi Salem (PS)	E-4	Mekhazen (PS: E-4)	Mekhazen (PS: E-4)
46	Sedi Salem (PC)	S-2	Abo Hamar (PC: W-6)	No.10 (PC: W-6)	94	Fowa (PS)	W-2	Kbreet (PS: W-2)	No.11 (PS: W-2)
47	Sedi Salem	S-3	Al-Fadili	Nashart	95	El Reyad (PS)	W-4	El Karadwah (PS: W-4)	Faraon (PS: W-4)
48	Sedi Salem	S-4	West Sid Salim Side	Nashart					

Note: PC = Pilot Candidate Site (but not selected as priority). PS = Pilot Site (selected and implemented sites except for W-5, since the Irrigation Complex has already been established in W-5). IS: Pump constracton has started.
A site called E-3 is not included in this table due to the fact that the site was not to deal with drain but irrigation canal, although this site was one of the pilot candidates.

4.5.2 Project 2: Improving Drainage Water Quality for Irrigation in Garbia Drain

As mentioned in the previous section, Garbia main drain flowing in the East part of Kafr El Sheikh Governorate is recognized as the drain whose water quality is seriously deteriorated in MWRI. Garbia main drain is also the only main drain in the Governorate, discharging the drainage water into the main canal. The drainage water from Garbia main drain goes through the Hamoul Reuse pump station located in Halmoul city, north of the Governorate. Then, it flows into Bahr Tera irrigation canal and used for irrigation in the area of about 84,800 feddan (34,600 ha)[1] at the downstream reaches.

The drainage water in Garbia main drain is supposed to be treated at the sewerage plant in the Mahala Kobra city. However, the plant now discharges a lot of untreated sewage water into Garbia main drain. In fact the sewerage facility is considerably dilapidated and its capacity cannot meet the recent demand due to the population increase in the city. Furthermore, the operating hour of Halmoul MPS is decreasing due to the deterioration of water quality, which makes the irrigation water shortage serious as well as the deterioration of water quality in the downstream reaches. The situation described above induced the lowering of agricultural productivity in the downstream reaches.

After passing the mixing point of Bahr Tera irrigation canal, the drainage water from the Garbia main drain is again used or irrigation. There are two points to consider, the Garbia Main Drain water is used for irrigation and water quality problem has been in serious problem causing very low production of crops. The areas are called the intakes of Al Nil Canal and AL Sheikha Canal.

The areas are also suffering from salinity problem due to being close to the coast, the Garbia main Drain is fully open to the Mediterranean Sea. Hence, the water in the Garbia Main Drain is not only polluted by sewage but also mixed with sea water which would be harmful to the soil as accumulating salt in the soil of this area. This problem may increase as time goes by due to the anticipation for the rise of water level of the Mediterranean Sea caused by climate change[2]. In such case, the sea water could penetrate deeper in to the upstream of the Garbia Main Drain, so the Garbia Main Drain water becomes more saline unable to reuse for irrigation. To mitigate this problem, installation of a tide gate at the outlet of the Garbia Main Drain can be an effective measure.

The drainage water reuse and water quality of the Garbia Main Drain have a very big influence due to its circumstance described above. Hence, the benefitted area in downstream reaches in Bahr Tera irrigation canal where the drainage water from the Halmoul PS is flowing in, and Al Nill Canal and Al Sheikha Canal where the drainage water is reused again from the Garbia Main Drain are prioritized in consideration of the consultation with EPADP. The project is a part of wide-area projects working apart from the Irrigation Complex. The Irrigation Complex could be established along with the branch drains flowing to the Garbia Main Drain, which is subproject of the Project 2. Also EU is planning to carry out F/S in the downstream reaches of Garbia drain covering various sectors including wastewater treatment. The output of the F/S can be utilized to implement this Project 2. The following table and figure show the components forming the Project 2.

[1] Source: The master plan study for the improvement of irrigation water management and environment conservation in the north-east region of the Central Nile Delta, 1999, JICA

[2] E.g. as a study on climate change: Mohamed Shaltout et.al. “Sea-level change and projected future flooding along the Egyptian Mediterranean coast”, Oceanologia (2015) 57

Table 4.5.6 Components of the Project for Improving Drainage Water Quality for Irrigation in Garbia Drain

Component	General Description
Mahala Kobra sewerage plant	Rehabilitation and strengthening the function of existing treatment plant. (90,000m^3/day → 120,000m^3/day + Industrial wastewater treatment plant 45,000m^3/day) To divide industrial and domestic wastewater, and establish new industrial wastewater treatment plant.
Halmoul reuse pump station	Rehabilitation of existing pump station (maximum capacity: 10m^3/s). To install sedimentation tank before pump station to improve the drainage water quality before the drainage water is mixed with fresh water for irrigation.
Rural sewerage facilities along Garbia Drain	To install rural sewerage facilities to the villages where untreated drainage water is discharged into Garbia main drain or branch drains. Some of those treatment facilities will be installed with the project establishing Irrigation Complex, and those projects will be subprojects of the Project 2.
Al Nil nad Al Sheikha areas	To consider the installation of in-stream treatment facility or drainage water reuse pump.
Tide gate at the outlet of Garbia drain	To examine the effectiveness of installation of a tide gate at the outlet of Garbia drain.

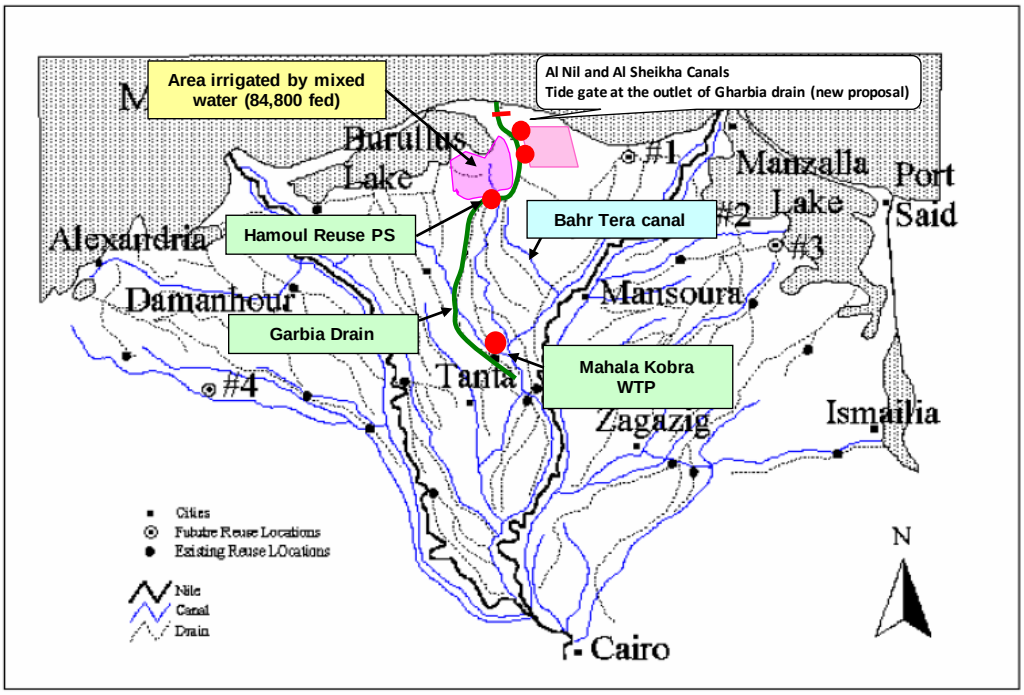


Figure 4.5.3 Location of Garbia Drain and Irrigated Area by the Mixed Water

4.5.3 Project 3: Construction of Large-scale Reuse Pump Station

The Project 3 is to construct large-scale reuse pump station in association with the installation of the city sewerage system for the drainage water improvement. The installation of the city sewerage system is managed at the initiative of HCWW. The large-scale reuse pump station is planned to be constructed where the sewerage system is already installed by HCWW. The status regarding the installation of the sewerage system is firstly checked up in order to identify and propose the sites for the construction of large-scale reuse pump station.

The main drains in Kafr El Sheikh Governorate are, from the right side, Garbia main drain, No.7 Main Drain, No.8 Main Drain, Nashart Main Drain, No.9 Main Drain, No.10 Main Drain and No.11 Main Drain. Garbia main drain has the large-scale drainage reuse pump station in Hamoul, which pump up the drainage water from Garbia main drain flowing into Bahr Tera main canal. The deterioration of the drainage water quality is getting serious recently. Therefore, the project to improve the drainage water quality for irrigation in Garbia drain is planned with high priority as described in the previous section, which is to be implemented in cooperation with HCWW.

In addition, No.7 Main Drain and Nashart Main Drain are included to the plan for increment of the drainage water reuse, which is described in NWRP 2017. Considering the fact that Those two main drains intersect with No.8 Main Drain, No.8 Main Drain is proposed as the site for the construction of large-scale reuse pump station/

1) No.8 Main Drain


Crossing point of No. 8 Main Drain and Mit Yazeed Irrigation Canal (front)

No.8 Main Drain crosses with Mit Yazeed Irrigation canal, which is one of the main canals in Kafr El Sheikh. It is possible to install a relatively large scale reuse pump station at crossing point. The benefited area in the downstream of the crossing point using the irrigation water from Mit Yazeed canal is 16,900 feddan (7,098 ha).[3] IIIMP has been implemented with support from World Bank since 2004 in Mit Yazeed canal, and the improvement of irrigation system has been in progress through improving the way of irrigation from the tertiary canals by WUA. However, according to the ex-director of IIIMP, the downstream area of Mit Yazeed canal still has the problem of irrigation water shortage, it is necessary to reuse drainage water to mitigate the problem. When it comes to construct a large-scale reuse pump station at crossing point of No.8 Main Drain and Mit Yazeed canal, the feasibility study would be carried out first to consider the scale and economic potential of the reuse pump station by reference to the degree of water shortage in the downstream reaches of Mit Yazeed canal command area. Although it would be necessary to check the drainage water quality of No.8 Main Drain, there is no problem with regard to the water quality as of now.

2) Nashart Main Drain

Nashart Main Drain has a wide cross section and hence the amount of collected drainage water is large. On the other hand, main irrigation canals running near the Nashart Main Drain are getting smaller as they are close to the most downstream reaches. Therefore, the relevance of constructing large-scale reuse pump station along the Drain is considered low. It may be more relevant to install small-scale reuse pumps at branch canal level in this area. In other words, it would be reasonable to install reuse pumps under the project for Irrigation Complex establishment.

3) No.11 Main Drain

The location condition of No.11 Main drain is similar to Nashart main Drain, as there are no large-scale irrigation canals close to the Drain. It will be more relevant to install small-scale reuse pumps (0.5 m^3/s ~1.0 m^3/s) along the Main Drain to pump into the tails of branch canals than constructing a large-scale reuse pump at the Main Drain. In the Pilot site, W2 (Kbreet canal) located along No.11 Main Drain, the reuse pump was already installed. For other irrigation branch canals (Bahar Al Kassab, TeraYusif, Fuwwah and Khalij Al Kuni), it would be also relevant to install small-scale pumps as a part of the Irrigation Complex establishment project. Whereas, there are the irrigation branch canals leading to No.11 Main Drain, and some of those are connected to Mit Yazeed irrigation canal. With regard to those branch canals, it would be unnecessary to install small-scale pumps at tail reaches if a large-scale reuse pump is installed at upstream reaches. The selection of the project sites with those prioritization should be considered with reference to the feasibility study

[3] Source: Irrigation department in West Kafr El Sheikh Governorate, which voices a strong request of the installation of the drainage water reuse pump station.

(Irrigation Complex establishment and installation of reuse pump station to No.8 Main Drain) considering the points mentioned above.

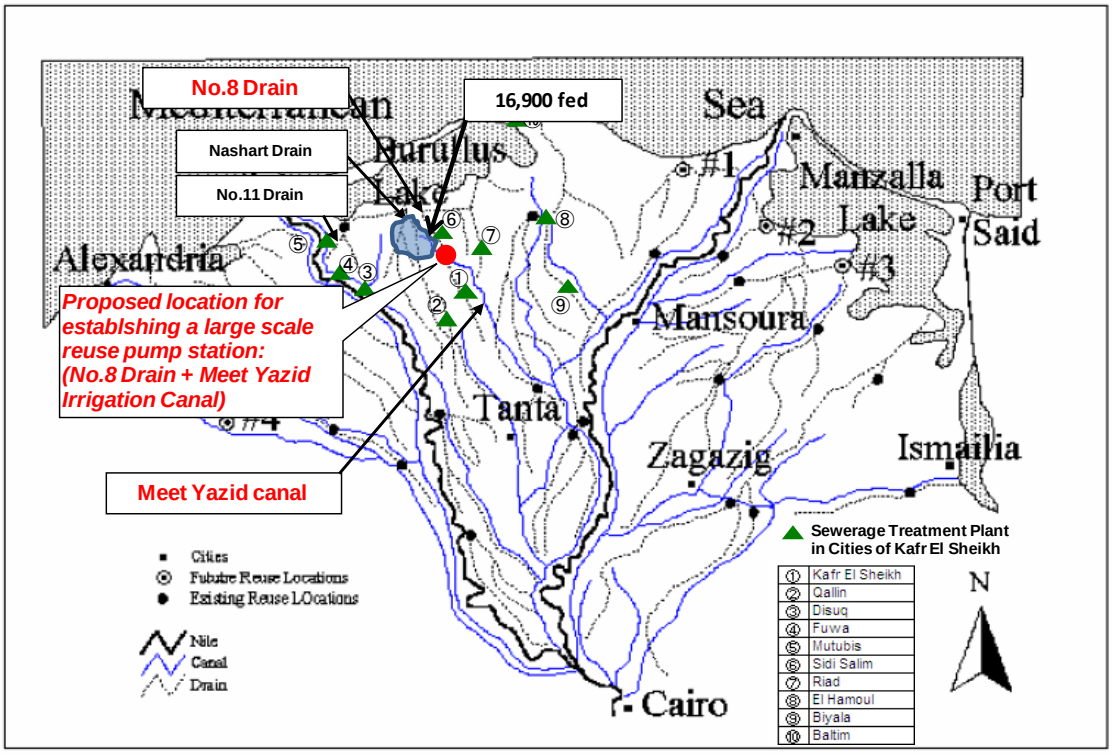


Figure 4.5.4 Proposed Location of a Large-scale Reuse Pump Station

4.5.4 Project 4: Renewal of Drain by Box Culvert

Population density in urban area is relatively high compared to rural area. There are sewerage systems and garbage collection systems in the urban area because the amount of sewage and garbage is big due to large population. However, the amount of these has grown rapidly so that untreated sewage and garbage are disposed directly into drains.

Solid waste disposed in drainage canals is decomposed at the bottom of the drainage canals and it becomes one of the causes of hygienic environmental deterioration. In addition, these wastes cause degradation of flow capacity as well as damage of canals. Hazardous materials such as metals and glasses are also included in the garbage, and they create risks to human health in down streams.

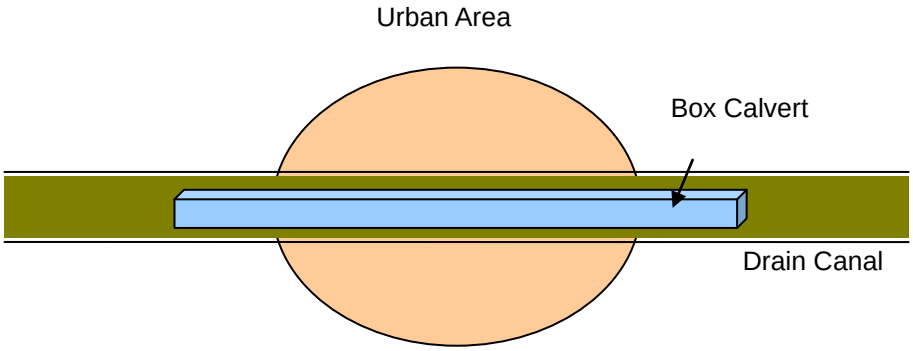


To improve this situation, the drain has been covered with box culvert in the urban area. It is possible to avoid inflow of daily garbage and industrial waste into drains and keep water quality and its flow in drain. One of the advantages of drain with box culvert is that heavy machinery is not necessary to maintain drains. Yet, it is difficult to remove inflow garbage once they enter inside box culverts. Screens install gateways of box culverts to catch inflow garbage, and it is necessary to remove

accumulated garbage at the gateways periodically. Inspection plates are also installed at every 100 m to push out or suck out sedimentation with drainage pump from the box culverts.

