United States Agency for International Development

Ministry of Water Resources and Irrigation

LIFE Integrated Water Resources Management
Task Order No. 802
EPIQ II: Contract No. EPP-T-802-03-00013-00

Assessment of Year 3 Information System Activities

Report No. 37

September 2007

This publication was produced for review by United States Agency for International Development. It was prepared by:

International Resources Group
In association with EPIQ II Consortium

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Water Resources and Irrigation

US Agency
for International Development

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Acronyms and Abbreviations

AAU	Agricultural Administrative Unit
AED	Academy for Educational Development (a US based entity providing USAID funded assistance regarding environmental education and awareness)
APRP	Agricultural Policy Reform Program
ASC	Alliance Steering Committee
BCWUA	Branch Canal Water User Association
CD	Central Directorate
CDA	Community Development Association
CDIAS	Central Directorate, Irrigation Advisory Service
CTO	Cognizant Technical Officer. The USAID person responsible for supervising a technical assistance contractor
CY	Calendar Year
DAI	Development Alternatives, Inc. (a Washington DC based consulting firm working with IRG to implement the project)
DBAF	Dual Biological Aerated Filter (waste water treatment process)
EEAA	Egyptian Environmental Affairs Agency
EEPP	Egyptian Environmental Policy Program (a USAID funded program aimed at achieving environmental policy reform)
EPADP	MWRI Egyptian Public Authority for Drainage Projects
EPIQ	Environmental Policy and Institutional Strengthening Indefinite Quantity Contract
ET	Evapotranspiration
FAQ	Frequently Asked Questions
FWUO	Fayoum Water Users' Organization Project
GDA	Global Development Alliance
GD	General Directorate
GIS	Geographic Information System
GOE	Government of Egypt
GPS	Global Positioning System
GW	Groundwater
GWS	Groundwater Sector
HD	(Aswan) High Dam
IAS	Irrigation Advisory Service
IBRD	International Bank for Reconstruction and Development or World Bank
ID	Irrigation Department
IDS	Irrigation and Drainage system
IIIMP	Integrated Irrigation Improvement and Management Project
IIP	Irrigation Improvement Project
IRG	International Resources Group (a Washington DC based consulting firm that is prime contractor for the IWRMP)
IRU	MWRI Institutional Reform Unit
IRs	Intermediate Results
IS	Irrigation Sector of the MWRI
IT	Information Technology
IWMD	Integrated Water Management District
IWMU	MWRI Integrated Water Management Unit
IWRM	Integrated Water Resources Management

IWRMP	Integrated Water Resource Management Project
LAN	Local Area Network
LIFE	Livelihood and Income from the Environment (project)
LOE	Level of Effort
M&E	Monitoring and Evaluation
MALR	Ministry of Agriculture and Land Reclamation
MED	MWRI Mechanical and Electrical Department
MIC	MWRI Ministry Information Center
MISD	Matching Irrigation Supply and Demand
MOE	Ministry of Education
MOH	Ministry of Housing
MOU	Memorandum of Understanding
MSEA	Ministry of Sate for Environmental Affairs
MS	Master of Science
MWRI	Ministry of Water Resources and Irrigation
NGO	Non-Governmental Organization
NWRC	MWRI National Water Research Center
O&M	Operation and Maintenance
OJT	On-the-Job Training
PM&E	Performance Monitoring and Evaluation
RSC/WP	Red Sea Coastal/Water Project, short name for USAID Red Sea Coastal and Improved Water Resource Management Project
RWP	Relative Water Supply
SIRs	Sub-Intermediate Results
SOs	Strategic Objectives
STTA	Short-term Technical Assistance
TA	Technical Assistance
TOR	Terms of Reference
USA	United States of America
USAID	United States Agency for International Development
WCU	MWRI Water Communication Unit
WDC	MWRI Central Water Distribution Center
WPRP	Water Resources Results Package
WQU	MWRI Water Quality Unit
WUA	Water User Association

