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RENEWABLE ENERGY RESOURCES
FIELD TESTING

19 JUN 1986

STATEMENT OF WORK FOR FIELD TEST #6
PHOTOVOLTAIC/DIESEL POWERED ICE MAKING PLANT

JUNE 1986

FINAL

Prepared for

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STATEMENT OF WORK

Design, Installation and Operating/Maintenance
Training for a Photovoltaic/Diesel Powered Ice Making Plant

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Design, Installation and Operating/Maintenance Training
For a Photovoltaic/Diesel Powered Ice Making Plant

1. PROJECT DESCRIPTION

1.1 Background of the Renewable Energy Resources Field Testing Project

The Government of Egypt herein referred to as (GOE) and the U.S. Agency for International Development (USAID) have initiated a four year renewable energy resource field demonstration project (REFT). The Egyptian Electricity Authority (EEA) and Louis Berger International, Inc. are leading a team of subcontractors in the REFT project activities that encompass solar industrial process heat, wind and photovoltaic system applications.

The specific objectives of the GOE/USAID project are twofold: (1) to demonstrate, analyze and evaluate the viability of commercially available renewable energy technologies in Egypt, (2) to establish the infrastructure necessary to ensure that successful renewable technologies are available for widespread use in-country. Three tasks are planned:

(1) Field Tests - Assessment of some selected renewable energy systems/ applications which could be suitable for commercial use in Egypt; develop detailed engineering design hardware specifications and system performance requirements; prepare RFP packages for procuring equipment; supervise the work of hardware contractors; and collect and evaluate data generated from the field tests.

(2) Supporting Analysis - Conduct technical, social, financial, economic, and market analysis of renewable energy systems related to the field tests. Develop a computerized Renewable Energy Information System (REIS).

(3) Training - Improve the skills of the EEA and the private sector in evaluating renewable energy technologies, applications, economics and markets, and provide technical assistance in systems design, installation, operation and maintenance.

The field test task consists of eleven separate renewable energy system application demonstrations; five solar industrial process heat applications, three photovoltaic field test applications and three wind system applications. One photovoltaic field test is a demonstration of a PV/Diesel hybrid power system

powering an ice making plant primarily to produce ice suitable for fish preservation. The system will be located at Wadi El Raiyan, a man-made lake managed by the Fish Resources and Development Authority (FRDA). The lake is near El Faiyum, about 140 kilometers southwest of Cairo.

1.2 Summary of Bidder Requirements

The tenderer shall submit a complete proposal for a turn-key job for the design, manufacture, supply, instrumentation, installation, testing and performance guarantee of a photovoltaic-diesel integrated power system and ice making plant. The complete system shall be capable of providing 5-6 tons/day (2000 pounds per ton; 24 hour day) of ice suitable for fish preservation for transport to commercial markets. There is also a requirement to supply power for small auxillary loads such as water pumping and lighting. The proposals shall include on-the-job, classroom and in-factory training programs, including training materials and manuals, according to requirements specified in Section 6.0, for assigned Egyptian engineers and technicians in the operation, maintenance, troubleshooting and repair of both the system and its various related individual components. The contractor shall support operation of the system for a period of two years after the system is accepted by the EEA/FRDA/USAID. Each tenderer shall submit a set of qualification documents describing in detail the contractor's and subcontractor's relevant capabilities and experience on similar projects. EEA/USAID reserve for themselves the right to refer to any of the tenderer(s) customers to get more information about the contractor and/or the performance of equipment to be supplied.

The offer shall be made on a turn-key-basis. The contractor shall define in detail all site preparation procedures. It is anticipated that needed civil works would be performed locally by the EEA/FRDA according to the tenderer's specifications and drawings and under the supervision of his representatives.

Representative climatic conditions are shown in Appendix A. The presence of airborne sand in the atmosphere, occassional sand storms and high relative humidity accompanied with high temperature in summer shall be taken into consideration in the design of the offered equipment.

For each component offered, the tenderers shall state in his offer the exact type and model number. He shall also submit a complete set of catalogues and drawings for each hardware item offered indicating its detailed technical specifications. All hardware offered shall be commercially available and proven by reliable use in similar applications.

The tenderer shall include in his offer a preliminary design; system layout drawing; functional schematic; system electrical circut diagram including the performance monitoring instrumentation system; typical daily power and load operating curves for the diesel, PV, battery, and ice maker; and maintenance requirements for each major equipment item. In addition, the proposal should include details of the installation design.

Packaging and shipping of all required hardware to Alexandria/Egypt shall be the responsibility of the contractor. Custom clearance and shipment to Wadi El Raiyan is the responsibility of the EEA.