Some culvert construction is covered by budget of local administration; yet, in most cases, MWRI budgets for culvert construction based on request from local residents, and EPADP provides technical support and construction supervision. In Kafr El Sheikh Governorate, approximately 3km of the open drain in 30 middle and small cities will be covered into box culvert in the near future.

Although MWRI has already been implementing culvert construction with their own budget, it is not necessarily to exclude this proposed box culvert project from the Drainage Water Reuse Plan. The renewal drain by box culvert is one of the water conservation measures; therefore, this proposed project should be a part of the Drainage Water Reuse Plan.



There is a study already carried out as, "Covering of Agricultural Drains in Residential Areas in Egypt", by BCEOM/DCE[4], December 2005. In this study, three (3) drain covering projects were selected and field assessment, environmental assessment, social survey and financial and economic study were carried out.

The results of this study show decision-making process for introducing box culverts. This process is attached as Annex-I. The JICA Study Team reached to the same conclusion as the results of this study: box culvert will be effective for drains with certain speed of water flow; yet, drain by box culvert is not direct solution for water conservation. The following are the significant points of this study:

- The best option to protect drains from pollution is the implementation of an integrated system for solid and liquid wastes collection, transportation, treatment and disposal/or reuse. It is therefore recommended that resources should be devoted to resolving the causes of the pollution.
- Covering the drains does not completely solve the existing environmental and health problems; the covering simply transfers the problem of solid wastes either upstream, downstream or both.
- Covering of the drains will prevent seepage of subsoil water into the drain, thus interfering with the primary purpose of the drains. This problem is not so obvious because sub-soil water finds its way to the open drains up-stream and down-stream of the covered area, but if the length of the covered parts increases, the negative impact will become obvious.
- Seepage of human wastewater (with its high hydrogen sulfide content), around the houses, from the flooded, ill-designed on-site sanitation systems (which in many cases are just an

[4] "Covering of Agricultural Drains in Residential Areas in Egypt", by BCEOM/ DCE, October 2005

un-lined hole) will harm the buildings.

- Maintenance of covered drain segments is difficult, leading to blockages which further exacerbate the problems with odors, flies and mosquitoes.
- According to the social survey, the overall perception of drain covering is rather positive (residents stated the covering is good e.g. eliminating offensive odor, preventing children from bathing in drain, increasing the street width, etc.). In the meantime, it was found that residents are more willing to pay towards a waste management solution rather than drain covering.

As of 2015, EPADP targets box culvert construction with 17.6 km for the whole country. Box culvert construction in Kafr El Sheikh is planned for 1.42 km, and it accounts for approximately 8% of the total length. In the 2015 year, budget for box culvert construction was approved for 240 m (Table 4.5.6). It is supposed to take 6 years to complete the whole construction of box culverts. The Governorate provides budget for box culvert construction in some areas. In fact, Kafr El Sheikh Governorate plans to construct box culverts for 36 m in 2015. The Drainage Water Reuse Plan assumes that Kafr El Sheikh Governorate constructs box culverts for 3 km as a long term plan (Table 4.5.7). In addition, box culvert construction includes installation of screens at gateways of each culvert.

Table 4.5.7 National Drainage Culverts Plan (Target Length in 2015)

Area	No. of Interval	Target Length (m)	Cost (000LE)	Approved in 2015 year (m)
East Delta	15	8,135	31,252	1,290
Central Delta	13	3,559	26,096	870
West Delta	5	1,030	10,215	130
Upper Egypt	17	4,876	29,124	1,700
Total (National)	50	17,600	96,687	3,990
Kafr El Sheikh Governorate	**5**	**1,420**	**9,500**	**240**
Percentage share of National	10.0%	8.1%	9.8%	6.0%

Source: EPADP Central Administration for Planning and Follow-up

Table 4.5.8 Target Length of Box Culvert Construction in the Drainage Water Reuse Plan

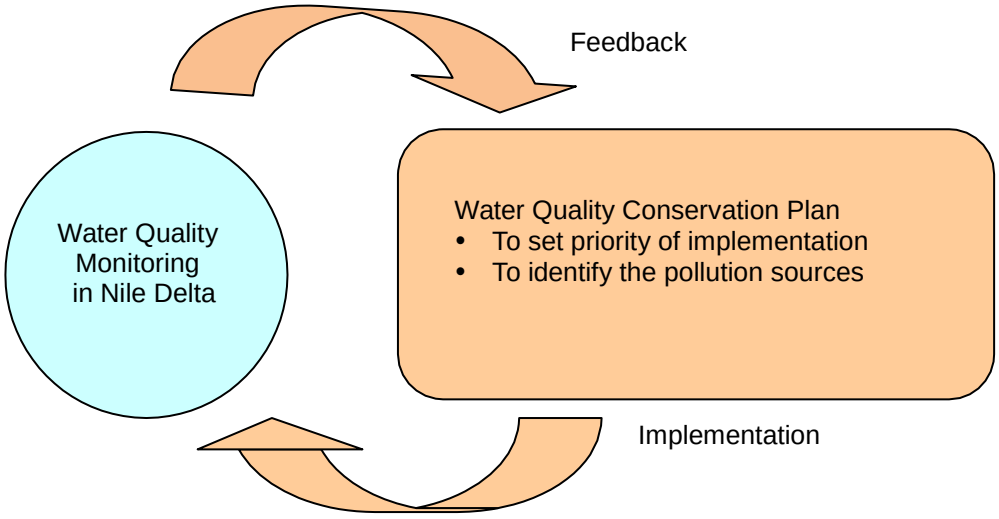
Interval		Target Length (m)	Implementation Target (m)		
Town	Drain		Short-term	Middle-term	Long-term
Biyala	No.4	500	720	700	-
Desouk	Faroon	330			
El Westany	El Westany	200			
El Arab	El Arab	200			
El Mandara Gharby	El Mandara Gharby	190			
Others	Others	1,580	-	-	1,580
Total		3,000	720	1,420	3,000

Source: EPADP Central Administration for Planning and Follow-up and Interview with Drainage Sector in Kafr El Sheikh Governorate

4.5.5 Project 5: Strengthening Effective Use of the Water Quality Monitoring System

Drainage Research Institute (DRI) conducts water quality measurement every month in the major drains, and they publish the results of the measurement as "Drainage Waters Status in the Nile Delta-Year Book". This annual report, however, has been almost in 2-year delay. For this reason, the existing monitoring data is not utilized effectively for planning and prioritizing of projects. In the Drainage Reuse Plan, the results of the existing monitoring system were also utilized to assess priority of Garbia drain. It is proposed to strengthen the effective utilization of the existing water quality monitoring system to utilize the results of the monitoring for mid and long term drainage reuse plan.

One of the utilization of the monitoring results will be; 1) priority of water quality conservation plan is decided depending on the degree of water pollution in the main drains, 2) pollution sources are identified whether they are from disposal of waste or agricultural chemicals, so that different countermeasures will be applied for each pollution source. Implementation agencies will conduct water quality survey at the time of feasibility studies. This water quality survey should be conducted when drainage reuse was planned; yet, the monitoring results of DRI could still be useful for evaluation of water quality in major drains. Therefore, establishment of effective water quality monitoring system should be included in implementation of drainage water reuse plan.



4.5.6 Project 6: Effective Use of Drainage Water for Crop Production (Reduction of Chemical Fertilizers)

Excessive use of chemical fertilizers is also said as one of the pollutants for water. On the other hand, in a sense the drainage water contains essential nutrients for crop production. This could be utilized as fertilizers for crop and using drainage water could reduce the amount of chemical fertilizers. This effect has been studied and practiced in the world, e.g. Monterey in California State in U.S.A. In Monterey the treatment of wastewater is controlled so as to clear the criteria of water quality at certain levels but at the same time leaving the nutritional effect for the crop.

As the drainage water reuse will be increasing, it is proposed to research for controlling the quality of drainage water as to be a sort of liquid fertilizer and develop a guideline for chemical fertilizer application together with the reuse of drainage water. The established method and guideline should be extended to farmers practicing drainage water reuse. MALR should take major roles in this component from the research to extension. The following outline of the project purpose, outputs and activities have been identified. This project to be titled "Effective Use of Drainage Water for Crop Production (Reduction of Chemical Fertilizers)" would be implemented from mid to long-term following progress

of the Irrigation Complex establishment.

Project title: Effective Use of Drainage Water for Crop Production (Reduction of Chemical Fertilizers)

Project Purpose:

Specify soil, water quality and adopt agricultural techniques with drainage water reuse.

Outputs:

1. Soil properties in project area are mapped to select the relevant area for the cultivation by each crop.
2. Drainage water quality is tested and verified.
3. Condition of the soil in the field is verified.
4. Effect of reusing drainage water for crops is confirmed.
5. Agricultural techniques and water management with drainage water reuse is developed
6. the above agriculture techniques and water management methods are extended to the governorate

Activities:

1. Mapping of soil types 2. Water quality investigation 3. Soil investigation
4. Questionnaire survey for farmers 5. Test farm 6. Demonstration farm 7. Yield survey
8. Formulation of guidelines / manuals 9. Extension of the agriculture practice with drainage water reuse

Implementing Agency:

MALR: Agriculture Research Center, Agriculture Extension Sector

4.6 Priority Components (Projects)

4.6.1 Approach of Priority Components

Priority components of the drainage water reuse plan promote middle drainage reuse; namely, promoting drainage water reuse at branch level is promoted. “Establishment of Irrigation Complex”, which includes water conservation at branch drains, is prioritized to promote drainage water reuse. Irrigation Complex Project could be implemented each component separately depending on MWRI’s budget. For example, environmental awareness activities might be able to implement earlier than other components in case if MWRI has limited budget. Also, the area of existing drainage pump stations are more prioritized than other areas.

Regarding projects for wide-area application, “Improving Drainage Water Quality for Irrigation in Garbia Drain” is proposed as one of the priority projects. Drainage water quality in Garbia Drain is one of the most deteriorated in Kafr El Sheikh Governorate, and its drainage water is mixed with upstream of major irrigation canals. For this reason, deterioration of drainage water quality affects in wider areas. Drainage water from Garbia drain is mixed into Bahar Tera irrigation canal with Hmoul reuse pump station.

As a result of the discussion with EPADP, a feasibility study is proposed for not only downstream area of Bahr Tera irrigation canal, but also the study covers Al Nil and Al Sheikha canal, further downstream area of Garbia drain. Ministry of Housing also concerns the capacity of Mahala Kobra drainage treatment facility which is upstream pollution source. EU once listed up as a target site of rehabilitation; however, specific support does not start.

A feasibility study for large-scale drainage pump installation at cross-point of Meet Yazid canal and Drain No.8 is planned after activities of IIIMP completes in October 2016. Box culvert construction is promoted by local government, and EPADP is to provide technical assistance. Budget for “Strengthening Effective Use of Water Quality Monitoring System” and “Promoting Effective Use of Drainage Water for Crop Productions” are relatively small-scale projects. These Projects are implemented depending on the progress of “Establishment of Irrigation Complex” and “Improving Drainage Water Quality for Irrigation in Garbia Drain”. Details of the proposed projects are summarized in“4.11”.

4.6.2 Prioritization of Irrigation Complex Extension

There are 95 potential sites for Irrigation Complex Establishment. These sites include four pilot project sites under this master plan study. It is necessary to assess and prioritize these 95 potential sites in order to introduce Irrigation Complex effectively. Feasibility studies are conducted to assess these potential sites and clarify their priorities. Upon prioritization, the comparative criteria used for the Pilot project site selection will also be applied. Those are frequency of water shortage, drainage water quality for irrigation, discharge of drain, possibility of land acquisition, etc. The following are basic selection criteria for Irrigation Complex sites:

1. Existing drainage pump station areas and/or under construction areas,
2. Ministry of Housing has a plan for sewerage construction. Coverage areas of the plan should be prioritized. List of target villages is attached as Appendix-G,
3. GIZ is also promoting solid waste management project. The area overlapping with the GIZ project can be prioritized so that the investment from GIZ in garbage collection system and its indirect benefits can be obtained in such area. However, information collection and coordination on the site selection[5] of the GIZ project needs consultation during the F/S.
4. Villagers' awareness should be studied, and potential sites are also prioritized based on villagers' awareness toward water conservation,
5. Al Nil and Al Sheikha, downstream area of Garbia drain, should be prioritized. These areas have high priority as a wide-area application of drainage water reuse.
6. Upstream area of Garbia drain should also be considered as one of priority areas.
7. Downstream area of Meet Yazid canal and Drain No.8 should be considered based on the results of a feasibility study for large-sale drainage pump station. The Feasibility Study includes demand assessment of new drainage reuse pump stations.

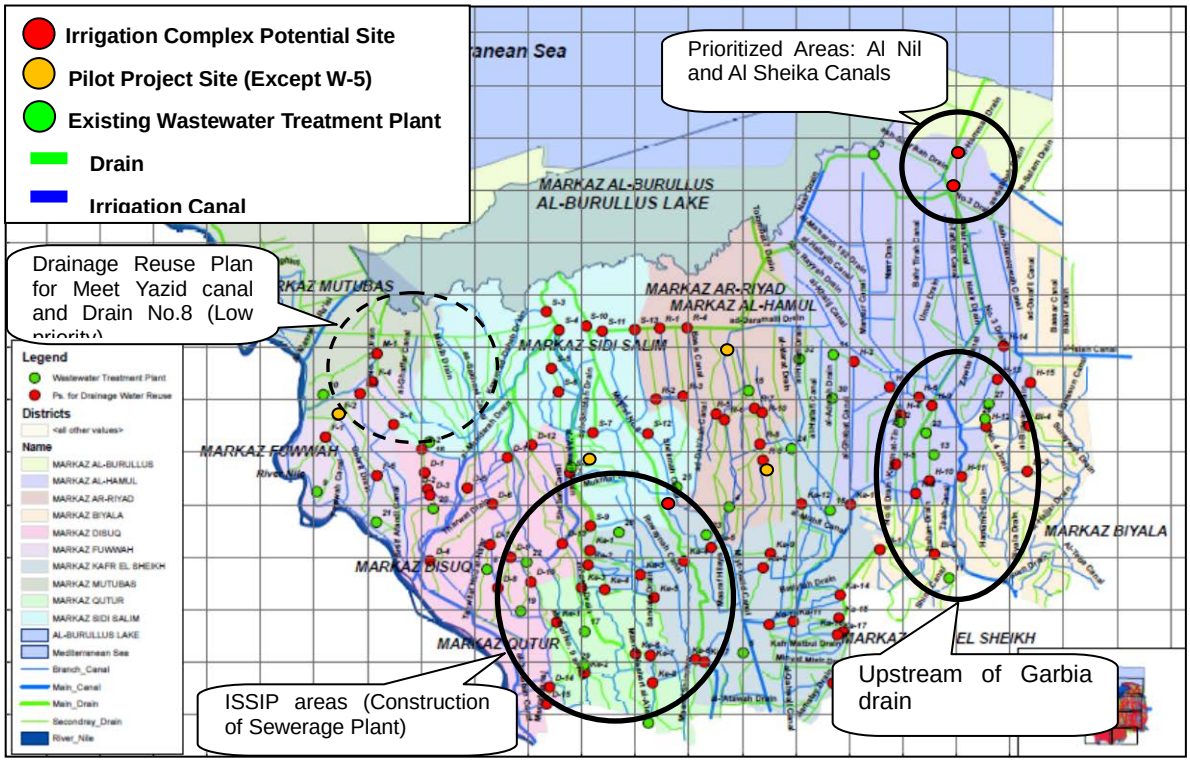


Figure 4.6.1 Basic Approach of Irrigation Complex Priorities

[5] The GIZ project was implementing capacity building of the governorate level officers as of end of 2015.andthe site selection was not done yet.