1. Introduction

1.1 Authorization

Under the USAID/Egypt-funded Livelihood and Income from the Environment (LIFE) Integrated Water Resources Management (IWRM) Project (Contract No. EPP-I-802-03-00013-00 Task Order 802) International Resources Group (IRG), in association with the Academy for Educational Development (AED), Development Alternatives, Inc. (DAI), ECODIT, Inc., Environmental Quality International, Inc. (EQII), Montgomery Watson Harza (MWH), and Training Resources Group, Inc. (TRG), is responsible for assisting the Government of Egypt (GOE) to promote integrated water resources management. The period of performance for the contract is October 1, 2004 – September 30, 2008.

1.2 Purpose of Report

The purpose of this report is to present an assessment of the Information System (IS) activities carried out under Tasks 2, 3, and M&E in Year 3 (October 2006 – September 2007). Furthermore, the report covers recommendations for the Year 4 IS program.

1.3 Project Objectives

Figure 1 Project Location Map

The GOE is implementing an aggressive irrigated agricultural area expansion program, which will reduce the supply of water per feddan. Currently, the high cost of operating and maintaining the water delivery infrastructure is a serious strain on the national budget because farmers pay only a small portion of the actual costs. This is further compounded by decreasing water quality as the water conveyance system is increasingly used for waste disposal.

The objective of LIFE/IWRM is to provide technical assistance, training, commodities, and small grants in support of the decentralization of water management decision-making, and increased participation of all rural inhabitants in such decision-making in two priority geographical areas and five irrigation directorates: Zifta and West Sharkiya in the Middle Delta; and West Qena, East Qena and Aswan in Upper Egypt, as shown on the right.

With a decentralized and participatory approach, USAID expects greater civic responsibility in maintaining the water conveyance infrastructure resulting in improvements in the quality of local water resources through better management of locally generated liquid and solid wastes.

The objectives of the project are expected to be achieved through the formation and development of functional and sustainable Branch Canal Water User Associations

(BCWUAs) and Integrated Water Management Districts (IWMDs), and by developing the capacity of stakeholders to manage solid and liquid wastes in the targeted directorates.

SUB-OBJECTIVE 1. Rural inhabitants accrue immediate and long-term economic benefits from participating in water-management decision-making and governance of the water conveyance infrastructure.

SUB-OBJECTIVE 2. Local communities and private associations participate in water resources decision-making, accept responsibility for maintaining the water conveyance infrastructure, and adopt improved management practices for solid and liquid wastes.
Seven tasks under three performance requirement categories are to be implemented under the LIFE/IWRM Program:

A.1 Performance Requirement I: Decentralized Management of Water Resources
1. Formation of IWMDs
2. Formation of BCWUAs
3. Equitable allocation of water resources

A.2 Performance Requirement II: Stakeholder Engagement in Water Resources Management
4. Improved maintenance and upgrading of water management Equipment
5. Improved water quality management through better environmental services
6. Improved wastewater reuse practices

A.3 Performance Requirement III: Capacity Building of MWRI staff
7. Graduate degree training for MWRI staff

There are also a number of cross-cutting issues that are common to all seven tasks, including: commodity purchases; workshops and training; monitoring and evaluation; donor coordination; public awareness through information, education, and communication; and gender considerations.

The LIFE/IWRM has worked closely with the MWRI Integrated Water Management Unit (IWMU), five Directorate Undersecretaries and General Directors, 27 IWMDs, and other key stakeholders over the past 36 months. To facilitate project implementation, provide technical coordination at higher levels, and resolve any inter-sectoral issues, a steering committee was appointed by the Minister of the MWRI. Members of the steering committee include:

- Chairman (Eng. Gamil Mahmoud, MWRI Special Consultant to H.E. Minister)
- Head of Irrigation Department
- Egyptian Public Authority for Drainage Projects
- Chairman of M&E Department
- Head of Sector - Minister's Office
- Director of Technical Office for Technology and Information – Minister's Office
- Head of Institutional Reform Unit Coordinator, Integrated Irrigation Improvement and Management Project
- USAID representative
- LIFE/IWRM representative