The bidder shall furnish at a minimum the following equipment, materials and services:

Hardware

1. Ice Making and Handling Equipment
2. Ice Storage Building
3. Photovoltaic Array and Support Structure
4. Diesel/Generator Set
5. Battery Storage System
6. Power Control and Conditioning System
7. Fishing Shelter Power System (lights, small radio, small refridgerator)
8. Area lighting (a single street light type) for boat handling
9. Water Supply Equipment
10. Water Treatment System (if required)
11. Appropriate User's Manuals
12. Required Operating, Maintenance, Repair Tools, Meters, etc.
13. Equipment for making ice blocks from daily production of plate or flake ice
14. An on-site data acquisition system for performance monitoring

Services

1. System Design, Instrumentation, Procurement and Shipment
2. Installation and Operations Support for 2 years
3. Acceptance Testing (30 days)
4. Training of Egyptian Engineers/Technicians(Classroom, in-factory and on-the-job in Operation, Maintenance, Troubleshooting and Repair)

1.3 Description of the Application Site

Wadi El Raiyan is a large depression containing two man-made lakes near El Faiyum, Egypt about 140 km southwest of Cairo (Exhibit 1). The Lakes are being formed by the discharge of an agricultural drainage canal. The lake area is being scientifically managed by the Fish Resources and Development Authority (FRDA) as a source of over 1400 metric tonnes per year of fresh fish for El Faiyum, Cairo, and other neighboring areas.

Exhibit 2 shows that the lake area consists of two distinct lakes joined by a short canal. The "Central Location" on the first lake near the outlet of the agricultural drainage canal is the collection point of all fish from the two lakes throughout the season. The location of the PV/Diesel Ice Making Plant will be at the Central Location as shown in Exhibit 3. The Central Location is approximately 10 kilometers from the nearest village. The road between the site and the village is unpaved and often indistinguishable from the surrounding desert. There are no suitable facilities of any type located at the site for accommodation or equipment security.

The existing practice for transporting fish from the lake area is to bring ice from El Faiyum and other locations, pack fish at a Central Location, and return to the market. The fishing season is regulated by the FRDA and may run from September through May over different areas of the lake. Fishing is not permitted during the summer months namely June, July and August because of the spawning season. Fishing was conducted regularly for the first time in December 1984 - April 1985. However, the 1985 fishing season started earlier (on October 2) and was expected to run until May of 1986. Fishing starts daily during the season at approximately 5 PM and ends at about 7 AM the next day. Fishing