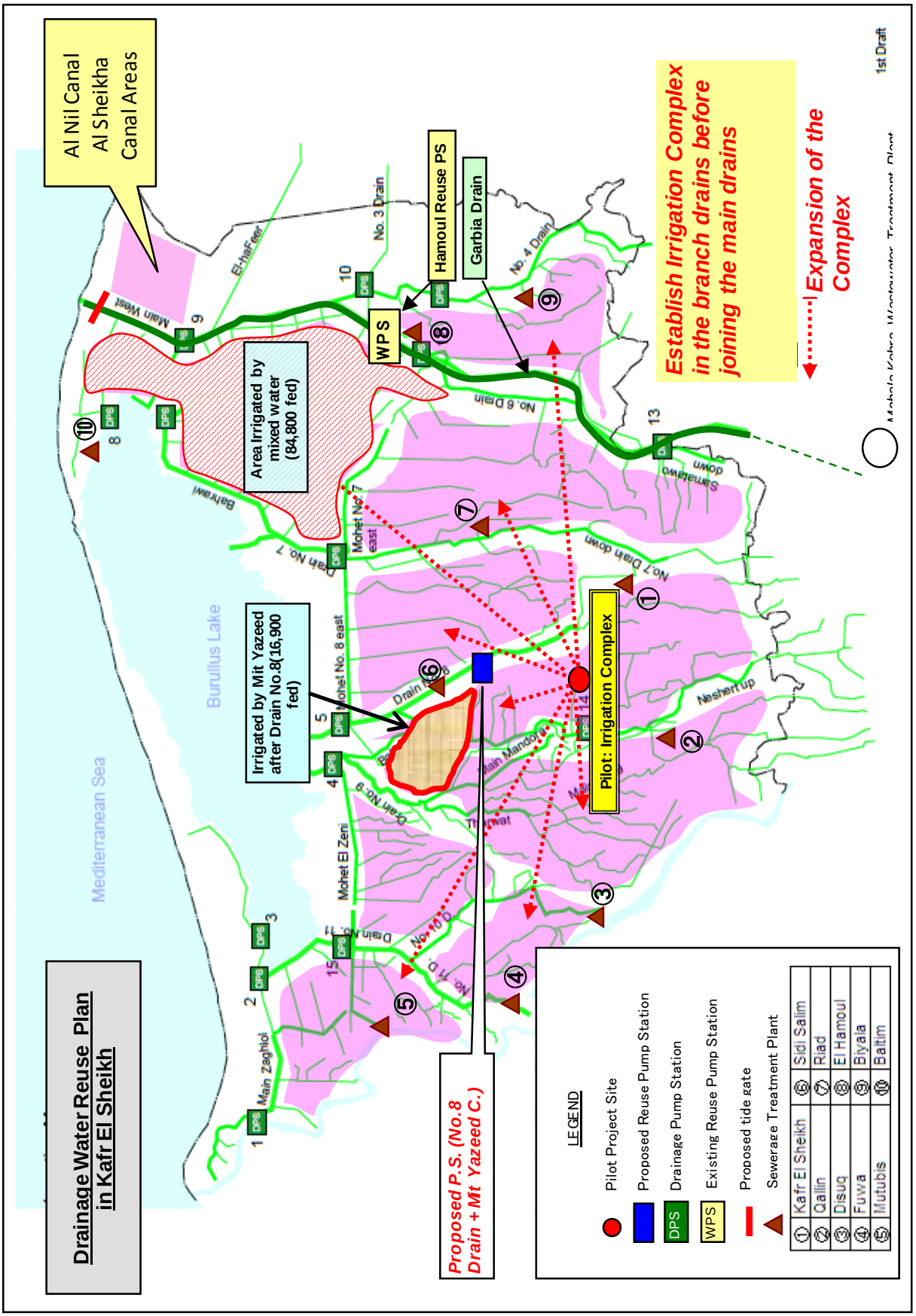


Figure 4.6.2 Drainage Water Reuse Plan in Kafr El Sheikh Governorate

4.7 Implementation Arrangement

4.7.1 Coordination among Ministries

(1) Implementation Arrangement of MWRI/ EPADP

It is very important to conserve the quality of drainage water in order to reuse it for irrigation as an alternative water source. Therefore, water quality conservation is of strong interest for MWRI. However, MWRI could not budget for rural sewerage facility which is one of the main components of Irrigation Complex. This is because rural sewerage facility is out of their mandatory services. It is necessary to get financial support from international development partners if MWRI is willing to promote the construction of sewerage facility.

Another option is to coordinate with MMHUUD to construct sewerage facility. Even if MWRI constructs the sewerage facility, it needs to request HCWW for assisting the community development organization for operation and maintenance of the facility. Therefore, it is necessary to agree on protocol between the two ministries on O&M of the sewerage facility. Other components of Irrigation Complex can be implemented by MWRI.

Environmental campaign, one of the soft components of Irrigation Complex, is possibly implemented with MWRI's budget as a short-term plan. In fact, EPADP mentioned that they can continuously implement environmental campaign through coordination with Drainage Advisory Service (DAS). In fact, DAS and GDIAS agreed that they conduct environmental campaign during the pilot project, and Drainage Sector could take part in their environmental campaign activities.

EPADP also requested extension of Irrigation Complex to the Minister of Water Resources and Irrigation, and the Minister is considering implementation through cooperation with Ministry of Housing. In addition, Environment and Evaluation Unit, implementation unit of this project, was upgraded to General Directorate since September 2015 in order to promote extension of Irrigation Complex. EWRMP funded by the World Bank and GEF is one of the reasons for this upgrade. EPADP emphasizes the importance of specific countermeasures against water degradation, and they are trying to strengthen capacity of related departments. Although the budget background has not been clear for the upgrade of the unit to directorate, the General Directorate for Environment and Evaluation should play a role of implementation agency and administrative office for implementation of the Drainage Water Reuse Plan.

(2) Coordination among Ministries

Involvement of multiple ministries is required for comprehensive implementation of the Drainage Water Reuse Plan, which mainly consists of drainage water quality improvement and drainage reuse for irrigation. It is proposed to maintain the existing Joint Steering Committee (JSC) consisting of the five ministries for the implementation of the Drainage Water Reuse Plan, and EPADP of the MWRI takes core position and coordinate within MWRI and other ministries. In case if MWRI requests fund and technical assistance for other development partners, MOIC will take part in the JSC.

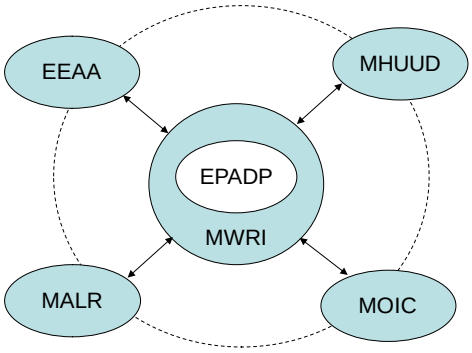


Figure 4.7.1 Coordination among Ministries

Related organizations and their roles are different depending on project components. Table 4.7.1 describes implementation arrangement of each proposed project. Regarding to establishment of Irrigation Complex, coordination among the stakeholders from central level to village level is essential.

More detailed implementation arrangement of Irrigation Complex is described in the next section.

Table 4.7.1 Implementation Arrangement of the Drainage Water Reuse Plan

Project	Implementer and Major Roles
Extension of Irrigation Complex	・ MWRI (EPADP, Irrigation Sector, and IAS): construction of the facilities, O&M for in-stream and drainage pump stations, Strengthening WUAs, and Environmental awareness creation. ・ HCWW: support for sewerage facility management ・ Local Unit: Support for sewerage facility management ・ MARL(Agriculture Extension Sector): extension activities for compost making
Improving Drainage Water Quality for Irrigation in Garbia Drain	・ MWRI (EPADAP, Irrigation Sector, and MED): sewerage facilities, Rehabilitation of Hamoul Reuse Pump Station, drainage reuse pump for Al Nil and Al Sheikha, and installation of tidal gates. ・ MHUUD (HCWW and NOPWASD); Rehabilitation of Mahala Kora Water Treatment Plant and support for rural sewerage facility.
Improvement and Construction of Sewerage System	・ MWRI (EPADAP, Irrigation Sector, and MED): construction of drainage pump stations, operation and maintenance (MED). ・ Irrigation Sector: pump operation of irrigation plan ・ EPADP: maintenance of Dain No.8
Renewal of Drain by Box Culvert	・ Local government (Governorate): facility construction and maintenance ・ MWRI (EPADP): technical support
Strengthening Effective Use of the Water Quality Monitoring System	・ MWRI (EPADP water quality monitoring unit, DRI, Water Quality Unit): utilize results of water monitoring.
Effective Use of Drainage Water for Crop Production	・ MALR(Agriculture Research Center, Agriculture Extension Sector): soil, water quality, pilot, demo, and extension. ・ MWRI: DRI, Irrigation Sector, EPADP: site selection and analysis of drainage water quality.

Source: JICA Study Team

4.7.2 Coordination among Development Partners

There are development partners implementing the programme / projects in the same fields, i.e. the World Bank (ISSIP), EU, GIZ, etc. for wastewater treatment, GIZ/KfW for solid waste management. The cooperation with these development partners will also be taken into consideration. The main focus of WARUS is the reuse of drainage water for irrigation, but the irrigation complex consists of several activities, which are also implemented by the other development partners.

In establishing the irrigation complex, the sites near the areas, in which other development partners are working, can combine the activities of these development partners to establish the irrigation complex. One of the advantages of this arrangement is to maximize impacts of other development partners' activities, and fund for implementation of the project components is also expected to be raised easily. These related development partners discuss coordination through the JSC.

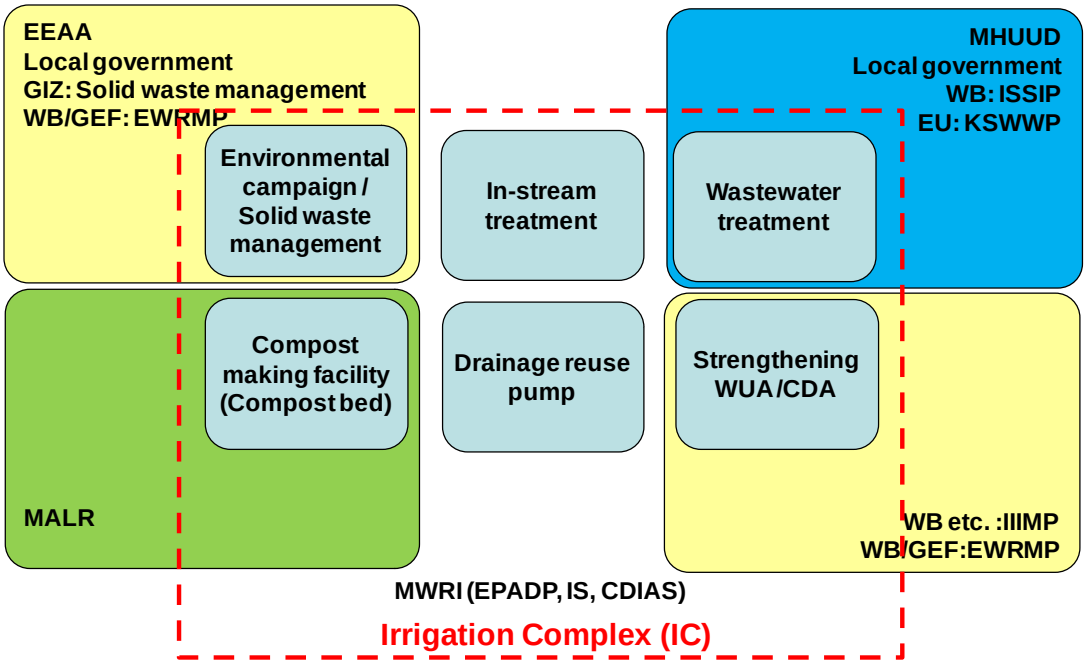


Figure 4.7.2 Coordination among the Stakeholders for Implementation of Irrigation Complex

4.7.3 Implementation Arrangement of Irrigation Complex

(1) Coordination at Governorate Level

A wide range of stakeholders are involved in irrigation complex facilities consisting of drainage reuse pump stations, in-stream facility, sewerage facility, and compost making facility. There are local agencies of MWRI such as EPADAP, irrigation directorate, irrigation service sector, HCWW, and agriculture extension service sector from MALR. Governorate agencies are also included such as Environmental Unit and Local Unit.

In addition, it is necessary to establish community development associations (CDA) and drainage pump committees (DPC) to operate and maintain the facilities. Clarifying roles and responsibilities of each stakeholder is essential to establish effective O&M system. A protocol is to clarify roles and responsibilities of each stakeholder. Getting consensus about the protocol is a key to set up implementation arrangement. The Protocol can provide all the stakeholders with the same understanding.

The Protocol clarifies roles and responsibilities of each stakeholder. It is important to have a number of discussions among all the stakeholders and authorize the Protocol. Signing meeting should be held at the governor's office and gathered all the stakeholders to confirm the contents of the Protocol. Also, the Protocol should cover whole the Irrigation Complex facilities; yet, the protocol for drainage reuse pump only covers a drainage reuse pump station.

As an example of the Protocol, the Protocol for drainage reuse pump is described in this section. Irrigation sector manages the existing drainage reuse pump stations; therefore, irrigation sector has responsibilities for drainage pump stations. The Protocol for drainage reuse pump stations is concluded among irrigation sector, drainage sector, and users' associations (drainage pump committee under the BCWUA). Drainage sector has responsibilities for drains and they also support drainage pump committees to implement environmental awareness activities. The major roles of the drainage pump committees are to coordinate irrigation sector in terms of pump operation period and implement environmental awareness creation activities.

Table 4.7.2 Summary of the Protocol about Drainage Pump Stations

Item	Summary
1) Pump Operator	Irrigation sector provides an operator. In case Irrigation Sector fails to provide an operator, the DPC provides an operator under the supervision of the Irrigation Sector.
2) Pump Guard	Irrigation sector provides a guard. In case Irrigation Sector fails to provide a guard, the DPC provides an operator under the supervision of the Irrigation Sector.
3) Materials for Pump Operation	Irrigation sector provides necessary materials for pump operation.
4) Operation Schedule	Irrigation sector and the DPCs coordinate operation schedule.
5) Operation Hours	The DPCs inform the demand of operation hours to Irrigation sector.
6) Roles of the DPCs	Irrigation Sector empowers the DPCs to perform their roles and responsibilities.
7) Environmental Activities	The DPCs promote environmental activities to raise community awareness of the environment.
8) Monitoring	The DPCs monitor pump operation and maintenance.
9) Electricity of the Pump Stations	Irrigation sector have responsibility for electricity of the pump stations.
10) Cleaning Irrigation canal	Irrigation sector take care of irrigation canal, and the DPCs cooperate with Irrigation sector to keep canal clean.
11) Cleaning Drainage	Drainage sector take care of drainage, and the DPCs cooperate with Drainage sector to keep the drain clean.
12) Drainage Water Quality	Drainage sector implements drainage water quality check. Drainage sector cooperate with the DPCs to implement environmental activities.
13) Others	In case the DPCs undertake any other things, which are agreed above, they discuss and coordinate with relevant authorities.

Source: JICA Study Team

(2) Users' Associations: Types and Legal Status

Users' associations should be organized to involve in project implementation. There are two types of users' associations; 1) DPC: Drainage –reuse Pump Committees and 2) CDA: Community Development Association. These associations are organized to take part in operation and maintenance of the facilities after the Projects.

Regarding establishment of Water Users Associations (WUA), WUAs establish when the irrigation improvement project implemented, and CDIAS (Central Directorate for Irrigation Advisory Service) follows-up these established WUAs. In other words, irrigation sector and drainage sector which are the counterpart organizations of this Project rarely involve in establishment of WUAs. However, drainage water reuse is strongly related to management of drainage and reuse pump stations. Not only CDIAS and members of irrigation improvement projects, but also irrigation and drainage sector should be involved in WUAs' establishment process.

Main beneficiaries of the drainage reuse pump stations are farmers who have farmland at downstream areas of the canals. Farmers in upstream areas are not direct beneficiaries of the pump stations. They are also not involved in the operation of the pump stations. BCWUAs appear to be too big to manage the drainage reuse pump stations properly. Therefore, the DPC have been newly organized for the drainage reuse pump stations under the pilot project.

On the other hand, the main purpose of irrigation improvement projects is to practice appropriate water distribution covering whole the branch canals. A DPC could be an internal committee of Branch Canal Water Users Association (BCWUA) if there is existing BCWUA in a canal. Board members of the DPC should include head and board members of a BCWUA. Appropriate water distribution system including drainage water reuse is established through the DPC.

The CDA has also been newly organized with local villagers at the irrigation complex site (W5 Kahmseen village). The main objective of the CDA is to conduct basic operation and maintenance of the sewerage facility, which is one of the components of the irrigation complex facilities. The CDA is registered to the Ministry of Social Solidarity as a NGO. A CDA is one of the most common organizations in rural areas. Most of them provide community services and charity activities in rural villages. Therefore, the CDA could take ownership of the sewerage facility and conduct operations and maintenance as one of their community services.