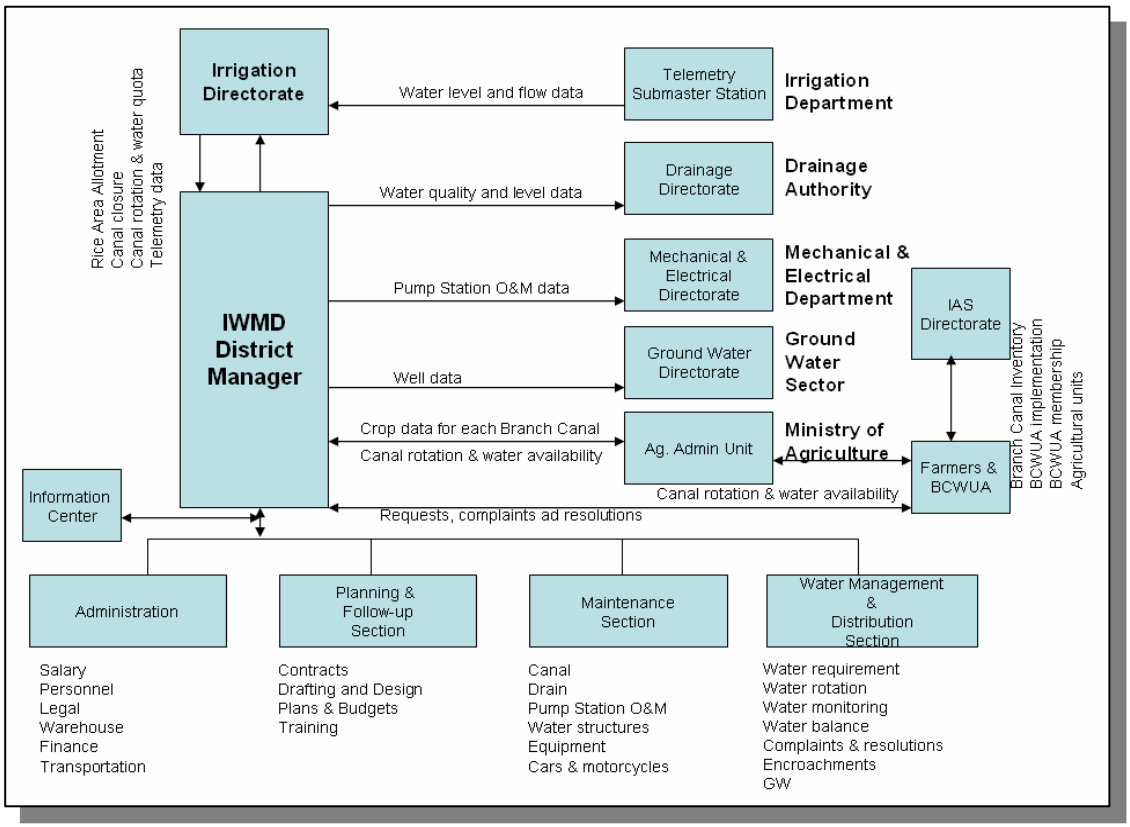
1. Information Systems Component

2.1 Data Flow

In general, data flows from the districts to their respective directorates. The directorates then review, aggregate, and summarize the data before forwarding the information to the respective regional offices and/or the MWRI departments in Cairo. The MWRI departments carry out similar data management activities as the directorates and use the data/information for central planning, operation, and analysis.

Once decisions are made at MWRI/Cairo, specific information such as 10-day water allocation and seasonal rice area allotments flow downward to the directorates via the regional water distribution offices. The directorates inform the districts and the districts inform the BCWUAs and/or the Agricultural Administrative Unit (AAU). In turn, the BCWUA and/or agriculture extension officers share the information with the farmers in the districts so they can manage their pumping operations at the mesqa level. When farmers have minor problems with water delivery, they try to resolve them with the BCWUAs. For major irrigation issues, BCWUAs file complaints with the districts, and District Managers consult with directorate staff members to resolve the problems.