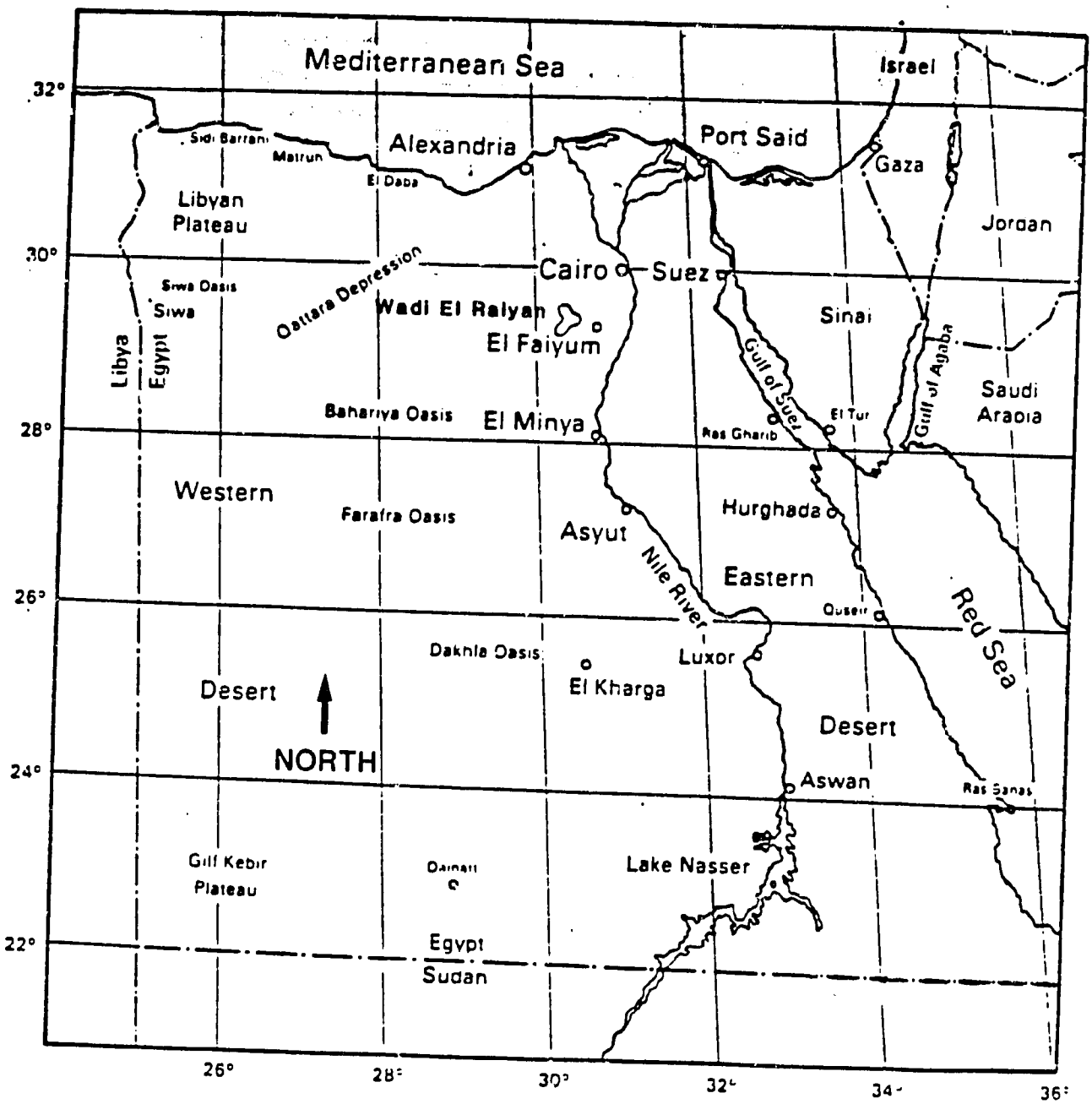

Exhibit 1 WADI EL RAIYAN LAKE LOCATION

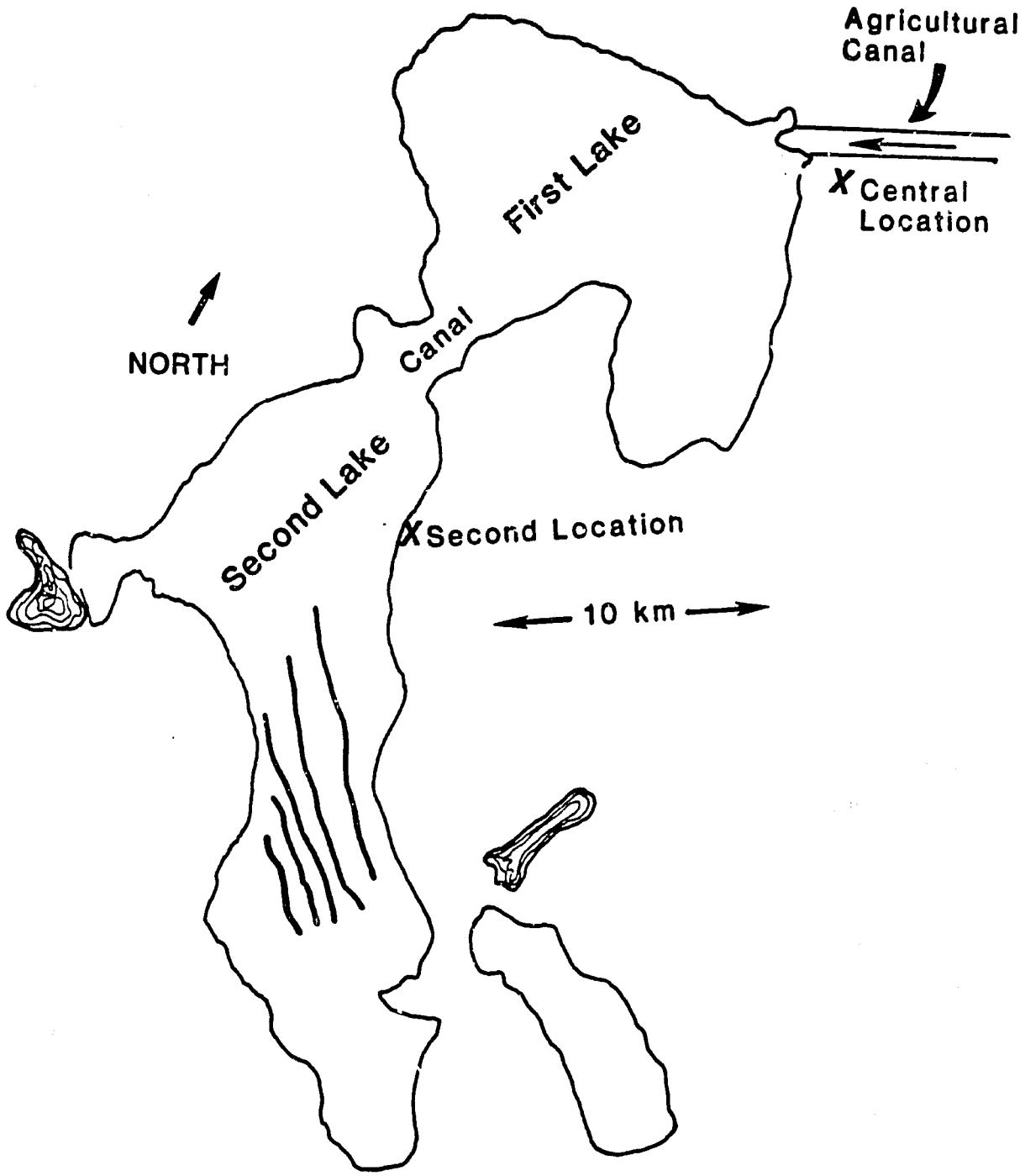

Exhibit 2 WADI EL RAIYAN LAKE AREA

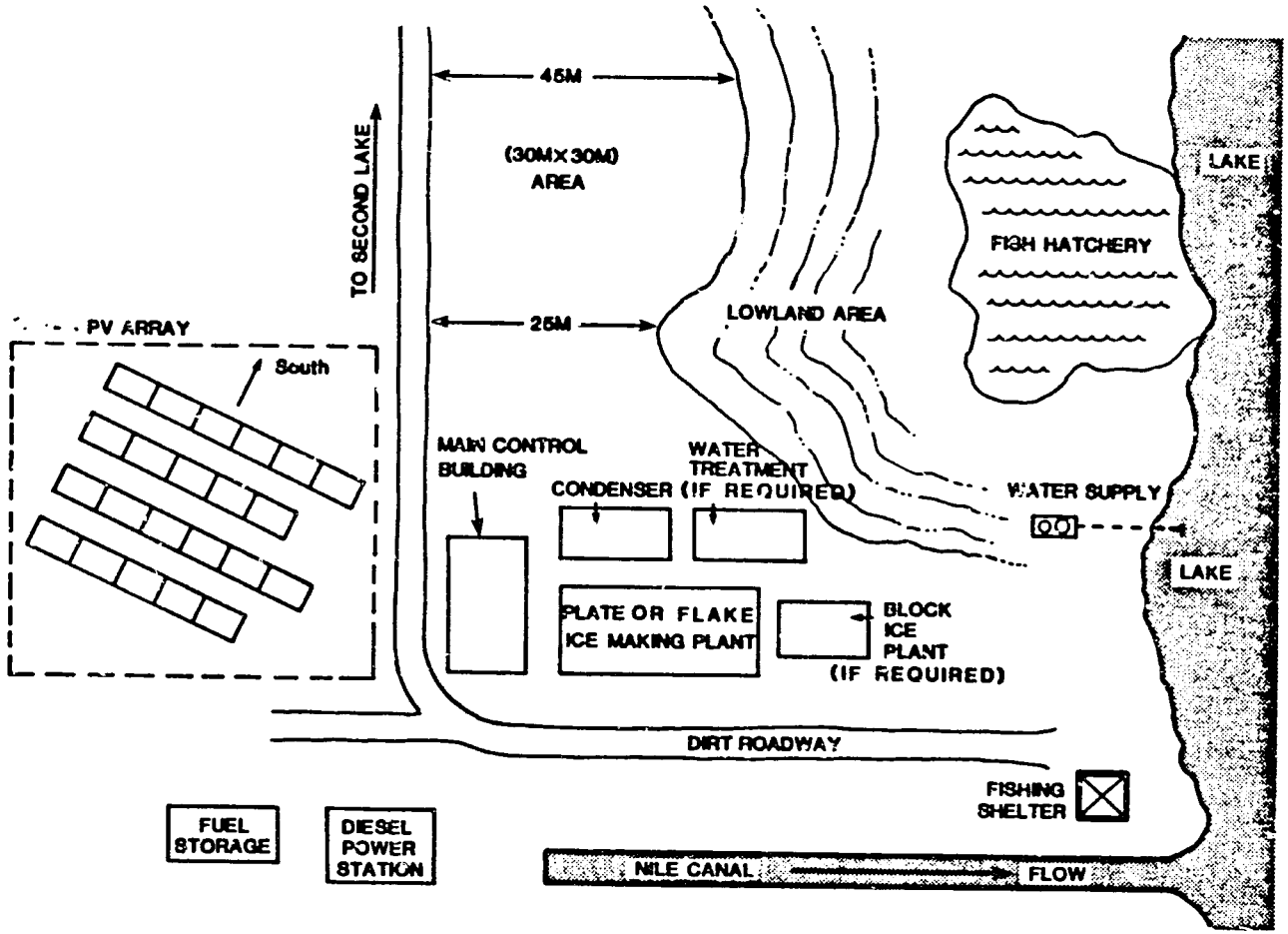

Exhibit 3 SITE EQUIPMENT LAYOUT

occurs 7 days per week. For this reason the PV/Diesel Ice Making Plant must provide a full capacity of ice at 7 AM daily to permit icing of the fish for transport to market.

The production of fish at the lake varies throughout the fishing season from 40 metric tonnes per day decreasing gradually to 0.2 tonnes per day at the end of the season. The ice to fish ratio ranges from 1/2:1 to 2:1. The average daily fish catch ranges from 10 to 15 tonnes. The ice making system will supply only a part of this demand, i.e. 5-6 tons per day. The system shall be instrumented to monitor its performance and to provide data to assess the technical, economic and social impact of such a hybrid power system.