The CDA was established based on the Law on Nongovernmental Organizations (Law No.84 of 2002) and registered to the Ministry of Social Solidarity. The Egyptian NGO Law articulates requirements and conditions regarding CDAs and civil associations including organization structure, financial management system, and possible activities. Unlike the DPCs, the CDA has solid legal status so that they can provide community services such as garbage collection and operation of the sewerage plant, and they can have a bank account.

Table 4.7.3 Users' Associations for Irrigation Complex

Type of Organization	Authorization
Voluntary organizations (DPCs)	Ministerial decree is issued by governorate irrigation sector and organizations are officially approved by MWRI.
CDA (uses' associations for sewerage facility)	A CDA is established based on Law No.84 of 2002 and registered to Ministry of Social Solidarity.

Source: JICA Study Team

(3) Steps for Organizing Users' Associations

There are several steps for organizing users' associations. Establishment process of users' association and preparation of the Protocol are conducted in parallel. There are three major preparation activities for establishment of the DPCs and the CDA; 1) Introductory Workshop, 2) Selection of Representatives, and 3) Setting up Internal Regulation. These preparation activities are almost common for establishment process of the DPCs and the CDA. The following diagram shows standard establishment process of users' associations.

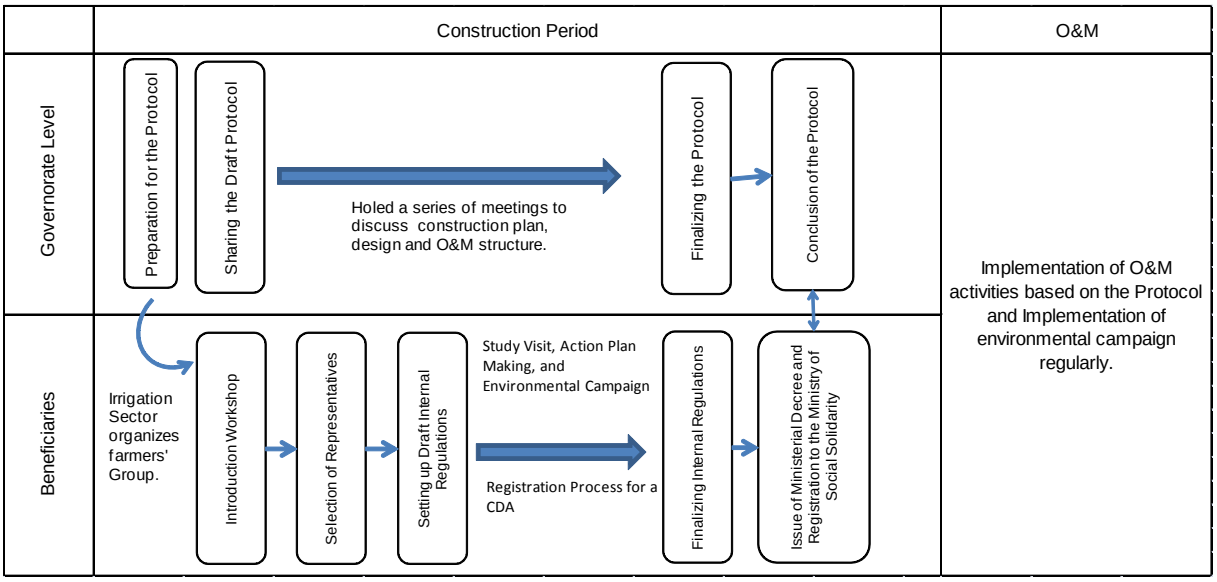


Figure 4.7.3 Flow of Protocol Making and Establishment of Users' Associations

These series of activities should be implemented in consideration with the progress of the facility construction. Users' association should conclude the protocol after they are registered to the Ministry officially as a NGO. For this reason, Finalization of the protocol should be done at the time of finalization of internal regulation and issue of ministerial decree. In addition, the finalization of the protocol should be completed a couple of months before the construction finishes. It might be necessary to review the contents of the protocol again if the protocol concludes too early; while, the protocol cannot effect properly if it concludes just right after the construction. Therefore, the procedure of the protocol and issue of ministerial decree should be completed a couple of months before the construction period.

Introduction Workshop

The purpose of the Introductory Workshop is to introduce the concept and objectives of the project to the project beneficiaries. This step is important to get a consensus from the beneficiaries of the Pilot Project. Particularly, community members are directly involved in operation and maintenance of the irrigation complex facilities. The Pilot Project could not continue if the community members would not accept the Pilot Project facilities and activities. The Introductory Workshop is the first step to establish trusting relationship among all the stakeholders including local beneficiaries as well as irrigation and drainage authorities.

Selection of Representatives

After series of the Introductory Workshops, local beneficiaries start to select representatives of the DPCs and the CDA at each project sites. Farmers and community members have a meeting and discuss the selection of the representatives and their roles and responsibilities. 5 to 7 representatives will be selected at each project site. Selection methods will be votes and other methods, and community members decide how to select their representatives. In the pilot project sites, most of the representatives of the DPCs and CDAs were selected through having a discussion with local community members rather than holding an election, and community members selected senior community members in the communities. This is because elderly members in communities are often influential to other community members. They can play a role of arbitration of there is a problem in communities. Also, active farmers often become representative of DPCs

It is important to select active farmers as representatives of DPCs and CDAs. Active farmers were

selected for representatives through a number of discussions among community members in the pilot project sites. These active farmers could get other community members involved in various activities such as environmental awareness activities. Female members, however, are rarely selected as representative because their roles are still limited in terms of the DPCs activities. Yet, one of the pilot project lessons is that female community members still can join a meeting of DPCs. Therefore, involving active community members is a key to motivate community members for project activities, and female community members should be involved in a planning process of community activities.

Setting up Drafted Internal Regulations

Internal regulations of DPCs are one of the key aspects to establish DPCs. This is because members of active committees are aware of their own internal regulations. Internal regulations stipulate basic rules of the DPCs. Members of active DPCs are supposed to understand and be aware of their internal regulations. For example, there is an active BCWUA in Garbeya Governorate, and most members are aware of their own internal regulations. Some of the board members even took a training session on internal regulations. Therefore, it is important to get the DPC members involved in the process of setting up internal regulations.

Internal regulations are drafted based on Law No.12/1984 and Law No.213/1994. These laws define management of irrigation and drainage networks, including branch canals, mesqas, and drains. Also, internal regulations of WUAs were also referred to as a model. Drafted internal regulations consist of 37 articles. It covers a wide range of topics such as frequency of meetings, communication protocols, organization structures, memberships, and administrative rules. It is not easy for DPCs' members to finalize their internal regulations before they implement any activities. For this reason, internal regulations are just prepared as a draft at the time of establishment, and they are finalized when all the facilities are ready to operate.

Capacity Development of Users' Associations

Capacity development activities are proposed before finalizing the internal regulations. Study-visit to advanced BCWUAs and environmental campaigns are supposed to be considered as capacity development activities. The purpose of the study-visit is that DPCs' and CDAs' members get practical experience on activities of users' associations. In fact, there are number of advanced BCWUAs established under IIIMP. Outcomes of IIIMP will be utilized for capacity development of DPCs and CDAs. Members of DPCs and CDAs will make an action plan after a study-visit, and environmental awareness activities are planned. This process strengthens capacity of DPCs and CDAs, and it clarifies contents of internal regulations. Furthermore, qualifications of representatives are confirmed through these capacity development activities, and some DPCs and CDAs are expected to have an opportunity to change their representatives before they finalize their internal regulations.

Finalization of Internal Regulations

DPC members review a draft of the internal regulations through implementation of their action plans. The DPC members finalize the internal regulations and they get consensus from DPC members. The DPC members are expected to empower through the pilot activities, and finalization of the internal regulations is a part of this empowerment process. The DPC members can review basic principles of their own organizations. The DPC members will submit the final internal regulations to the Undersecretary of the MWRI and irrigation sector in Kafr El Sheikh to get approval on it. Although the DPCs do not have any legal status, the DPCs are related to a wide range of stakeholders including irrigation, drainage sectors, and local units. Therefore, it is important for the DPCs to formulate the internal regulations and get approval from the Undersecretary of Irrigation Sector in Kafr El Sheikh.

Table 4.7.4 Main Items of Internal Regulations

Items	Contents
1. Regulation of the Internal Actions	・ Term of Appointment ・ Communication, Records and Books ・ Committee Meetings ・ Membership
2. Responsibilities	・ Responsibilities of the Board members ・ Terms of reference of the Committee/ Functions of Committee Members ・ Relationship between Branch Canal Water Users Association and the Committee
3. Penalties and Irregularities	・ Sanctions of violating Committee members - Replacing violators and offenders ・ Types of irregularities impose sanctions for violations ・ Dispute Settlement

Source: JICA Study Team

Ministerial Decree

The Undersecretary of Irrigation Sector in Kafr El Sheikh Governorate circulates a ministerial decree regarding the DPCs' establishment after internal regulations are approved. The ministerial decree mentions main purposes, activities, and members of DPCs. DPCs are officially approved by the ministry, and they become official representatives of the beneficiaries of the drainage reuse pump stations.

Contents of the Ministerial Decree
Article I: Pump Committee members Article II: Roles of Engineers Article III: Pump Committee's obligations Article IV: Dissolution of Pump Committee Article V: Implementation of resolution

4.7.4 Procedures and Points on Planning of Facilities

Procedures and points on planning of Irrigation Complex facilities are shown as follows.

(1) Rural Sewerage Facility

One of the important issues of planning for rural sewerage facility is to find a proper site. Acquisition of farm land is generally difficult in Egypt. Empty lot is usually used for communal area and it takes so complicated procedure to obtain all landowner's consent for construction. Therefore, planned site is mostly in the public land.

Once a proper site is chosen, authorities will approve the construction of rural sewerage facility, through discussions among stakeholders It needs explanation to and approval from CDA, Governorate, drainage authority, public health department of municipality. Each authority offers their strict conditions and sufficient preparation period to deal with these considerations is necessary.

Treatment method should be decided through the consideration on ease of operation and maintenance (O&M), also cost of O&M. As for the way of O&M for rural sewerage facility, management commission to private company and technical staff's periodically check will be considerable in the future. In the current condition, number of this rural sewerage facility is not so many and it is not a realistic way to cosign the O&M work to a private technical corporation. From this point of view, choosing an optimal treatment method that O&M work can be easy for farmers, villagers and managing staff without sufficient knowledge and experiences on O&M of the rural sewerage facility is needed.

In regard to equipments in the treatment facility, a necessary and sufficient configuration is desirable. High level of measurement instrument is hard for handling and to be avoided. Also, rural sewerage

facility is a small scale treatment plant and its budget for construction and operation is often limited.

Odor from sewerage treatment plant sometimes causes complaint from residents. Adopting a type of underground treatment tank or installation of cover on the opening of treatment tank is recommended. Keeping distance from houses is also important. In the case that such effective measures are taken, deodorization equipment is not necessary.

(2) In-stream Treatment Facility

In the consideration on the type of In-stream treatment facility, to comply with drain water level provided by drainage authority is important. In the present regulation of drainage authority, elevated water level after installation of In-stream treatment facility should be less than 20 centimeters. However, a base of drain water level before the installation of facility is often different from their original designed water level of drain and it needs an attention.

Under the condition of less than 20 centimeters of water level elevation, and with consideration of not using pump, blower or other equipments in the view of economical operation, applicable treatment method is confined. Moreover, careful maintenance is not available in rural area. Sludge treatment and filter element that needs frequent exchange are unsuited in Egypt. Sedimentation and Vegetation treatment system used in this pilot project is an appropriate way.

Study on plant species for vegetation treatment is done by some research institute such as DRI. Not only ability of treatment but also continuity is important in the practical stage. That is to say, ease of obtaining and good growth is necessary. Water hyacinth and reed grows wild in drain are suitable for visitation treatment in rural area. Especially, water hyacinth grows in short period and when it become the condition of rank growth, removal and dredging work is required. Periodical dredging with construction machine by drainage authority is a key for continuous effectiveness.

If the vegetation zone extends for a few kilometers, effectiveness of treatment increases. However, maintenance toward long distance of drain is not practical and a few hundreds of meters of vegetation zone is good for introduction.

In-stream treatment facility is not a kind of plant that over 90 percent of pollutant removal rate is expected. Therefore, urban wastewater treatment is a fundamental measure for the drain of high contamination. It is recommendable to plan the In-stream treatment facility for the sake of ensuring water quality conservation or 1- to 20 percent of water quality improvement.

(3) Drainage Reuse Pump

Many type and scale of drainage reuse pumps are working in Egypt. It is useful to refer such existing plan and design of pump facilities. Important point is to choose a reliable pump manufacturer which has a lot of delivery records and less of accidents. Regarding incoming work, demarcation between power company and construction side is necessary. In the stage of supervision of construction of buildings and installation of pump, confirmation of schedule and careful quality control are must. Pump committee of Irrigation sector joins at inspection of factory test and handover of facility. Scheduling and confirmation of test points should be done beforehand.

(4) Compost Bed

Since land acquisition for composting facility is also difficult, it is better to plan this structure on the bank of drain. However, in the case that compost bed is located on the bank, bank protection against drain flow is required. As for bank protection, discussion and considering with drainage authority is necessary so as not to design an excessive structure.

4.7.5 Women's Involvement

Although it is not common for female community members to join a DPC and a CDA, female community members are expected to facilitate environmental awareness activities. In particular, women are usually responsible for children's education about household waste management and environment. In addition, most rural women involve in raising animal and some agricultural activities. Introducing Irrigation Complex facilitates female involvement in environmental awareness activities. Male community members can also realize the importance of female roles. Female involvement is even limited at mosques with Imams. It is necessary to promote female participation carefully. The major roles of female in Irrigation Complex extension as follows:

Table 4.7.5 Female Roles and Involvement in Environmental Activities

Environmental Awareness	Activity	Female roles/ how to involve female
Spreading environmental awareness in communities	Garbage collection in communities	Female has responsibilities for domestic garbage management. It is necessary to get female involvement in garbage collection.
Environmental awareness creation through Imams	Meeting with Imams	Female session should be organized since female rarely visit mosques.
Environmental campaign/ canal cleaning	Garbage collection and tree planting	It is difficult for female members to participate in the activity. It could be effective to facilitate female participation through female teachers in communities.
Environmental Campaign/ Education at school	Lectures for students and parents	Mothers take care of children. Mother should participate in environmental education activities at school. It is expected mothers spread environmental awareness at home.

Source: JICA Study Team

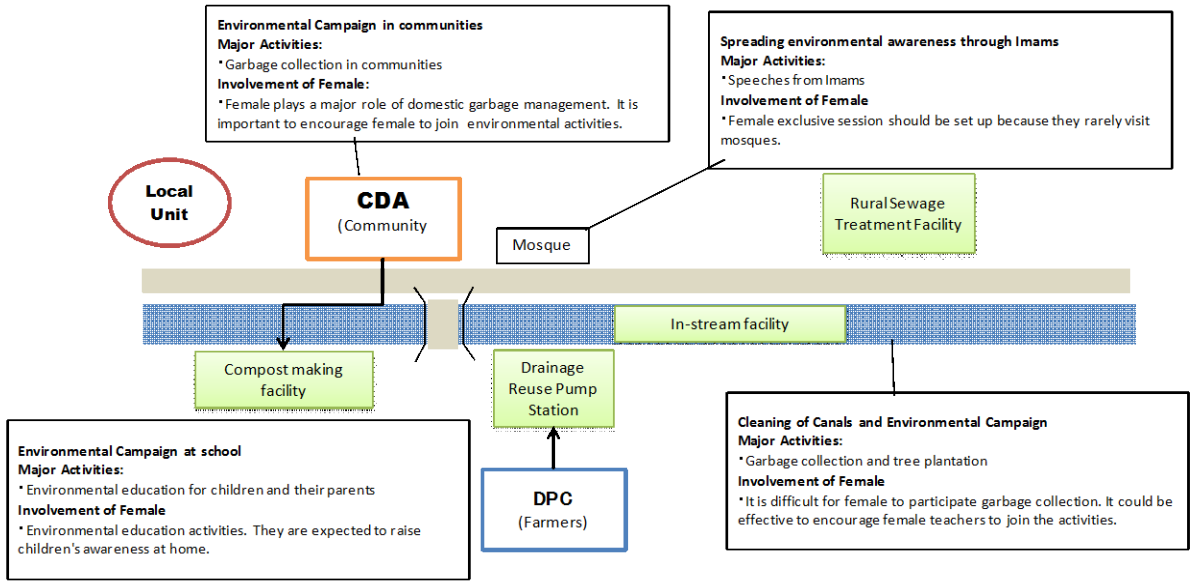


Figure 4.7.4 Approach for Female Involvement in Environmental Awareness Activities

4.8 Operation and Maintenance Plan

4.8.1 Operation and Maintenance Plan for Drainage Water Reuse Plan

Construction of irrigation complex facilities involves in wide range of organizations. These organizations are also involved in operation and maintenance of drainage water reuse plan. Some part of irrigation complex component is transferred to the users' associations. The following table summarizes operation and maintenance of irrigation complex facilities.