Figure 2 IWMD Data Flow



IWMDs currently receive crop data from the AAU. Nile water supplies and crop water requirements are prepared fortnightly as a part of the matching irrigation supply to demand (MISD) program and the information is submitted to the respective directorates. For each

directorate, a monthly water distribution meeting was established by the project in early 2007. The monthly meetings are attended by water distribution engineers from the directorate, respective regional water distribution offices, and IWMDs. During the monthly meetings staff members evaluate the computed MISD values for each IWMD, assess and examine the differences between the demand and supply figures, and identify and suggest ways to resolve water distribution issues.

The five directorates are starting to respond to the MISD water demand by adjusting the Nile water allocation to each IWMD. To further improve the MISD program and integrated water resources management practices, available water supplies from other sources (i.e., groundwater and drainage water reuse) and water demands from "unofficial" rice growing areas, and municipal and industrial requirements should be incorporated, calculated, and accounted for as a part of MISD program.

2.2 Concept

With the integrated water management approach, the main objectives are to:

- Integrate all water management functions so the IWMD can manage all water supplies (i.e., Nile water, groundwater, and drainage water) within each district; and

- Decentralize water management so the district staff can match water supplies with all water demands (agricultural, municipal, and industrial requirements) within each of the districts fortnightly.

The IWMDs now have the authority to make district-level management decisions. In order to make well-informed decisions, district managers require information, not just data. They also need to be able to understand the information as opposed to just being handed a report; managers need this support to be put into context and to receive it in a timely manner. To support these information requirements, district water, agricultural, and spatial data must be digitized and stored in computerized information systems that can be structurally organized, systematically maintained, freely accessed, and fully analyzed by staff members within each IWMD.

The IS component under the project consists of two major technologies: database management and digital mapping systems. While the database management and mapping systems evolved independently, both are integrating, analytical, and strategic technologies that are complementary to each other. The convergence of both technologies offers an extraordinary opportunity for producing information management tools that connect disparate, but indispensable, threads of spatial and non-spatial data across different information systems and management units. These tools create broader knowledge and understanding for decision makers at the district, directorate, and central levels. As of the end of Year 3, the two systems are starting to converge through shared unique canal identifiers established under the project.

2.3 Objectives

Under an integrated water management approach, the specific IS objectives are to:

Establish databases to support measurement-based water management practices and data/information-based decision making at the district and directorate levels;

Provide specific information systems to support the MISD program matching water supply to demand from all sources (agricultural, municipal, and industrial requirements) within each of the districts;

Establish IWMD and directorate digital mapping systems to prepare and provide geo-referenced maps with water objects for each of the districts and directorates; and

Use satellite imagery (free NASA Landsat 7 ETM+) and GPS survey data to verify and/or calculate IWMD boundaries, canal and drain alignments, water structure locations, and BC total and irrigable areas to improve water management practices.

2.4 Approach

The IS development approach of the project consists of three phases. Specific IS activities under each of the three phases are listed below.

Phase I activities:

1. Install computer hardware and software at the IWMDs and directorates;

2. Install MISD, Water Level, Complaints, Groundwater, and Water Quality databases at all 27 IWMDs;

3. Train selected staff from the IWMDs and directorates on computer basics, hardware maintenance, database operation, and general GPS use.

Phase II activities:

4. Establish five functioning databases at the IWMDs;

5. Install MISD, Water Level, Complaints, Groundwater, and Water Quality databases at the directorates.

6. Support district and directorate implementation of MISD water management practices with the MISD Database;

7. Support district water monitoring activities with the Water Level Database;

8. Build capacity for digital mapping at the IWMDs and directorates;

9. Construct and print geo-referenced IWMD maps, including water objects such as canals, drains, water monitoring sites, structures, pump stations, and wells;

10. Conduct a survey of branch canal areas and support inventory of control structures at each IWMD using GPS receivers;

11. Introduce and support the district M&E program with data from the five databases;

12. Aggregate the IWMD water and agricultural data at each directorate using MS-Access based databases and customized MS-Excel worksheets.