1.4 Summary of Solar, Water, and Ambient Temperature Data

Meteorological and water quality data are provided in Appendix A and Appendix B respectively. The design of the system should be based on these data. The solar insolation data for the site is based on recorded data (sunlight hours) from a meteorological station in El Faiyum. Horizontal daily global insolation ranges from 3.4 kWh/m2-day in December to 8.1 kWh/m2-day in June. The ambient temperature data for the site is based on meteorological station data from El Giza, a city near Cairo. An additional 2 degrees Centigrade has been added to each temperature value to reflect the generally higher temperatures at the site compared with El Giza. The lake water temperature ranges from 8 to 26 degrees Centigrade in the vicinity of the Central Location.

Exhibit 3 is a site sketch showing one possible location of the ice maker in relation to the lake and the agricultural drainage canal. The agricultural drainage canal dries up for 1 to 2 months in January and February. This fact combined with the high sediment content of the agricultural canal water precludes it from being used as a source for either ice making water or condensor cooling water. Therefore, water must be pumped from the surface of the lake. A water quality analysis of the lake water in the location of the ice plant is provided

in Appendix B. Ice will be used for commercial applications, not for human consumption. However, it is anticipated that water pretreatment will be required to ensure low maintenance of equipment. Equipment should be designed to minimize corrosion.

2.0 PV/DIESEL HYBRID POWER SYSTEM AND ICE MAKING PLANT DESIGN SPECIFICATIONS

2.1 Schedule for Design, Delivery and Installation

The Contractor's proposal shall include the dedicated time requirements for the design, manufacture, factory testing, procurement, and delivery of the complete system CIF to Alexandria, Egypt. In no case shall the total time exceed 180 days from the date of final design review and approval (Section 2.2). The duration for installation of the system shall also be indicated and in no case shall it exceed 60 days from the date the equipment arrives on the site.

Within 14 days after contract award and a site visit, the Contractor shall submit for EEA/USAID review a detailed project schedule for the design, manufacture, factory testing, installation, instrumentation, startup and acceptance testing of the proposed PV/Diesel Ice Making Plant. The schedule shall include provision for a final design review and approval by EEA/USAID, or its designated representative, prior to start of manufacture and procurement. The schedule will be approved in writing by the contracting officer within 21 days of receipt in Cairo.

2.2 Design Review

The EEA/USAID or its authorized representative shall have the right to review drawings and specifications pertaining to the design of the system and individual components. Submission of the drawings and specifications for review and the completion of the review will be in accordance with the detailed project schedule (Section 2.1) submitted by the Contractor and approved by EEA/USAID. The EEA/USAID shall have the right to require modifications to the design prior to

final design approval for specified cause, namely: for minimum safety, prevention of harm to the property or equipment, or negative impact on the fishing or agricultural activity in the Wadi El Raiyan lake area.

2.3 General Design Requirements

The PV/Diesel Ice Making Plant design shall conform to U.S. standard specification and practice with all equipment sited and sized for efficient, safe and functional use. The system should be designed for a life of a minimum of 20 years except for the battery system which may be designed for a 10 year life based on one charge/discharge-cycle per day. The power control system, including switches and circuit breakers, should provide for reasonable equipment protection against incorrect procedures for starting, stopping and operating the equipment. A warranty shall be offered, above a standard warrant if required, to guarantee the proper function of all components of the system for a period of 5 years from the date of the approved acceptance test. Operating and maintenance personnel safety shall be an integral part of the system design. All proposed equipment shall be commercially available, to the maximum extent possible, and of demonstrated reliability; the use of prototype or one-of-a-kind hardware is discouraged.

The required level of design detail shall include as a minimum:

- Justification for system sizing and design including all calculations and technical/operational assumptions
- Justification for component selection
- Component (product) literature where appropriate
- General electrical schematics showing junction connections, grounding circuitry, voltage and current limits, etc.
- An installation diagram that includes the relative sizing and location of major pieces of equipment in relation to the lake at Wadi El-Raiyan

2.4 Technical Design Requirements

2.4.1 System Sizing

The PV/Diesel Ice Making Plant shall be designed to provide 5-6 tons/day (10,000 to 12,000 pounds in 24 hours) of ice at 25 degrees Farenheit (-4°C) available daily at 7 AM. An ice storage building shall be designed to maintain a minimum of 10 tons (20,000 pounds) of ice for a period of at least 2 days.

The provision of water for making ice and for condensor cooling, in the case that a water cooled condensor is proposed, shall be the responsibility of the Contractor. The proposal shall include the provision of any water treatment equipment which may be necessary to produce a quality of ice suitable for fish preservation and to minimize the level of maintenance of the ice making equipment. The proposal should clearly describe any water treatment requirements including needed chemical treatment and disposal of any residues.

The power system shall be designed for the following characteristics:

- Either DC or 50 Hertz AC power is acceptable.
- The diesel/generator shall be able to operate the ice plant, independent of the PV/battery power system.
- Battery Storage shall be the minimum necessary to accept the full array charging current rate and operate the load independent of the PV array or diesel.
- The PV array for ice making (excluding block ice production) shall be sized to meet 40 percent of the average daily energy demand over the year for a 5-6 ton/day capacity unit.
- The production and use of PV power shall be maximized.
- The power control system shall be automatic with manual override.