Table 4.8.1 Roles and Responsibilities of Each Drainage Water Reuse Project

Facility	Implementer and O&M
Establishment of Irrigation Complex	Preparation of the Protocols: Irrigation Sector: O&M of drainage reuse pump stations (operation, fuel supply, and maintenance), Drainage Sector: O&M of In-stream facility (dreading, removing plants, and gate operation), HCWW: monitoring for sewerage facility, technical support, supply chlorine, buying sledge, DPC: coordination about pump operation and canal cleaning CDA: O&M of sewerage facility (collection of service fee, operation, basic maintenance, dreading, garbage collection, and operation of compost making facility)
Improving Drainage Water Quality for Irrigation in Garbia Drain	EPADP: Maintenance of drains Irrigation Sector and MED: O&M of pump stations HCWW: O&M of urban sewerage facility
Large-scale Reuse Pump Installation Project	EPADP: O&M of drains Irrigation Sector and MED: O&M of pump stations
Renewal of Drain by Box Culvert	Local Government and Drainage Sector: garbage collection and regular maintenance including dreading.

Source: JICA Study Team

4.8.2 Operation and Maintenance of Irrigation Complex Facilities

The irrigation complex facilities are new approach to increase drainage reuse for irrigation. It consists of many different facilities. Some of the facilities have already been installed in other areas in the delta region. For example, drainage reuse pump stations have already been installed in many areas. The irrigation sector is used for the operation and maintenance of the drainage reuse pump stations. On the other hand, some of the facilities are new to the irrigation and drainage sectors, and to other stakeholders such as in-stream facility and sewerage facility. It took time to get consensus about the operating system of the new facilities

The in-stream facility is managed by the drainage sector. Yet, it is new facility to the drainage sector, and they have no experience in taking care of this kind of a facility. There are three main activities; 1) clean up garbage in the drain, 2) dreading, and 3) drain water level control in irrigation period. These activities should be incorporated in mandatory services of the drainage sector

A CDA is a major actor for operation and maintenance of sewerage facility. Operation of sewerage facility is simple and even CDA members can operate the facility. It is, however, difficult for a CDA to conduct regular maintenance and repairing the facility. HCWW provides technical support to a CDA. This kind of arrangement should be clarified in the Protocol. Therefore, it is important to clarify roles and responsibilities of each stakeholder. It is recommended that a meeting for protocol signing should be held at the governor's office so that all the stakeholders take the protocol seriously. Under the pilot project, the protocol meeting was held at governor's office with 10 stakeholders. All the stakeholders agreed the contents of the protocol and signed the protocol in front of the Governor.

1) The Governor of Kafr El Sheikh,
2) Undersecretary of Drainage in Middle Delta,
3) Undersecretary of Irrigation in Kafr El Sheikh,
4) The Holding Company for Water and Wastewater in Kafr El Sheikh,
5) General Directorate of Irrigation in West of Kafr El Sheikh,
6) General Directorate of Drainage in West of Kafr El Sheikh,
7) Head of the Kafr El Sheikh City Council,
8) Head of Sandel Local Unit,
9) Head of the CDA,
10) Head of the Drainage re-use Pump Committee.

The protocol for the irrigation complex facilities consists of five parts; 1) Operation and Maintenance of the Pump Station, 2) Operation, Maintenance, and Follow-up with the In-stream Treatment Facility, 3) Operation, Maintenance, and Follow-up with the Network Pipeline and the Sewerage Plant, 4) Operation, Maintenance, and Follow-up with the Compost Facility using Agricultural Waste, and 5) Operation, Maintenance, and Follow-up with the Garbage Collection System. The table below shows summary of the operation and maintenance systems of each facility:

Table 4.8.2 Summary of Operation and Maintenance of Irrigation Complex Facilities

Facility	Operation and Maintenance
Drainage re-use Pump Station	・ Irrigation Sector has all the responsibilities for O&M. ・ DPC plays a role of coordinator between irrigation engineers and farmers. Also, they promote environmental activities. ・ Drainage Sector has the responsibility for maintenance in drain.
Sewerage Facility	・ The CDA has all the responsibilities for daily operation and maintenance such as collection of service fee, preparation of operators, and coordination with HCWW and local units. ・ HCWW provides technical support to the CDA. ・ Local Units support the CDA in terms of administrative works including service fee collection from villagers.
In-Stream Facility	・ Drainage Sector has responsibility for In-Stream Facility since it is installed in the drain. Particularly, Drainage Sector takes care of drainage water level, garage stack piled up at the screen, and dreading.
Compost Making Bed	・ The CDA operates the compost making bed. They coordinate users and produce compost. Also, the CDA coordinate relevant organizations such as Agricultural office if necessary.
Garbage Collection System	・ The CDA continues garbage collection system. They collect garbage from villagers and bring it to the dumpsite of the local unit. They also collect garbage collection fee from villagers.

Source: JICA Study Team

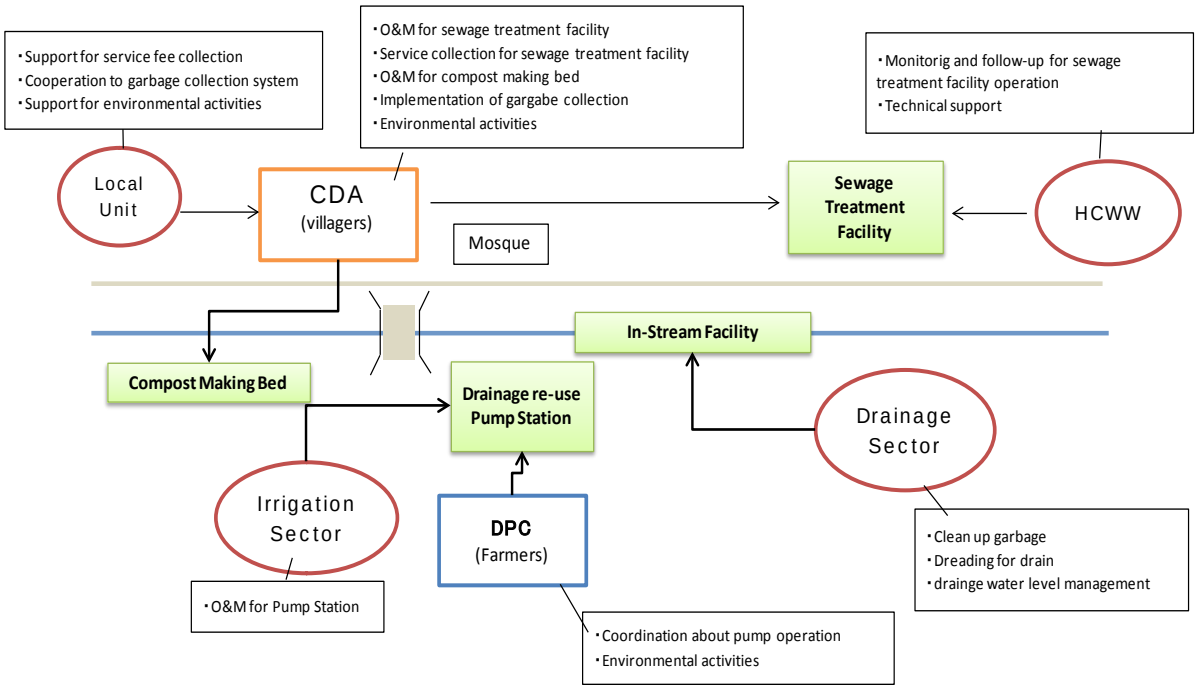


Figure 4.8.1 Operational Structure of Irrigation Complex Facilities

4.9 Project Cost

Table 4.9.1 shows total cost of Drainage Water Reuse Plan and Table 4.9.2 shows project cost of each component of the Plan. Total project cost of this 10-year Drainage Water Reuse Plan is estimated USD231 million. The project cost of Improving Drainage Water Quality for Irrigation in Garbia Drain is the largest part of the total cost with USD200 million, and it accounts for 87% of the total cost. Major components of Strengthening Effective Use of the Water Quality Monitoring System and Effective Use of Drainage Water for Crop Production are soft component activities with experts. Renewal of Drain by box culvert is planned by MWRI, and budget for box culvert construction with 240 m has already approved in the 2015 year.

Table 4.9.1 Project Cost for Drainage Water Reuse Plan (USD1,000)

Project	Total	Short Term	Mid Term	Long Term
Extension of Irrigation Complex	21,500	1,250	9,000	11,250
Improving Drainage Water Quality for Irrigation in Garbia Drain	200,000	1,000	149,000	50,000
Improvement and Construction of Sewerage System	4,000	800	3,000	200
Renewal of Drain by Box Culvert	2,600	624	607	1,369
Strengthening Effective Use of the Water Quality Monitoring System	700	350	350	-
Effective Use of Drainage Water for Crop Production	2,000	1,000	1,000	-
Total	230,800	5,024	162,957	62,819

Irrigation Complex with full component costs USD450,000 per site. Partial components of the irrigation complex will be decided in consideration of site condition and budget. In fact, MWRI is promoting installation of drainage reuse pump stations. Partial components of the irrigation complex (in-stream facility, sewerage facility, compost making facility, and environmental campaign) can be introduced to these target sites of MWRI's drainage pump stations. Also, the irrigation complex is supposed to introduce to 46 potential sites out of 90 potential sites after the feasibility study.

Table 4.9.2 Contents of Each Project Cost

Project	Description
Extension of Irrigation Complex	Each irrigation complex site costs USD450,000 (USD230,000 for pump stations, USD86,000 for in-stream facility, USD 76,000 for Sewerage facility and USD20,000 for sewerage pipe, USD33,000 for compost making facility, and other activities such as strengthening WUAs and environmental campaign). F/S: USD800,000, 46 sites will be selected from 90 potential sites.
Improving Drainage Water Quality for Irrigation in Garbia Drain	Construction of Mahala Kobula sewerage facility (domestic sewage 120,000 m^3/day and industrial sewage 45,000m^3/day) USD180,000,000, rehabilitation of Hamor pump station (10m^3/s)USD4,000,000, drainage reuse pump stations (Alniel and Al sheika canals) USD2,300,000, construction of sewerage facility in Garbia Drain USD1,000,000.
Improvement and Construction of Sewerage System	Cross point between No.8 Drain and Mit Yazeed Irrigation Canal (10m^3/s)USD4,000,000
Renewal of Drain by Box Culvert	Box culvert USD867/m×3,000m
Strengthening Effective Use of the Water Quality Monitoring System	One expert, 6 years * 0.6 (annual assignment), equipment
Effective Use of Drainage Water for Crop Production	Two expert, 6 years * 0.6 (annual assignment), equipment

4.10 Expected Outcomes

4.10.1 General Impacts

(1) Solving Water Shortage Problems at Peak Period

Water deficiency in Kafr El Sheikh Governorate is estimated with 822MCM in a year. The government announced that the amount of annual drainage water reuse is 669.5MCM. It is common that farmers use drainage water with their own small pumps to cope with shortage of irrigation water. Although there is no official record of personal drainage water reuse, the amount of water deficiency is estimated with 1,508MCM in total[6].

Water deficiency in Kafr El Sheikh Governorate is 516MCM at peak period (September). Irrigation complex including sewerage facility plans to establish at 46 sites. 1 m3/s of drainage water is expected to be available for reuse at each site. Also, drainage reuse pump stations have capacity to provide 10m3/s. Total drainage water reuse amount reaches 56m3/s. A monthly drainage water reuse amount will reach 145MCM at a peak month. It accounts for approximately 28% of total water deficit in Kafr El Sheikh. Drainage water reuse has already practiced widely; yet, water demand is also increasing. Expansion of sewerage facility promotes drainage water reuse with water conservation. Therefore, the expected drainage reuse amount under the Drainage Water Reuse Plan has a certain impact on current situation.

[6]As mentioned in Chapter 2, 2.3.3, This shortage is an estimation of assuming the increase of farmlands by land reclamation from 600,800 fed to 680,700 fed.

(2) Improve Rural Sewerage Situation

As shown in Chapter 2, sewerage construction rate in Kafr El Sheikh Governorate is 100% in urban area and 35% in rural area (72 villages from 206 villages). The rate of sewerage construction will increase to 57% if irrigation complex establishes at 46 sites. The rate of swage coverage by population, however, will decrease because irrigation complex targets even small hamlets. Therefore, the Ministry of Housing should also promote construction of sewerage facilities in small-middle sized cities.

(3) Increase of Agricultural Income

Direct impact of drainage water reuse is to solve water deficit and increase of agricultural production. The irrigation complex facilitates is so called middle-drainage water reuse; namely, it pumps up branch drain to the end of branch canals. As for Garbia Drain and Bahar Tera (84,800 feddan), drainage water is mixed at upstream of the branch canal. Drainage water of Drain No.8 is also mixed at upstream of the branch canal to provide irrigation water for 16,900 feddan. Each irrigation complex site covers 1,800 feddan, and the total beneficial area is 82,800 feddan with the 46 potential irrigation complex areas. Expected total beneficial area of a long term irrigation plan is approximately 190,000 feddan. It accounts 34% (566,024 feddan) of cultivation area (566,024 feddan) in Kafr El Sheikh Governorate.

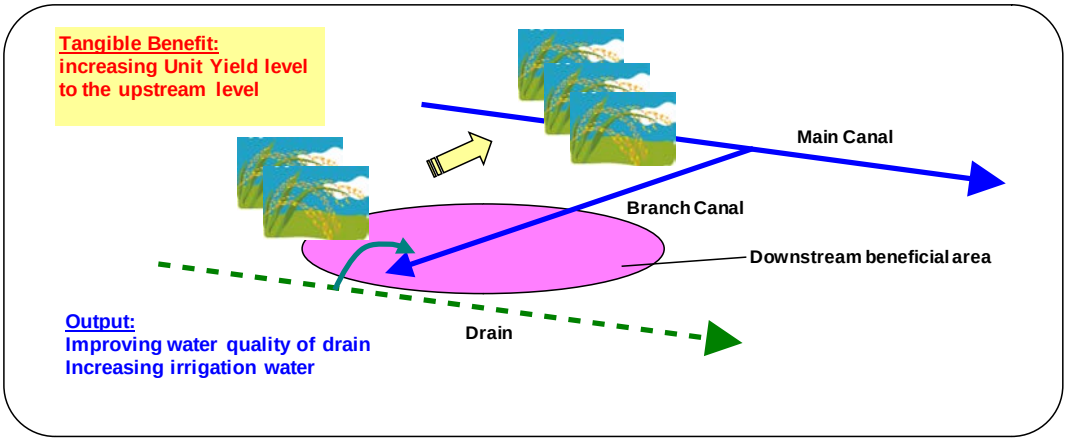


Figure 4.10.1 Benefit of Drainage Water Reuse through Irrigation Complex

One of the major impacts of the proposed Projects is increase of crop yield, and it leads increase of agricultural income. Cutting-crop experiment was conducted during the pilot project. The result of this experiment reveals that yield gap between upstream and downstream is 16%. Crop yield in the whole canal was simply set as 8% which is average values of upstream and downstream. Target increase rate of Maize was decided 23% based on the results of the cutting-crop experiment. Target increase rate of cotton and other vegetables was also set as 8%, which is the same as target increase rate of rice. Increase rate of winter crops also targeted between 3% and 5% since there is water shortage even in winter season. In addition, it is estimated that average farm income is increased 692 LE/ feddan. This estimation is calculated based on standard farm size and cultivation area by crop. Total farm income increase in Kafr El Sheikh Governorate is expected 131.5 million LE per year.