13. Carry out corresponding training events.

Phase III activities:

14. Devise a way to systematically identify and correct all district spatial data errors (line and polygon overlap and gap issues) one by one to ensure high quality map products.

15. Build and print directorate maps based on district spatial layers using Arc View;

16. Link the water resources tabular data to the georeferenced map objects to provide additional analytical functionality and spatially distributed water information for the managers at each directorate;

17. Carry out corresponding training events.

The project successfully completed IS activities under Phase I and Phase II over the last 36 months, except Activity 9. Phase III activities plus Activity 9 will be carried out in Year 4.

2. 3. Review of IS Activities

3.1 Computer Hardware and Software

Over the last 12 months, some of the project hardware and software has had occasional minor problems. With the support of the project and the trained IT staff at the directorates and IWMDs, most of the problems such as failure of power supply units, virus infection, and overheating have been quickly resolved locally. In general, all hardware and software are functioning properly and are being maintained by the IWMDs.

A summary of computer hardware and software provided by the project in Year 3 is presented below.

IWMDs:

- 1 USB mobile hard drive for each IWMD (except the four original IWMDs)
- 1 data logger for Quesna, Birket El Saba, and Deshna
- 1 Falcon Tango GSM/GPSR modem for Birket El Saba and Deshna
- 2 Falcon Tango GSM/GPSR modems for Quesna
- 2 data loggers with 1 Falcon Tango GSM/GPSR modem for Luxor

Directorates:

- 3 USB mobile hard drives for East Qena
- 2 data loggers for West Sharkiya
- 2 Falcon Tango GSM/GPSR modems each for New Zifta and West Qena
- 4 Falcon Tango GSM/GPSR modems for West Sharkiya
- 1 Falcon Tango GSM/GPSR modem for East Qena

IWMU:

- 5 USB mobile hard drives

Telemetry:

- 3 Falcon Tango GSM/GPSR modems

Water Distribution:

- 2 Falcon Tango GSM/GPSR modems

Water Communications:

- 2 desktop computers
- 2 laptop computers

Special Items for East Qena document imaging activities:

- 4 scanners
- 2 desktop computers
- 2 laptop computers

3.2 IWMD Databases

The overall IS development approach used by the project was to implement the databases that have already been developed, tested, and used by the MWRI in the past. These included:

- Water Level Database prepared by MIC under the Red Sea Sustainable Development and Improved Water Resources Management Project.
- Complaint Database prepared by MIC under the Red Sea Sustainable Development and Improved Water Resources Management Project.
- MISD database developed under the Water Policy Reform Program.
- Water Quality Database developed by the Water Quality Management Unit.
- Groundwater Database developed by the Groundwater Sector.

The five databases have been enhanced based on feedback from the IWMDs over the last several years. All of the 27 IWMDs have the latest version of the databases with the exception of the Groundwater Database in the Aswan directorate; this database was not implemented in the Aswan directorate due to a limited number of groundwater wells in each of the IWMDs.

In Year 2, one of issues was that the MISD Database did not work or function properly in some of the IWMDs. Over the past 12 months, project staff has worked closely with the IWMDs to check and verify crop water requirement calculations and fix database programming errors. Additionally, the database has been improved to allow the District Manager in each IWMD to set the conveyance efficiency value for each BC, rather than using the hardwired efficiency factor of 0.7 to incorporate differences from one BC to another and one IWMD to another.

New directorate versions of all five databases have been developed and installed by the original groups with functionality to merge and store the IWMD water data at each directorate. Simultaneously, the five databases for the IWMDs were upgraded with customized data and report export options to meet the data consolidation requirements at the directorates.