The PV array structure shall be of a manually adjustable tilt design. For example, the array would be capable of being adjusted in October/November and March/ April time period at an angle that maximizes energy production for each respective time period. The design and sizing of the power system shall be performed considering the system to be operated in an optimum fixed position so as to maximize energy production from the array from October through March.

The diesel should be capable of manual self-starting, independent of the PV array and control system.

2.4.2 Control System Design

The control system design should be kept as simple as possible and should conform to standard industry practice for wiring, environmental protection of solid state electronics, and safety. The control system shall incorporate manual and emergency disconnects for the load and power equipment. NEMA 4 enclosures will be used throughout the system. EEA/USAID, or its designated representatives, has the option to request and to witness the full load testing of the control system at the manufacturer's facility prior to shipment.

2.4.3 PV Array

The PV array shall be made of commercially available flat plate modules of single, poly(multi), or ribbon technology. Grounding of the array and structure shall conform to U.S. standard industry practices, or the equivalent.

2.4.4 Diesel/Generator Set

The diesel/generator shall produce 50 Hertz AC power if AC loads are used. If DC loads are used either an AC or DC generator is permissable. The unit shall be skid mounted and it shall contain standard operating gauges and controls separate from those supplied with the system controls. The diesel generator shall be designed for heavy duty full load operation under environmental conditions specified in Appendix A.

2.4.5 Battery

Lead acid deep cycle batteries, sealed or vented are desired. They should be supplied with recombination caps and an easy method of determining electrolyte level. The proposal shall describe battery operation including required equalization periods and duration and any special procedure for operation

in a high temperature environment.

2.4.6 Ice Making Plant

The ice making plant shall include the compressor, ice making unit and all necessary components to provide the required ice production. The tenderer is expected to justify and include in his proposal the related equipment and its installation necessary to supply condensing water and/or air in the required amounts and pressures to meet the ice making plant capacity requirements. Maintenance requirements for each equipment component and the entire system should be clearly explained.

2.4.7 Ice Storage Building

A prefabricated ice storage building shall be supplied by the tenderer and be of a size and construction to permit the storage and maintenance of a minimum of 10 tons of ice for a period of up to 2 days in the environment specified in Appendix A. A minimum of ice handling is preferred in order to reduce the number of moving parts and reduce energy load. Ice should remain loose and accessible during normal operating schedules.

2.4.8 Additional Equipment

- <u>Inverter (if proposed)</u>

  If inverter(s) are to be supplied they must conform to U.S. industry standard or equivalent and have a demonstrated field performance history. Operating procedures should be simple and clear. EEA/USAID or their representatives reserves the option to request and to witness full load testing of the inverter prior to shipment. Documentation of past experience with proposed inverters is required.

- <u>Battery Charger/Rectifier</u>

  A commercially available battery charger/rectifier is required so that the battery bank can be charged by the diesel.

- <u>Building and Tools</u>

  The proposal shall include a building with adequate ventilation to house the batteries, control electronics, and possibly the diesel/generator. An ajoining room should be provided for plant operators. Construction

of the building is the responsibility of the Contractor. A set of tools and instruments necessary to troubleshoot usual problems and make repairs utilizing the spare parts supplied shall be provided.

- Area Lighting

  A single street light-type lighting system is required at the staging area for fishing boats. The light shall be automatically controlled.

- Water Pre-treatment

  The proposal shall include a discussion of the effect of the water quality at Wadi El Raiyan, as described in Appendix B, on the production of ice suitable for the commercial application of fish transport. Equipment that the Contractor believes is required for water pre-treatment shall be included as part of the contractor's proposal and appear as a separate item in the cost proposal.

- On-Site Data Acquisition System (ODAS)

  An ODAS shall be designed, purchased and installed by the contractor as specified in Section 5 of this statement-of-work.

2.5 Proof of Performance

The EEA/USAID and/or its appointed representatives reserves the right to witness inspection and performance tests for all hardware equipment at the manufacturer's (or contractor's) facilities prior to shipment. The Contractor shall provide 30 days notice of performance testing for components. As mentioned under Section 2.4.2 and 2.4.8 the power control system and inverter, if supplied, shall be required to undergo full load testing (burn-in) prior to shipment. The proposal should address this issue by explaining what tests will be performed to assure field and reliable operational performance of components prior to shipment. This testing is the responsibility of the Contractor. It may be witnessed by EEA/USAID or appointed representatives.

3.0 PV/DIESEL ICE PLANT INSTALLATION

3.1 Equipment Shipment

Packing, insurance, freight and related charges to deliver all equipment items to Alexandria, Egypt is the responsibility of the Contractor. EEA, FRDA and/or its appointed agent will receive the equipment, be responsible for

custom clearance and transport of the equipment to the site. The Contractor and/or a representative agent is required to witness a receipt inspection at Alexandria and at the site.

The supplier shall send shipping documents, bill of lading, inspection certificates and other related documents to EEA one month prior to the receipt of the equipment at Alexandria.