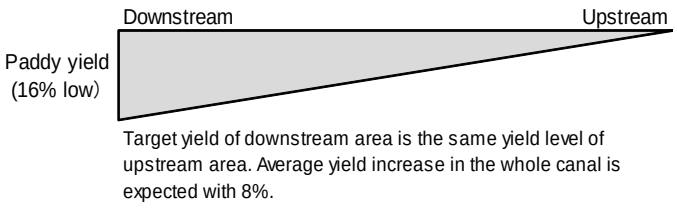


Figure 4.10.2 Estimation of Agricultural Benefit

Table 4.10.1 Average Income Increase through Drainage Water Reuse

Crop	Without Project					With Project(Sumer:rice 8%, maize 23%, Other 8%)) (Winter: wheat 3%, berseem 3%, sugarbeet 5%)					Difference
	Cropped Area (fed)	Yield (t/fed)	Price (LE/t)	Cost (LE/fed)	Net Income (LE)	Cropped Area (fed)	Yield (t/fed)	Price (LE/t)	Cost (LE/fed)	Net Income (LE)	(LE)
Summer Crop											
Paddy	1.44	3.00	2,000	2,290	5,342	1.44	3.24	2,000	2,290	6,034	
Maize	0.24	3.50	1,500	2,888	567	0.24	4.31	1,500	2,888	858	
Cotton	0.60	0.90	6,300	4,226	866	0.60	0.97	6,300	4,226	1,131	
Other (melon)	0.12	13.22	697	2,764	774	0.12	14.28	697	2,764	863	
Winter Crop											
Wheat	1.20	1.59	1,700	1,541	1,395	1.20	1.64	1,700	1,541	1,496	
Berseem	0.36	39.02	55	279	673	0.36	40.19	55	279	695	
Sugar beet	0.84	17.62	270	1,618	2,637	0.84	18.50	270	1,618	2,837	
Total	4.80				12,254	4.80				13,914	1,660
farmland =2.4fed					**5,106**					**5,798**	**692**

Source: JICA Study Team

4.10.2 Impacts of Each Project

Expected impacts of each Project are summarized in the following table. Quantitative impacts are also described in this section.

Table 4.10.2 Expected Impact of the Proposed Projects

Project	Impact
Extension of Irrigation Complex	Increase of drainage reuse water for irrigation, improve crops productivity, increase of agricultural income, decrease conflict among farmers, improve living condition, and decrease of hydraulic diseases, etc.
Improving Drainage Water Quality for Irrigation in Garbia Drain	Increase of drainage reuse water for irrigation, improve crop productivity, increase crop price by water conservation, increase agricultural income, improve living condition, and decrease of hydraulic diseases, etc.
Improvement and Construction of Sewerage System	Increase of drainage reuse water for irrigation, improve crop productivity, and increase agricultural income.
Renewal of Drain by Box Culvert	Drainage water conservation, reduce odor in residential areas, prevention from slip and fall accidents, and land creation.
Strengthening Effective Use of the Water Quality Monitoring System	Identify pollution sources, prioritize countermeasures, and improve investment efficiency.
Effective Use of Drainage Water for Crop Production	Reduce agricultural production cost through, and increase of agricultural income.

Source: JICA Study Team

(1) Establishment of Irrigation Complex

There are 91 potential sites for Irrigation Complex Establishment. The number of feasible sites of Irrigation Complex, however, seems to be rather limited. In fact, some of the potential sites are excluded during the pilot project because of water quality and willingness of local residents. For this reason, Irrigation Complex is planned to introduce to 46 sites out of 91 potential sites in the Drainage Water Reuse Plan. As mentioned in the above, agricultural income is expected to increase 692 LE/feddan through promoting drainage water reuse. Benefit area of Irrigation Complex site in the pilot project was 1,800 feddan. Thus, total benefit area of Irrigation Complex for 46 sites is estimated 82,800 feddan (34,776ha). It covers 15% of the total cultivation area in Kafr El Sheikh Governorate. Also, increase of annual agricultural income is expected to reach 57.3 million LE.

The result of financial evaluation shows that Irrigation Complex is feasible; FIRR is calculated 27.8% for Irrigation Complex including drainage reuse pump, in-stream facility, and rural sewerage facility. Rural sewerage facility should be installed from the view point of civil minimum. Water conservation and improvement of agricultural productivity seem not to be direct impacts of rural sewerage facility.

Even though, the result of financial analysis shows that irrigation complex is economically feasible even considering construction cost of sewerage facility.

(2) Water Quality Improvement of Garbia Drain

Benefit area between Hamoul Reuse Pump Station and Bahar Tera canal is 84,800 feddan. Also, benefit area of Al Nil and Al Sheikha canals is 5,000 feddan. The total benefit area of this Project is 16% of governorate cultivation area. Increase of annual agricultural income is estimated 62.1 million LE. This proposed Project also includes improvement of Mahala Kobra sewerage facility and strengthening its capacity. 90% of the total Project cost is improvement of this sewerage facility. It is difficult to cover this Project cost by increase of agricultural production at downstream farm areas. Benefit of drainage water reuse is only a small part of the total project impact. Therefore, the Project should not be justified by only financial aspects of the Project such as IRR.

The area of fish pond is increasing in North east of Hamoul district, downstream benefit area of Bahar Tera canal. Not only profitability of aquafarming, but also low productivity of farm land causes increase of aquafarming. Figure 4.10.4 shows comparison between income of aquafarming and agriculture. The figure also includes increase of agricultural income (average increase and maximum increase), improvement of productivity based on governorate agricultural statistics data.

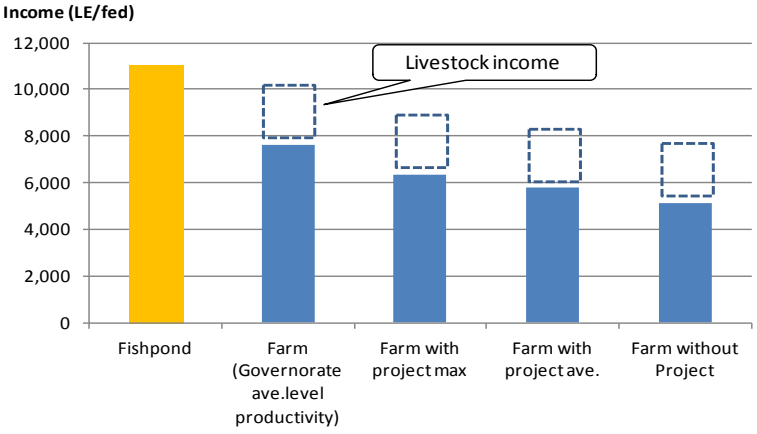


Figure 4.10.3 Income Comparison between Agriculture and Aquaculture

As described in Chapter 2, according to the interview survey, profitability of aquafarming was almost double as profitability of agriculture. Even if agricultural productivity is improved, agricultural income could not exceed the amount of income from aquafarming. Short-term profitability of aquafarming, however, could not be strong incentive for farmers. Aquafarming has a lot of risks. For example, a large amount of initial investment is necessary, and diseases could cause severe damage on fish. In addition, farmers can cultivate berseem for livestock in winter season, and they can get steady livestock income. On the other hand, aqua farmers cannot cultivate any crops in winter season. Income gap between farming and aquafarming can be smaller if considering income from livestock such as selling meat and dairy products.

Furthermore, there are still number of subsistence farmers. They cultivate rice and wheat for home consumption. This could be another reason for farmers to keep their farm land. From this point of view, solving water shortage with water conservation leads improvement of agricultural productivity. This positive linkage encourages farmers to keep farm land and involve in more productive farming.

(3) Construction of Large-Scale Drainage Reuse Pump Station

Propose Drainage Reuse Pump Station Project is located at crossing-point between Drain No.8 and Meet Yazid canal. Expected benefit area is 16,900 feddan (7,098ha), and it accounts for 3% of the total cultivation area in Kafr El Sheikh. IIIMP is working on irrigation improvement in this area; yet, there is severe water shortage at peak period. Drainage water reuse should be facilitated to cope with this

water shortage problem in this area. The proposed Project contributes to increase of agricultural income with 11.7 million LE/ year. FIRR of this Project is calculated with 25.8%. This financial analysis result indicates that the Project is feasible financially.

(4) Drain by Box Culverts

It is difficult to measure solid impacts of drainage culvert Project. Particularly, short culverts affect nothing on water quality. Drainage culverts are introduced only in residential areas. As such, length of drainage culvert becomes less than 500m. Drainage culvert is expected to reduce suspended solids through decrease of household waste in the drain. Although it is necessary to set screens at drainage gateways and collect solid wastes regularly, drainage inflow can be improved. There are other positive impacts such as improvement of safety and clearness, odor prevention, and creation of new area. 3km of drainage culverts can create 180,000 m2 (1.8ha).

(5) Strengthening Effective Use of Water Quality Monitoring System

This proposed Project is to strengthen existing water quality monitoring system with water quality experts. The major activities suppose capacity development activities; thus, it is difficult to measure impacts of the Project quantitatively. Yet, financial efficiency of whole the proposed Projects will be improved if results of water quality monitoring utilize for drainage water reuse plan and implementation.

(6) Effective Use of Drainage Water for Crop Production

BOD and DO are improved through drainage water conservation, and drainage water includes nitrogen. Nitrogen can be used for crop production as fertilizer. The amount of available nitrogen depends on soil and climate condition. This substitution effect of fertilizer is estimated as follows:

1) Estimate the amount of nitrogen in drainage water,
2) Estimate absorption rate of rice for nitrogen,
3) Estimate absorption amount of nitrogen and drainage reuse amount. Also, estimate reduce amount of chemicals
4) Estimate reduction of production cost with transferred nitrogen cost into fertilizer unit price

Water quality monitoring was conducted in 2014 and 2014 at the 5 pilot project sites. The result of this monitoring system reveals that average T-N value was 9.98mg/l between July and August, namely during the period when nitrogen is utilized for crop production as fertilizer.

Table 4.10.3 Results of Nitrogen Measurement in the Pilot Project Sites

Month	E1: Frash Alganaen		E4: Mekhazen		W2: Drain No.11		W4: Faraon		W5: Sandela		Average		
	2013	2014	2013	2014	2013	2014	2013	2014	2013	2014	2013	2014	Average
Jul	4.20	11.40	21.80	11.42	17.00	8.20	12.60	10.52	11.76	5.60	13.47	9.43	11.45
Aug	6.72	9.82	12.88	10.44	11.00	7.20	8.48	8.45	5.48	4.54	8.91	8.09	8.50
Ave.	5.46	10.61	17.34	10.93	14.00	7.70	10.54	9.49	8.62	5.07	11.19	8.76	**9.98**

Source: JICA Study Team

The amount of water shortage in July and August reaches about 38.5% and 47.2% of required amount respectively. The amounts of water are 501.27m3/ month in July and 687.7m3/month in August. Maximum nitrogen concentration set as 4ppm to avoid excess input of nitrogen. Nitrogen will be provided 10.82kg/feddan based on this condition. The amount of substitute for fertilizer is estimated between 1.62kg/feddan and 4.76kg/feddan under the assumption of rice absorption rate with 44% (NH4-N) and 15% (NO3). Nitrogen absorption rate varies depending on the situation. Timing of drainage water reuse is also important to maximize substitution effect of fertilizer.

According to the interview survey, farmers applied fertilizer approximately 19kg/10a (80kg/feddan) of Nitrogen. Reduction of fertilizer is expected between 2% and 6%. Farmers, however, applied fertilizer larger than the standard amount. In Japan, farmers use 10kg/ha (42kg/feddan). Of course, cultivation environment is different so that it is difficult to compare the amount of fertilizer. Proper fertilizer application design will contribute to achievement of further reduction rate of fertilizer.

Reduction cost is equivalent to 10LE/feddan to 28LE/feddan of chemical fertilizer. Agricultural cooperatives sell fertilizer with subsidies and farmers have to purchase fertilizer in the market if they cannot get fertilizer from agricultural cooperatives. Therefore, it is important for farmers to control the amount of fertilizer. If fertilizer reduction practices in the area of 190,000 feddan, total benefit area of the Drainage Water Reuse Plan, production cost will be saved approximately 1.9 million LE and 5.3 million LE yearly.

Table 4.10.4 Drainage Nitrogen and Rice Absorption in Kafr El Sheikh Governorate (Paddy)

Month	Water Requirement for Paddy (m^3/fed/month)	Deficiency Rate	Drainage Reuse (m^3/fed/month)	N-T (kg/fed)	Nitrogen Supply (kg/fed)	
					Rice Absorption Rate 15%	Rice Absorption Rate 44%
July	1,302	0.385	501.27	5.00	0.75	2.20
August	1,457	0.472	582.8*	5.82	0.87	2.56
Total				10.82	1.62	4.76

* Total nitrogen concentration rate is 4ppm or less so that deficiency rate of drainage water reuse set as 0.4

Source: JICA Study Team

Table 4.10.5 Drainage Nitrogen and Rice Absorption in Kafr El Sheikh Governorate (Paddy)

Case	Nitrogen Absorption (kg/fed)	N fertilizer conversion unit price (LE/kg)	Reduction of fertilizer (LE/fed)
Nitrogen absorption rate of rice 15%	1.62	5.94	10
Nitrogen absorption rate of rice 44%	4.76	5.94	28

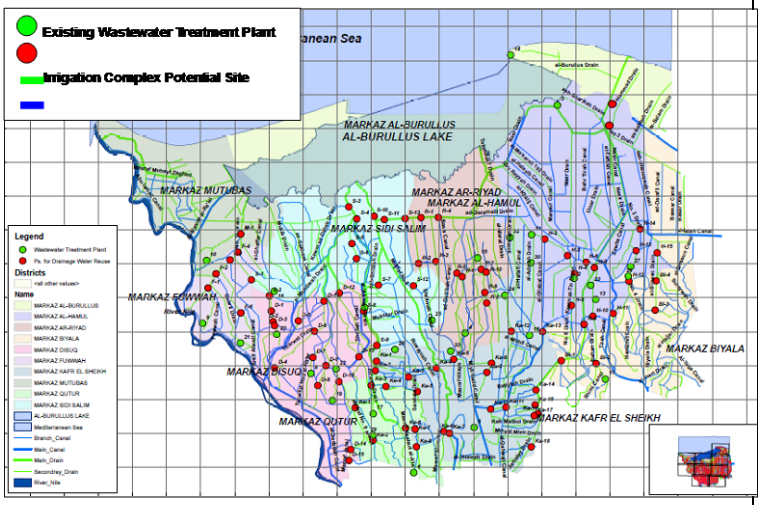
* Fertilizer price is subsidized (N fertilizer conversion unit price is average price of Urea: LE100/50kg, N46%, Nitrate LE95/50kg, N33%, Nitrate Femex LE85/50kg, N22%)

Source: JICA Study Team

4.11 Project Profiles (Action Plans)

Following summarize the profile of the aforementioned proposed projects. In this profile, the organization in charge of implementation and actions to be taken by time are also proposed.