3.3 Digital Maps

The IWMDs, with the assistance of the IWMU: completed a GPS survey of total BC area (official and unofficial area lying outside the formal IWMD boundaries); demarcated total area for each BC; identified and digitized urban areas within each BC area using Google Earth; used the deduction method (total – urban) to obtain the irrigable area for each IWMD; delineated canals and drains and marked the water monitoring points with GPS receivers; and built geo-referenced, multi-layer digital IWMD maps with Autodesk Map software.

All 27 districts have successfully completed the digital mapping work using Garmin GPS receivers and Autodesk Map software. Each IWMD now has the geo-referenced BC irrigable areas, BC boundaries, canals, drains, water monitoring points, and water quality sampling sites. Using the GPS survey data, the Aswan Irrigation and Agricultural directorates were able to reconcile the irrigation and agricultural area differences by agreeing on the GPS irrigable area, which incorporated the GPS “unofficial” irrigable areas for each IWMD.

Due to the recent access restrictions imposed by the MWRI on the IWMD mapping data, the international consultant of the project was unable to assist the project: (1) verify the accuracy of the BC GPS tracks and the GPS irrigable areas for each IWMD; and (2) confirm that the IWMD spatial layers are topologically correct: shared boundaries among the IWMDs within a directorate are perfectly matched, canals and drains are snapped together by node, and any extra polygons, lines and points have been deleted. The result is that the quality assurance work will be postponed and carried out by each directorate with the assistance of the IWMU specialists in Year 4.

3.4 Training

A comprehensive training program was designed by the Task 3 Team in Year 3. The project, with the assistance of IWMU, MIC, WQ Management Unit, GW Sector and Telemetry staffs, successfully trained a total of 371 participants in the following areas: Computer Maintenance (73), Assessing BC Areas and Location of BCWUAs (111), Data logger and Logger Net Software (51), Water Quality Database (90), and Groundwater Database (46). The Applied M&E course was cancelled because the project decided not to introduce and implement the project M&E worksheets at the district and directorate levels at this time.

3. 4. Achievements

The project has successfully accomplished tasks that have the potential to permanently change how the 27 IWMDs and the five directorates manage, use, and communicate their water resources data in the near future. The major achievements under Task 3 in the past 12 months are:

- Twenty seven (27) IWMDs have been equipped with functional database management and digital mapping systems.
- Five directorates have been equipped with GIS and database management systems.

Six additional CSI data loggers were installed and are providing hourly water levels and pumping hours data (Luxor IWMD only) to five IWMDs, four directorates, Water Distribution/Cairo, and Telemetry/Cairo via a low cost GSM/GPSR communication system.

- All IWMDs are using the five databases (Water Level, Complaints, MISD, Water Quality, and Groundwater) to support measurement-based water management practices and data/information-based decision making at the district and directorate levels (i.e., comparing the fortnightly MISD water demand with actual water deliveries).
- Three of five project supported databases (MISD, Water Quality, and Groundwater) have been installed but are not yet used by the directorates as of August 2007. Training for and full utilization of the five databases is planned for Year 4.
- A total of five training courses were developed and conducted at the directorates in Upper and Lower Egypt with 371 participants.

The 27 IWMDs have capable staff members to operate and maintain the IS, and to share their IS experience and expertise with other irrigation districts. However, the IWMDs need to improve computer and equipment maintenance process with sufficient budget.

- The IWMD staff members have developed additional computer applications and databases (e.g., personnel management and canal maintenance) to better manage administrative and water data and information at some of the IWMDs.
- A digital mapping team was established and equipped with computer hardware and software and GPS receivers, plus the scanned maps (1:25,000) and Landsat images at each IWMD in Year 2. The mapping staff members were trained and tasked with the BC GPS survey at each of the 27 IWMDs in Year 3.
- The IWMD mapping staff members have productively applied their (newly acquired) digital mapping skills to complete the BC GPS survey and compute the irrigable area for each BC and IWMD. As a result, any disagreement between the irrigation and agricultural area figures has been resolved in the Aswan directorate by working with the AAU during the survey and incorporating the GPS “unofficial” irrigable areas as a part of the BC irrigable area for each IWMD.
- Canals, drains, BC areas, water monitoring points, and water quality sampling sites have been surveyed and geo-referenced by the IWMDs with the assistance of IWMU. In Year 4, the geo-referenced spatial layers can be easily maintained and used to build multi-layered, projected district maps with the latest information and real coordinates rather

than the out dated Survey Authority paper maps and/or freehand paper sketches to meet modern water management needs.