All equipment shall be packaged or boxed in clearly numbered cartons or boxes. A Box Contents List (BCL) shall be delivered to the USAID contracting officer with a copy to EEA prior to the delivery of any equipment at Alexandria. This is in addition to Bill of Lading documents. The BCL shall identify the numbered contents of each box by the number of the box. Box number shall be grouped by subsystem. For example, PV arrays and related hardware are number series 200, batteries 300, and so forth. Prior to shippment, the tenderer should define in writing such equipment transport and receipt controls in similar detail as that provided above.

3.2 Plan and Schedule for Construction

The schedule for design, delivery and installation submitted in accordance with Section 2.1 shall include the number and skill level of laborers which will be employed; the duration of the work; and the plans for accomodations for both the labor force and the Contractor's personnel.

The Contractor is required to furnish all installation tools such as shovels, concrete forms, and mechanic's and electrician's tools necessary for the installation, startup and regular operation of the equipment. This equipment shall remain at the job site as part of the deliverable hardware under this contract.

Within two weeks of EEA/USAID approval of the design of the PV/Diesel ice-making plant the Contractor shall submit a "Plan and Schedule for Construction" to the USAID Contracting Officer for approval. The Contracting Officer will

approve the Plan/Schedule, or recommend changes required for approval within two weeks of receipt in Cairo. All construction work shall be completed within 60 days of notification to the contractor by EEA/USAID or its appointed agent that the system hardware is at Wadi El Raiyan.

The EEA/USAID reserves the right to periodically inspect all phases of the work while in progress or after completion of the whole or any part thereof to insure that the work is performed in compliance with the terms of the contract. If EEA/USAID determines that the work is not performed in accordance with the specifications, they reserve the right to require that the work be corrected of deficiencies or be redone if corrections cannot be made acceptable or are too expensive to economically correct. Any part of the work that is redone shall be at the Contractor's expense. All work related records shall be available at all times for examination by the EEA/USAID Contracting Officer. The Contractor shall provide all necessary facilities for such inspection during contractor's regular working hours, if necessary. It should be clearly understood, except as otherwise provided, that such progress inspection shall not constitute acceptance by the Contracting Officer of any part of the work, but will be for the purpose of coordination and assistance in interpretation of specifications and technical requirements.

3.3 Site Planning and Construction

The contractor is responsible for the proposed design of the foundations, earthwork, drainage and method to prevent or or minimize errosion. The contractor shall specify requirements for array structure foundations and cost these as a separate item in the cost proposal. In lieu of soil boring data, foundation specifications and cost shall include the minimum and maximum expected based on a range of soil conditions.

Within one month of system acceptance (see Section 7), the Contractor

shall enter all changes and corrections to the original system design incurred in the system installation on the original tracings. Changes and corrections so entered shall be indicated by a lettered circle, and noted as "As-Built" in the revision. In the case where no revisions or corrections to an individual drawing were necessary, the notation "As-Built-No-Changes" shall be made directly below the revision block. Where several manufacturers' brands, types or classes of items listed have been used in the project, the specific areas where each item was used shall be designated. Designations shall be keyed to the area and space designations on the contract drawings. Information shall be furnished, typewritten, for the listed materials. Copies of the "As-Built" drawings shall be given to the Contracting Officer.

The Contractor is encouraged to use local Egyptian labor and in-country fabrication of subsystems whenever possible. Low-cost fabrication techniques should be emphasized. The proposal shall discuss the extent to which the proposed system can be constructed and installed by local labor using local materials should the system be replicated elsewhere in Egypt. The contractor shall indicate where this approach has been taken with this or similar equipment in other developing countries. The contractor should specify needed facilities for housing local labor installation personnel.

4.0 OPERATION AND MAINTENANCE

4.1 Schedule of Energy Production

The Contractor shall include in the proposal an "Energy Production Plan and Schedule." This document shall contain, but is not necessarily limited to, average daily energy supply and demand projections for twelve months of electrical power generation and ice tonnage from the PV/diesel system based on the insolation in Appendix A. A complete description of how these projections were computed, including descriptions of any computer models used, is required. Input parameters to any model shall be given. Planned scheduled outages during

the upcoming year and planned changes in equipment, control mode, or operating characteristics significantly impacting the energy production of the system will be given, if applicable.

4.2 Guarantee/Spare Parts Requirements

The contractor shall provide at least a 5 year guarantee on all parts from the time of EEA/USAID system acceptance. The contractor shall separately cost an itemized list of spare parts that should be purchased by EEA/USAID and made available to insure trouble-free operation for five years. Any specialized, custom manufactured tools or equipment required for operation and maintenance of the system shall be specified and provided by the contractor.

4.3 Operations Support

The contractor is required to provide technical support of the operation of the system for a period of 2-years after system acceptance by EEA/USAID. The contractor's proposal shall describe the level of support offered, the procedures for management and control of the technical support and related support issues such as availability of spare parts, anticipated response time to a request for support, etc. This technical support shall be costed as a separate cost item in the contractor's cost proposal.