(1) Project Profile: Establishment of Irrigation Complex

Project Title	**Irrigation Complex Establishment**
Project Purpose: Crop productivity is improved by the available drainage water acceptable for reuse for irrigation.	
Project Outline: The Project is to establish a set of facilities as "Irrigation Complex" to improve the water quality in the drain and enhance the reuse for irrigation. The Irrigation Complex consists of facilities such as drainage reuse pump, in-stream treatment, rural sewerage and compost making unit. Since it is difficult to establish these facilities by the beneficiaries' party themselves, a public investment is, therefore, necessary for the expansion of the complex but with the participation of farmer beneficiaries in operation and management for the sustainable use of the facilities. From the sustainability point of view, the activities of strengthening water users'' association and environmental awareness creation are incorporated in establishing Irrigation Complex.	Target Area: Whole Governorate 

Beneficiaries	Farmers suffering from water shortage especially located downstream reaches of irrigation canal Rural inhabitants suffering from deteriorating living environment, e.g. water borne diseases and bad smell.
Outputs	Short-term: Identified and prioritized project sites with feasibility study *(assumed a half of the candidate sits would be feasible, namely 46 sites to be identified as the project sites)*, one established irrigation complex Mid-term: Established irrigation complex *(assumed to be 20 sites)* Long-term: Established irrigation complex *(assumed to be 25 sites)*
Implementation Agencies	MWRI (EPADP, Irrigation Sector, IAS): facility construction, O&M of interim facility and pump station, strengthening WUA, environmental campaign HCWW: supporting O&M of rural sewerage system Local Unit: supporting O&M of rural sewerage system MALR: extension of compost making

Major Activities and Schedule (S: short-term, M: mid-term, L: long-term)

Activity		1th	2nd	3rd	4th	5th	6th	7th	8th	9th	10th
S-1	Showcasing the Pilot site (study tour, seminar etc.)	■	■								
S-2	Identifying proposed sites	■									
S-3	Carrying out Feasibility Study	■	■	■							
S-4	Prioritizing the feasible sites		■	■							
S-5	Commencing the implementation			■							
M-1	Expansion of the implementation				■	■	■				
L-1	Expansion of the implementation							■	■	■	■

Inputs	Rural sewerage system, In-stream treatment facility, Agricultural / Livestock disposal compost facility, Water reuse pump, Users' organization, Environmental campaign, and others (e.g. sub-surface drain reuse facility)
Project Cost Estimate	USD21,500,000
Project Benefits	Increase of available drainage water for irrigation, increase of crop productivity by mitigating water shortage (8% - 23% for summer crop), increase of farm income (692LE/fed, benefitted 82,800 fed in 46 sites or 15% of the governorate cultivated area and total 53.7 million LE/year), alleviation of conflicts among farmers along the same irrigation canal, improvement of living environment, reduction of waterborne diseases, etc. FIRR = 27.8%

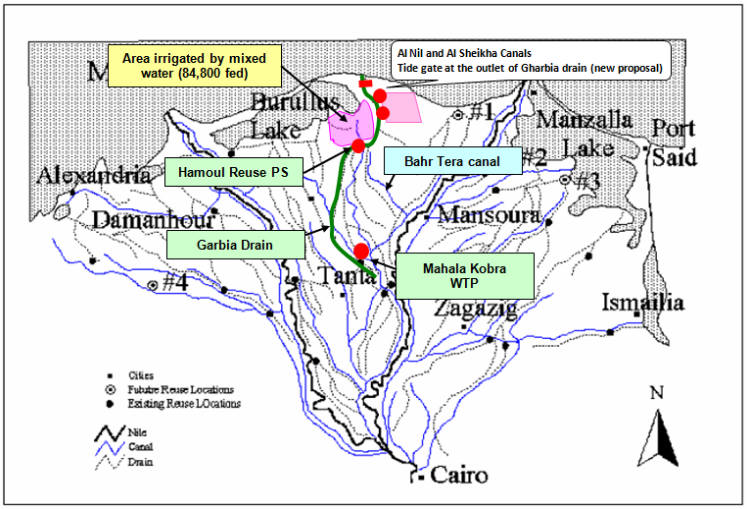
(2) Improving Drainage Water Quality for Irrigation in Garbia Drain

Project Title	**Improving Drainage Water Quality for Irrigation in Garbia Drain**

Project Purpose: Crop productivity and production are increased by improving drainage water of the Garbia drain for reusing for irrigation.

Project Outline:
Garbia main drain runs in the east side of the Governorate. The drain collects sewage from the big cities, namely Tanta and El Mahala El Kobra cities At the point of El Hamoul city, the drain crosses with Bahr Tera irrigation canal. At the crossing point, Garbia drainage water is mixed into Bar Tera by the Hamoul Mixing Pump Station. The water quality in Garbia drain is highly deteriorated mainly due to ineffective treatment of WTP in Mahalla Kobra by growing population.
Although it needs due feasibility study, the project would be consisted of rehabilitation of Mahalla Kobra WWTP, rehabilitation of Hamoul MPS, improving the reuse system of Al Nil and Al Sheikha canals, installation of tide gate, and rural sewerage installation in the villages along the Garbia drain (to be associated with irrigation Complex)

Target Area: Along the Garbia Drain / Farmlands in the downstream reaches of Garbia drain



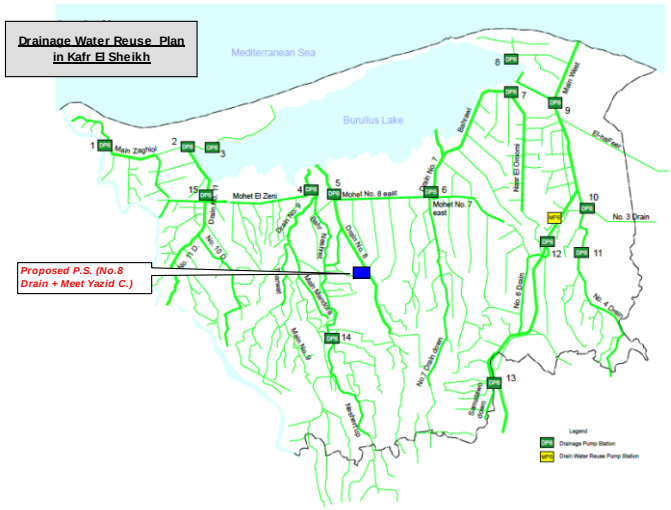
Beneficiaries	• Farmers suffering from water shortage and contaminated drainage water of Garbia drain in the downstream reaches of Bahar Tera irrigation canal, after the Garbia drainage water is mixed into the irrigation canal. • Farmers suffering from water shortage and contaminated drainage water of Garbia drain along Al Nil and Al Sheikha irrigation canals • Rural inhabitants suffering from deteriorating living environment in the downstream reaches of Garbia drain.
Outputs	Short-term: Feasibility Study, Basic Design, Detail Design Mid-term: Basic Design and Detail Design, implementation of some packages Long-term: Implementation of the remaining packages
Implementation Agencies	MWRI (EPADP, Irrigation Sector, MED): constructing rural sewerage system, rehabilitating Hamoul MPS, Installing reuse pumps to Al Nil and Al Sheikha, constructing Tide gate MHUUD (HCWW, NOPWASD): Rehabilitation and improvement of Mahala Kobra WWTP, supporting O&M of rural sewerage system

Major Activities and Schedule (S: short-term, M: mid-term, L: long-term)

Activity		1th	2nd	3rd	4th	5th	6th	7th	8th	9th	10th
S-1	Carrying out Feasibility Study	■	■								
S-2	Carrying out the Basic and Detail Designs (Prepare packages for implementation)			■							
M-1	Carrying out construction work of some packages				■	■	■				
M-2	Carrying out the Basic and Detail Designs (prepare packages for implementation)				■	■	■				
L-1	Carrying out construction work of the remaining packages							■	■	■	■

Inputs	Rehabilitation of Mahalla Kobra Wastewater Treatment Plant (WTP), Rehabilitation of Hamoul mixing pump station, Improvement of reuse system of Al Nil and Al Sheikha canals, installation of tide gate, and Irrigation Complex establishment along Garbia drain as associated project
Project Cost Estimate	USD200,000,000
Project Benefits	Increase of available drainage water for irrigation, increase of crop productivity and production by mitigating water shortage (8%-23% for summer crop), alleviation of bad reputation due to reuse of Garbia drainage water thereby the rise of crop prices, increase of farm income (89,800 fed or 16% of governorate cultivated area, or 62.1million LE/year), improvement of living environment, reduction of waterborne diseases, etc.

(3) Large-scale Reuse Pump Installation

Project Title	**Large-scale Reuse Pump Installation (associated with Improvement and Construction of Sewerage system**
Project Purpose: Crop productivity and production are increased by supplementing the Mit Yazeed irrigation canal water	
Project Outline: No.8 Main Drain crosses with Mit Yazeed Irrigation Canal, which is one of the main canals in Kafr El Sheikh. It is possible to install relatively large-scale re-use pump station at this crossing point. The scale of the re-use pump station will be designed from the degree of water shortage in the downstream reaches of the Mit Yazeed Canal command area. The irrigation system under the Mit Yazeed Canal has been implemented as IIIMP. The installation of the reuse pump station should be consulted with IIIMP overall picture of the plan. The associated improvement and construction of sewerage system would be implemented by the projects of MHUUD such as ISSIP, IWSP. Also the Irrigation Complex establishment in this M/P would be associated with this project, as well.	Target Area: Crossing point of No.8 drain and Mit Yazeed canal 

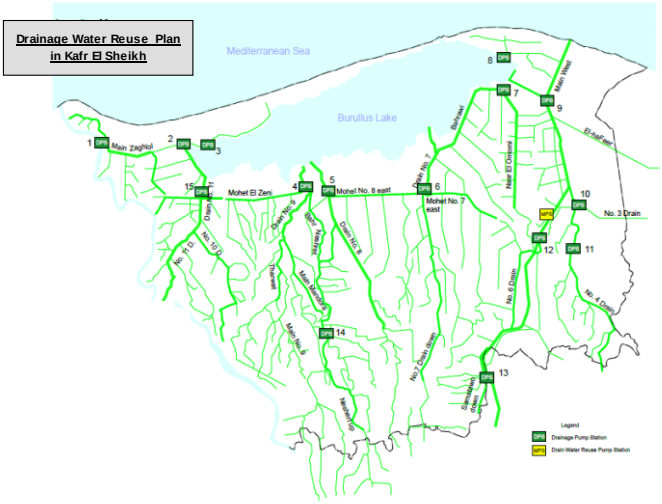
Beneficiaries	Farmers located in the downstream reaches of Mit Yazeed canal after the crossing point of No.8 drain and the canal.
Outputs	Short-term: Feasibility Study Mid-term: Basic Design, Detail Design, Construction Long-term: Construction
Implementation Agencies	MWRI (EPADP, Irrigation Sector, MED)

Major Activities and Schedule (S: short-term, M: mid-term, L: long-term)

Activity		1th	2nd	3rd	4th	5th	6th	7th	8th	9th	10th
S-1	Discussion and consent making with IIIMP	■									
S-2	Feasibility Study		■	■							
M-1	Basic Design and Detail Design				■	■					
M-2, L-1	Construction work						■	■			

Inputs	Pump station construction Technical trainings for pump operation and operation planning
Project Cost Estimate	USD4,000,000
Project Benefits	Increase of irrigation water, increase of crop productivity and production by mitigating water shortage (8%-23% for summer crop), increase of farm income (16,900 fed or 3% of governorate cultivated area, or 11.7million LE/year), etc. FIRR = 25.8%

(4) Renewal of Drain by Box Culvert

Project Title	**Renewal of Drain by Box Culvert**
Project Purpose: Contamination of drainage water passing through urban areas is reduced.	
Project Outline: Solid waste disposed in drainage canals is decomposed at the bottom of the drainage canals and it becomes one of the causes of hygienic environmental deterioration. Hazardous materials such as metals and glasses are also included in the garbage, and they create risks on human health in down streams. To improve this situation, drain has been covered with box culvert in urban area. It is possible by this method to avoid inflow of daily garbage and industrial waste into drains and keep water quantity and its flow in drain. In Kafr El Sheikh Governorate, approximately 3 km of the open drain in small and middle cities will be converted into box culvert in near future. With proposed decision criteria to choose the suitable site for applying the covering of drain, the project can be implemented mainly by the governorate.	Target Area: drains crossing the residential areas 

Beneficiaries	Farm reusing drainage water for irrigation. Inhabitants living in the township, through which drains are passing.
Outputs	Short-term: implement the project by MWRI (EPADP is to supervise and technically advise to the construction) according the request from the governorate (total 720m planned) Mid-term: - ditto – (total 700 m planned) Long-term: - ditto - (total 1,580 m planned)
Implementation Agencies	MWRI (EPADP): facility construction, technical advice Local Government (Governorate): O&M

Major Activities and Schedule (S: short-term, M: mid-term, L: long-term)

	Activity	1th	2nd	3rd	4th	5th	6th	7th	8th	9th	10th
S, M, L	Prepare annual implementation plan according to the request from the governorate										
S, M, L	Support designing work, construction work and O&M according to the annual plan										
S, M, L	Monitoring & Evaluation										

Inputs	Installment of box culvert to the drain, installment of screen on both side ends of the culvert
Project Cost Estimate	USD2,600,000
Project Benefits	Reduction of drainage water contamination, more available reuse water, reduction of odor in the residential areas, reduction of accident, and creation of land (18,000m^2)

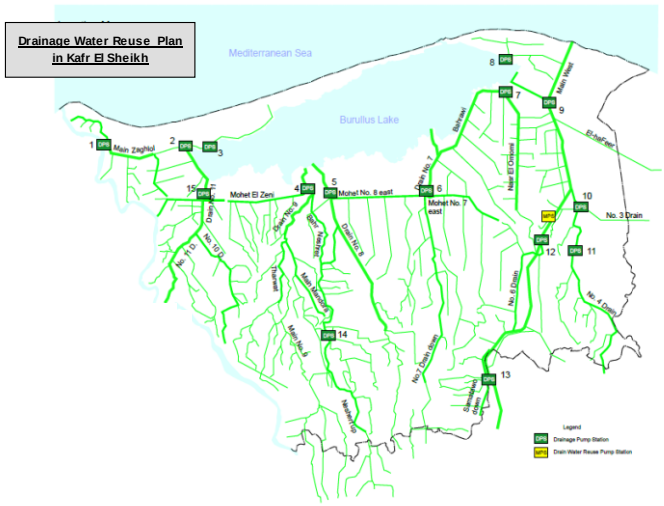
(5) Strengthening Effective Use of Water Quality Monitoring System

Project Title	**Strengthening Effective Use of Water Quality Monitoring System**

Project Purpose: Project promotion, planning and prioritization are efficiently carried out. Efficient and effective allocation of investment in water quality protection is realized.

Project Outline:
In the mid and long term, it is proposed to strengthen the effective utilization of the existing water quality monitoring system of the Ministry. As the existing system, DRI conducts water quality measurement regularly in the major main drains and publish the results as Drainage Waters Status in the Nile Delta- Year Book.
How to utilize the result of the water quality monitoring will be: 1) priority of water quality conservation plan is decided depending on the degree of water pollution in the main drains, 2) pollution sources are identified whether they are from disposal of waste or agricultural chemicals, so that different countermeasures will be applied for each pollution source. In implementing the components of this master plan, the effective use of the water quality monitoring system is combined in order to continuously monitor the water quality as well as the effects of the projects.

Target Area: whole governorate



Beneficiaries	Public and private organizations in water sector, agriculture sector and industry sector.
Outputs	Short-term: reviewing and improving of the existing water quality monitoring system Mid-term: practice of water quality monitoring, reviewing and improving the system Long-term: -ditto-
Implementation Agencies	MWRI (EPADP, DRI, Planning Sector (Water Quality Unit))

Major Activities and Schedule (S: short-term, M: mid-term, L: long-term)

Activity		1th	2nd	3rd	4th	5th	6th	7th	8th	9th	10th
S-1	Reviewing the existing water quality monitoring system	■									
S-2	Improving the existing water quality monitoring system		■								
S-3	Utilize the information to identify pollution sources and set the priority			■							
M-1	Practice the water quality monitoring				■	■	■				
M-2	Reviewing & improving the system						■				
L-1	Practice the water quality monitoring							■	■	■	■
L-2	Reviewing & improving the system									■	

Inputs	Technical assistance, installation of water quality testing equipment
Project Cost Estimate	USD700,000
Project Benefits	Identification of pollution sources is performed well. Prioritization of the intervention is performed well. Investment efficiency, i.e. Cost-benefit ratio in water quality protection projects is improved.

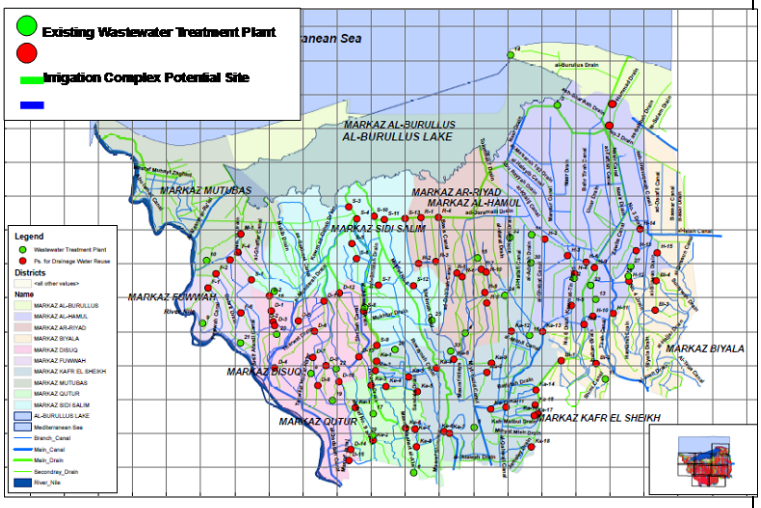
(6) Promoting Effective Use of Drainage Water for Crop Production

Project Title	**Promoting Effective Use of Drainage Water for Crop Production**

Project Purpose: Specify soil, water quality and adopt agricultural techniques with drainage water reuse, thereby farming with appropriate inputs is practiced by the farmers.

Project Outline:
Excessive use of chemical fertilizers is also said one of the pollutants for water. On the other hand, in a sense the drainage water contains essential nutrients for crop production. This could be utilized as fertilizers for crop and using drainage water could reduce the amount of chemical fertilizers.
As the drainage water reuse will be increasing, it is proposed to research for controlling the quality of drainage water as to be a sort of liquid fertilizer and develop a guideline for chemical fertilizer application together with the reuse of drainage water. The established method and guideline should be extended to farmers practicing drainage water reuse.