- A digital mapping team (equipped with GIS computer hardware and software and GPS receivers, plus the scanned maps (1:25,000) and Landsat images) was established and the staff members were trained by the end of Year 2. One of the five directorates (East Qena) is in full operation and providing technical assistance to all IWMDs in Upper Egypt.
- The project Website was updated periodically with project reports and success stories. A web counter was added to keep track of visitors and provide real-time website hit statistics.

During the last 12 months, implementation of the five databases, mapping systems, and training programs was successfully carried out. All the IWMDs have populated and utilized the five databases, surveyed BC areas, built digital maps, computed fortnightly crop water demand values and actual water supplies, and compared and analyzed the water demand vs. supply figures to support the MISD program. Furthermore, directorate mangers and engineers have been working with the IWMD and regional water distribution engineers on the MISD program and adjusting water allocation to each IWMD; all are eager to learn and do more with the newly installed water resources databases and the GIS system in Year 4.

4. 5. Lessons Learned and Recommendations

The following lessons learned and recommendations resulted from working closely with the IWMDs and directorates over the past three years. The recommendations are an attempt to objectively identify items that will move the IWMDs and directorates closer to achieving equitable allocation of water resources through decentralized ISs for improved data collection, analysis, and use.

5.1 Databases

The Water Level and Complaints databases are too complicated for the IWMDs. IWMD staff members have experienced many problems (i.e., lost data and database functionality) upgrading the databases from one version to another and it is difficult, if not impossible, for the MIC staff to fix any programming errors in the field due to the .Net software. The result is long turn around times for error fixes because most of the programming issues need to be fixed and re-compiled in Cairo by the designated MIC staff. In the future, all IWMD databases should be "open-source" systems and based on standard MS-Access database software.

For development of a canal maintenance database in Year 4, it is best to start with the West Sharkiya canal maintenance worksheets and improve them for the 27 IWMDs and five directorates. The worksheets have been successfully used by West Sharkiya to keep track of all district maintenance contracts since 1999. Eng. Soba of West Sharkiya, with assistance by the project staff, will modify the worksheets to meet other user requirements and link maintenance contracts within an IWMD/directorate to respective canals, using the canal identifiers established by the project so maintenance activities can be tracked by contract or canal.

5.2 Near Real Time Water Data

One CSI CR510 data logger with a Falcon Tango GSM/GPSR modem was installed in the existing Telemetry's RTU box at the Meit Bera intake, Quesna IWMD at the end of Year 2. The data logger has been reliable and maintenance free and has provided water level data without interruption via GSM communication since August 2006. Based on this positive experience, six more data loggers (CSI CR510 and CR800) were installed during Year 3. Five of the data loggers have Druck PTX 1850 water level sensors to provide hourly water level data at key control points in Birket El Saba district (1), West Sharkiya directorate (2), Luxor district (1), and Deshna district (1). One of them is connected to a pump for track pumping hours at one of three pump stations in Luxor IWMD. Moreover, MWRI is buying 17 data loggers under its own program in the next several months.

Experience shows that the CSI data logger is a practical and inexpensive way to collect continuous flow data. Purchasing and installing more CSI data loggers is recommended for the MISD program.

5.3 Area Data

As stated in Year 2, a total of 16 of the 27 IWMDs have gross command areas that are different from the GIS area estimates calculated using the Year 2000 Landsat imagery. A comparison between the GIS and IWMD area estimates varied from 88% to 269%.

Using the latest BC GPS survey results, an initial review of the GPS irrigable area vs. MISD area for all 25 IWMDs (excluding Wady El Norkra and Wady El Saaida districts under development) shows the comparison varied from 74% (Armant) to 116% (Nakada), with an average of 96%. Overall, the GPS irrigable area closely matches the agricultural area (MISD). According to district mangers, the GPS irrigable area is regarded as accurate and good quality. The project is considering updating the MWRI decree area with the GPS irrigable figure for each IWMD and using the GPS irrigable areas to resolve the differences between irrigation and agricultural area figures in the remaining four directorates (East Qena, West Qena, New Zifta and West Sharkiya).

5.4 Digital Mapping

During a brief review of the IWMD digital map layers, it became apparent that (1) some of the shared boundaries among the IWMDs within a directorate are not matched perfectly; (2) canals in the irrigation system network are not linked by node; (3) drains in the network are also not linked by vertex; and (4) extra polygons, lines, and points have not been deleted. It is recommended that systematically identifying all errors (overlap and gap issues) and fixing them one by one to provide high quality map products is devised.

District maps are currently rare and generally not available. A majority of the 27 IWMDs have out-dated maps from the Egypt Survey Authority. As a part of the digital mapping effort, the mapping staff in each directorate will consolidate all IWMD map layers under their directorate, and generate and print the IWMD and directorate maps with the pre-defined MWRI/USAID/LIFE map layout for the IWMDs in Year 4. To meet the requirements of the IWMDs, the maps will have a minimum of nine layers including boundaries (directorate and/or IWMD), canals, drains, water monitoring points, water quality sampling points, wells, control structure locations, BCWUA locations, and branch canal areas (total, urban and irrigable). The mapping team at each directorate, with the assistance of the IWMU specialists, will be responsible for producing the high quality, professional multi-layer digital maps.

5.5 Data Consolidation and Utilization

Water and agricultural data are not systematically organized and consolidated at the five directorates. In order to improve directorate data management activities in Year 4, the directorate and IWMD Groundwater, Water Quality, and BCWUA databases will be updated with canal identifiers so the water resources data can be aggregated by canal to create comprehensive datasets to support IWRM at both district and directorate levels.

Canal identifiers have already been incorporated into the latest IWMD and directorate versions of MISD Database to facilitate data consolidation at the directorate level. The Complaints and Water Level databases built by MIC are compiled and closed systems. However, it is possible to export the data from both databases to MS-Excel worksheets and add the canal identifiers to the respective branch canals via Arc View software.

With Arc View GIS software, water objects on the digital maps (i.e., wells, water monitoring sites, and BCWUA locations) can also be linked to the databases to provide additional attributes for GIS spatial analysis. With a rich collection of tools in Arc View, many key spatial relationships can be derived, and results can be symbolized, visualized, and presented through thematic maps.

In order to fully utilize the IWMD and directorate data, it is essential to improve coordination and two way transfer of information between IWMDs, directorates, and central level through digital data transfer, monthly coordination meetings, and preparation of integrated water management plans. Additionally, MWRI needs to seriously promote data sharing, collaboration, and reuse at all levels by abolishing the data access restrictions.

5.6 Project Website

The Website has been a great tool for sharing project news, information, successes stories, and reports with the all the districts and directorates in Egypt. With upcoming new IWMD maps and information, updating the Location page with the GPS irrigable areas and Map page with IWMD jpg maps is recommended.

5.7 Training

The IWMD staff members have had hands-on experience using all five databases, digital mapping using GPS receivers, and Autodesk Map. For most of the directorates, the staff members are behind, especially on the five databases because they were not introduced and installed until the last few months. Several formal training courses to build the capacity of directorate staff are recommended as follows:

- Water Level and Complaints databases O&M (2 days at each directorate).
- MISD Database O&M (2 days at each directorate).
- Groundwater Database O&M (2 days at each directorate).
- Water Quality Database O&M (2 days at each directorate).
- Arc View - Building directorate maps based on district data (4 days at MWRI).

Refresher courses for digital mapping and computer maintenance may be necessary for some of the IWMDs.