Target Area: Whole Governorate (implemented in the Irrigation Complex sites)



Beneficiaries	Farmers in the areas with the establishment of Irrigation Complex
Outputs	Short-term: 1) Soil properties in project area are mapped to select the relevant area for the cultivation by each crop, 2) Drainage water quality is tested and verified and 3) Condition of the soil in the field is verified. Mid-term: 4) Effect of reusing drainage water for crops is confirmed and 5) Agricultural techniques and water management with drainage water reuse is developed. Long-term: 6) the above agriculture techniques and water management methods are extended to the Governorate
Implementation Agencies	MALR (ARC and Agriculture Extension Sector): soil and water quality survey, test, demonstration and extension MWRI (DRI, Irrigation Sector, EPADP): selection of the sites, analysis of drainage water quality

Major Activities and Schedule (S: short-term, M: mid-term, L: long-term)

Activity		1th	2nd	3rd	4th	5th	6th	7th	8th	9th	10th
S-1	Mapping of soil types	■	■	■							
S-2	Water quality investigation	■	■	■							
S-3	Soil investigation	■	■	■							
S-4	Questionnaire survey for farmers	■	■	■							
S-5	Test farm			■	■	■	■				
M-1	Demonstration farm							■	■	■	■
M-2	Yield survey			■	■	■	■				
M-3	Formulation of guidelines / manuals						■				
L-1	Extension of the agriculture practice with drainage water reuse							■	■	■	■

Inputs	Researchers, experimental farms, demonstration farms, laboratory equipment including soil and water quality testing, etc.
Project Cost Estimate	USD2,000,000
Project Benefits	Reduction of crop production cost thereby improving the profitability of farming: decrease of chemical fertilizers in the value of N: 1.62kg/fed – 4.76kg/fed; saving of fertilizer cost (10LE/fed - 28LE/fed); total benefitted area (190,000 fed), total annual saving cost of fertilizers (1.9million LE/year – 5.3million LE/year)

Chapter 5 Recommendations

It is important to promote the drainage water reuse in combination with hardware and software aspects, namely facility and equipment installment, institutional improvement and environmental awareness creation. The Irrigation Complex should be developed with these two aspects together. Therefore, the following recommendations should not be implemented individually but in an integrated manner.

5.1 Justification of Water Reuse Plan

5.1.1 Water Distribution

Adequate and equal irrigation water distribution should primarily be worked on with the improved irrigation management, which has been pursued by the Irrigation Sector (IS) and the Irrigation Advisory Services (IAS), together with the participation of farmer beneficiaries. This entails the establishment of Branch Canal level Water Users Associations (BCWUA) for efficient water distribution among the Water Users Associations (WUA) within the branch canal. The JICA technical cooperation project, Strengthening Water Management Transfer (SWMT) has also been implemented to achieve the same goal by the capacity development of BCWUA and the transfer of irrigation management to it. It is expected that the water distribution and demand control by the farmers themselves within the branch canal would achieve equal water distribution among them.

Then the drainage water reuse for irrigation should be practiced theoretically as a supplemental measure. Yet considering the actual circumstances and future predictions of significant water shortage in the Nile Delta region, the drainage water reuse at main and branch drain levels will contribute to improving stable irrigation water distribution, and therefore the drainage water reuse needs to be expanded in all over the Kafr El Sheikh Governorate even in the future.

Considering the situation of irrigation water distribution in Kafr El Sheikh in 2015, it is possible to improve the water distribution for a certain extent by balancing the cropping plan and water distribution plan in the governorate. Cultivation of paddy is officially restrained by the MWRI and MALR based on the irrigation plan made by MWRI every year. This is ,of course, due to the heavy water requirement of paddy compared to other crops. However, it can be said that farmers are indifferent with the policy of the government and the gap between the actual cultivation and plan would be big. While making efforts to correct such situation, drainage water reuse would play a vital role in filling-in the gap.

5.1.2 Water Quality

The deterioration of drainage water quality results in the decrease of available water for irrigation. Since the deterioration has been progressing due to the increase of wastewater from the swelling urban population in the Nile Delta region, it is crucial to regularly monitor the water quality by each drainage canal network system and study the necessary mitigation measures.

Preventive measures at the source are the most effective ones to protect water quality. Wastewater Treatment Plant (WTP) for urban areas is the efficient measure, while in the rural areas it would be effective to establish the irrigation complex consisting of the rural sewerage systems proposed in this master plan. Although the contamination load at each village is small, the accumulation from wide areas will be significant, and therefore establishing a number of irrigation complexes with rural sewerage systems should be planned to cover a wider area to realize its effectiveness. As for the measures against the negative impacts of solid wastes, covering drains by box culvert and strengthening garbage collection systems would be the considerable measures.

5.1.3 Facility Plan

It is difficult to secure land for constructing wastewater treatment plants in the rural area with high population density in Egypt. Another issue is the clearance of Environmental Impact Assessment (EIA), in which it is regulated to construct such plan at least 500 m away from residential area. In the Pilot Project, constructing the plant under the ground of drain slope and the road along the drain enabled to get EIA approval since the underground plant can solve the issue of bad smell. Placing the plant underground of public lands such as drain slope and rural road along the drain solved the issue of land scarcity. This method is suitable for the rural area in Egypt where the population growth has been prevailing.

5.2 Towards Implementation of the Drainage Water Reuse Plan

5.2.1 Promoting the Projects in Harmony with the Existing Plans of MWRI

This drainage water reuse plan has been proposed from the viewpoints of drainage water quality conservation and reuse for irrigation. At the same time, some of the proposed projects and sites have also been overlapped with the existing plans of MWRI. Therefore, it is effective to implement the proposed projects in relation to the on-going projects by the MWRI's budget. Reuse pumps have been under installment in some sites based on the requests from the farmer beneficiaries and the reuse pump is a basic component of Irrigation Complex.

As mentioned in Chapter 4, reuse pump stations have been planned or under construction in seven sites out of the 91 sites proposed for irrigation complex establishment. Also for covering drains by box culvert, the budget for total 240 m has been approved by MWRI in FY2015. It is hence effective to give priority for establishing the irrigation complex at the sites, in which some components have been under implementation or the budget for the facility is to be approved by MWRI. It is also effective to implement the less expensive components such as environmental awareness campaign at such priority sites.

5.2.2 Implementation in Cooperation with Other Ministries and Development Partners

Among the components of the irrigation complex, the rural sewerage system is the one, which is difficult for MWRI to construct alone. Construction of rural sewerage system is not properly in the mandate of MWRI. Although some model projects have been implemented e.g. by the water Quality Unit of MWRI, it is still difficult for MWRI to extend the models by its own budget. Under such circumstances, it is required for MWRI to cooperate with the MHUUD, to establish the irrigation complex at the site of the sewerage system to be installed by other development partners, or to get fund from the development partners to implement the irrigation complex establishment by MWRI in order to materialize the extension of the rural sewerage system.

MWRI will be able to cooperate with MHUUD or development partners by offering the lands of MWRI, namely drain slopes and canal maintenance road to install the rural sewerage system under them. This will solve the issue of land for sewerage construction and make it easy to cooperate among the stakeholders.

During the presentation of the draft drainage water reuse plan to the stakeholders on 3rd February 2016, there were comments and suggestions such as preparing protocol for the cooperation between MWRI and MHUUD to implement the M/P, finding a way of institutionalization of the stakeholder cooperation, and assigning a focal person in each related ministry for the implementation. These comments and suggestions should be due considered for their materialization.

5.2.3 Involvement of Stakeholders from the Central to Village Levels

Various stakeholders have participated in the implementation process of the Pilot Project. In addition to the member organizations of JSC, the Ministry of Education and other organizations at the field level gave their support to the implementation of environmental awareness creation activity. Such cooperation arrangement would enable to realize the effects of the projects in wider area.

As discussed above, it will be necessary to cooperate between MWRI and MHUUD, and others to implement the drainage water reuse plan. It is therefore proposed to maintain the current JSC and position EPADP as the core coordination body. JSC was originally organized with the current five member ministries to deal with water issue by the initiative of the Embassy of Japan in 2010. This project for master plan formulation should be considered as a part of this JSC activities.

It is necessary to arrange cooperation among the stakeholders at governorate level, as well. The method of cooperation arrangement is to use the process of preparing and agreeing with a protocol for operation and maintenance (O&M) after the completion of facility construction among the stakeholders. It is proposed to organize the stakeholders meeting through the protocol preparation by the Irrigation and Drainage Directorates of the Governorate as the implementer. This protocol is to define the role and responsibility of each stakeholder for O&M of the facility. By signing on this protocol among the stakeholders with the presence of the Governor, it will give authority and become effective official document.

The involvement of various sectors is effective for environmental conservation. During the Pilot Project, not only the MWRI, but also other agencies, namely, the Ministry of Education, the Ministry of Youth and Sports, the Ministry of Awqaf (Religious Affairs), and local units were involved in the environmental awareness creation. Water quality conservation is not only a technical matter, but also the absence of effective garbage collection system in the village is related to morals of the people. For expansion of the environmental awareness creation, these agencies will have to be involved along with the MWRI.

5.2.4 Upstream and Downstream Cooperation towards Expanding the Projects

Drains run through several villages and therefore unless the villagers in upstream reaches have awareness on water quality, the effort of the villagers in downstream reaches to conserve water quality would be less effective. Therefore, it needs to extend the irrigation complex all over the governorate and at the same time implement the projects, which can influence wide-area. The W5 site, the irrigation complex site established by the Pilot Project will be the pivotal point to extend the irrigation complex to the suitable areas. W5 site can be the venue of study visit by the people in other villages. Then the stakeholder meeting should be held to agree on the method of implementation including protocol preparation and environmental campaign, etc.

It takes time to construct the facilities and so does to extend the irrigation complex in wide areas. Therefore, forming organization of the farmer beneficiaries in the villages for water quality conservation should be implemented even during the construction period. Especially, the Irrigation and Drainage Directorates of the Governorate should take a role to coordinate the villages in upstream and downstream reaches and cooperate with Local Unit and BCWUA to promote the upstream downstream cooperation in order to tackle water quality conservation.

5.3 Towards Sustainable Water Quality Conservation

5.3.1 Involvement of People Related through Their Interests for O&M

For the village with sewerage system, they keep maintaining the pump station and pipeline to connect the sewerage to house well. However, they are not much interested in the maintenance of wastewater

treatment facility and the water quality of final effluent. This attitude would be partly attributed to the amount of treated wastewater, which is so little to the total discharge in the drain that the effects of the water quality improvement are not clearly visible. But also it is rooted to the human propensity that once filthy water passes by, people do not have to worry about it anymore.

The target of constructing sewerage system was to improve the rural sanitation improvement, while the target of WARUS is the re-use of drainage water for irrigation. Therefore, the direct beneficiaries of the sewerage system are not only the villagers discharging wastewater but also farmers re-using drainage water for irrigation in the downstream reaches of the sewerage system.

From the viewpoint of such concept of WARUS, it is a suggestion to involve the downstream farmers in the O&M of sewerage system as they are also the beneficiaries of the facility. Some of these farmers would also be the user of the sewerage system though others may not. Each stakeholder has each interest from their point of view. Increase of re-use water for irrigation is one of the incentives for downstream farmers, and reduction of sewerage cost and improvement of environmental condition could motivate villagers to involve in the O&M of sewerage system. Furthermore, improving drainage condition and solving water shortage could encourage governmental officers in irrigation and drainage sectors to promote sustainable water quality conservation. It is considered to clarify the interest of people from the water re-use point of view and campaign the participation of the people in O&M of the facility based on the interest of people concerned.

5.3.2 Cooperation of Stakeholders for Farmer Organization

The DPCs should be integrated into BCWUAs when the BCWUAs are established. The DPCs were organized only with the farmers downstream because the drainage reuse pump stations directly benefit the downstream areas. The DPCs' major problems, however, are related to the whole canal. For example, most garbage comes down to the end of canals from upstream. The DPCs have to work together with people in upstream areas to solve garbage problems in canals. Therefore, the DPCs should be integrated into BCWUAs and are expected to work as committees under BCWUAs in the future.

GDIAS should be involved in establishment process and capacity development activities of the DPC. GDIAS has a plenty of experience in the establishment of WUAs and BCWUAs. Their experience and capacity could be helpful in strengthening the capacity of the DPC. In fact, GDIAS in Kafr El Sheik cooperated with the project by providing detailed information about WUAs and BCWUAs in the pilot project areas, yet their involvement was still limited. Their strong involvement in the development of the DPC could bring out more sustainable involvement of farmers in promoting drainage water reuse.

In general, a water users association is established at the occasion of implementing the irrigation improvement project and GDIAS is to follow-up the activity of WUA. For this reason, the staffs of the Irrigation and Drainage Directorates are hardly involved in the process of WUA establishment. However, in case of installing the reuse pump there will be work for maintenance of the pump and cleaning of the drain, which will be carried out in cooperation with WUA. Therefore, it is recommended that not only GDIAS but also the Irrigation and Drainage Directorates are involved in establishing WUA or DPC inside the WUA.

5.3.3 Clarification of the Official Position of Drainage Pump Committee

The DPC is a voluntary organization to use the drainage reuse pump stations properly. There is no specific legal framework for the DPC; however, it is important for the DPC's members to get official approval from the Government. It is also important for the Irrigation Sector to recognize the DPC as a representative of beneficiaries of the drainage reuse pump station to operate the pump station effectively. Therefore, the Irrigation Sector issued a ministerial decree about the DPC and they were

officially approved as representatives of the pump stations.

Internal regulations of the DPC are one of the key aspects to establish active DPC. The internal regulation of DPC is required to get approval by the Irrigation Directorate of the Governorate. Based on this approval, the ministerial decree from the Undersecretary of the Irrigation Directorate will be issued. The decree is to officially recognize the DPC and to define the objective, members and major activities of the DPC. In case of establishing an organization for facility O&M, it is important to get official recognition by the decree of the ministry.

5.3.4 Environmental Awareness Creation

(1) Continuous Implementation of Environmental Campaign

Environmental awareness creation activity can be implemented without the construction of facilities and therefore it can be implemented prior to the facility construction in wide areas. Continuous implementation of the activity will maintain its effectiveness. Due to environmental awareness by the Local Units and Imams (Mosque leaders), people's behaviors regarding waste disposal have been improved, which leads to less pollution of water according to the final reviews of the W/S.

It is very important to continue such awareness creation activity, since it takes time for the concept for of environmental conservation to be taken root at the village level. For sustainable water conservation, not only temporary events such as environmental campaigns, regular environmental awareness creation activity is necessary. According to the current system, DAS has a duty for water conservation of drainages, and they should visit the field around twice per year. It is requested that DAS and IAS staffs visit the villages to communicate with the people more frequently.

(2) Utilizing Materials for Environmental Protection

Some school students prepared attractive posters for environmental awareness at the environmental campaign of the Pilot Project, which are very impressive, even for the governmental staff. These paintings can be utilized as awareness material, and such materials can become attention grabbing for villagers to promote awareness, which can be more effective than relying only on oral explanations.

Also the process of preparing the materials such as the posters will help people understand the importance of the environmental protection and actions to take. It is also expected that when the school children talk to their families at home about the environmental protection, it will bring positive effects to the rural life for environment.

The CDA at the W5 site requested the project to provide the picture-card-show style material, which was prepared by the project, for continuous awareness by the CDA members targeting the villagers. It is recommended to prepare/use such kinds of material, which is sustainable and not costly.

5.3.5 Gender Consideration

Women's involvement in spreading environmental awareness is also important. In rural areas, one of the main roles of women is to sort out domestic garbage and dump it. Environmental awareness campaigns have been conducted through Imams and schools in most sites. However, it is difficult to deliver the message directly to women in the channels. There was a case that the Imam conducted awareness sessions exclusively for women on weekdays, but it is not common. Considering different genders in awareness creation is also necessary in the future.

Female teachers are considered as mediator of the environmental campaigns for women. During an environmental campaign they complained about no garbage collection system and strongly requested the staff of the local units to do the activity regularly. It is clear that female teachers have a high level of concern about waste management. In the Delta area, seemingly, women who have a high education

level such as teachers or journalists can express their opinions in public. Therefore, in the future, through further collaboration with school teachers, there is a possibility for women to take initiatives in environmental awareness from women to other women.