5.0 PERFORMANCE MONITORING

5.1 Field Test Data Acquisition System

The contractor will provide an on-site data acquisition system (ODAS) for monitoring the performance of hardware installed for this field test. This requirement is in addition to any other requirement for system control instrumentation and instrumentation necessary for routine test and maintenance checks as specified in Sections 2.4.2 and 4.2 of this statement-of-work.

The ODAS will comply with the specifications listed in Appendix C of

this statement-of-work and will monitor, as a minimum, the data parameters listed in Appendix C. The contractor will provide output ports and transducers to sample and measure each data parameter as specified in Appendix C and to insure compatibility with the data storage system proposed. The contractor will also provide a separate meteorological station to monitor data parameters as specified in Appendix C. The meteorological station will have its own data recording system that is compatible with the ODAS. If an exception must be taken to any of these requirements, the contractor will clearly note the exception and explain why the exception should be acceptable to the EEA/USAID.

5.2 ODAS Installation and Training

The contractor will install the ODAS at the same time that the field test hardware is being installed. Training for Egyptian engineers and technicians in the installation and operation of the ODAS will be included in the on-the-job training program described in Section 6 of this statement-of-work.

The ODAS instrumentation and installation shall be a separate item in the cost proposal for this field test. The EEA/USAID reserves the right to replace or modify the proposed ODAS during contract negotiation if required to maximize compatibility with other data collection, analysis and storage requirements of the REFT Project.

5.3 Log Sheets/Maintenance Records

The contractor shall develop, as part of the proposal, a log sheet of pertinent data that should be manually recorded on each major subsystem to document operations and maintenance history. The recommended frequency for maintenance of each item shall be stated. These logs/records should comply with the specifications outlined in Section 8.

6.0 TRAINING REQUIREMENTS

The following training program and materials are required from the contractor for this project. These training programs fall into three general areas: classroom training in Cairo, in-factory training in the U.S. and on-the-job training at Wadi El-Raiyan, Egypt. Training sessions and materials vary in content and presentation from informal "one-on-one" type instruction to more formal group "lectures and workshops." The sections below describe the training requirements. All training and materials will be written and conducted in English. All emergency start-up and shut-down procedures must be provided in both English and Arabic.

6.1 Operator Training Program

Formal Classroom training will be given in Cairo for EEA and FRDA engineering, operating, and maintenance staff in the design of the PV/Diesel Powered Ice Making Plant. This training is anticipated to be for 20 hours (5 days, 4 hours per day) and intended to provide the EEA and FRDA staff with an understanding of the engineering parameters, design process, and decisions which resulted in the final design of the system. This training will be conducted at the start of the installation work and is not intended to require a separate dedicated travel to Cairo.

As part of this proposal, the Contractor shall develop a syllabus that briefly summarizes topics and content of the classroom design training program.

6.2 Maintenance Training Program

Formal classroom training will be given in Cairo for selected EEA and FRDA engineering, operating and maintenance staff in the operation, maintenance and repair of the system and individual components. The training is anticipated to be for 20 hours (5 days, 4 hours per day). The training will utilize the actual working drawings for this project to cover such topics as installation procedures, specifications, construction schedule and labor requirements. This

training is intended to familiarize EEA and FRDA staff with the details of the installation as well as the project management aspects of the project. System installation will begin as soon as possible following this training and the operator training program (Section 6.1).

The Contractor is required to operate the PV/diesel ice maker for a period of 30 days after the system is designated as operational by the EEA/USAID. During this time period the contractor shall provide an on-the-job training program in the operation, maintenance and repair of the system and equipment components. The training program shall consist of a minimum of 20 hours of on-site formal classroom training and 80 hours of on-the-job (OJT) field training. As part of the proposal the contractor shall develop a syllabus for the on-site training program that briefly summarizes the topics, operating and maintenance procedures which will be taught.

It is assumed that the OJT field training will consist of selected EEA and FRDA personnel accompanying the contractor personnel during normal daily operational tasks. The contractor shall briefly describe, as part of this proposal, the itinerary of the PV/diesel ice plant operating personnel over an average day. The itinerary should take into account the demonstration nature of this field test, i.e., the Egyptian engineer must understand the function and operation of any specialized equipment and instrumentation.

6.3 In-Factory Training Program

The Contractor is required to provide and/or coordinate in-factory training on the operation, maintenance and repair of the PV/diesel ice making plant system and major equipment components. This training is anticipated to take place at the respective manufacturer's facilities for the following components; PV array, batteries, diesel engine, ice making plant, inverter and system controller. The training should be both classroom and "hands-on". The

total number of training days is not expected to exceed 20 days covering all subsystems. All expenses for the visiting engineers are the responsibility of EEA/USAID. As part of this proposal the Contractor shall develop a syllabus for the in-factory training and suggested itinerary for the program.

7.0 SYSTEM ACCEPTANCE TEST CRITERIA

The Contractor shall include in his proposal a proposed Acceptance Test procedures for "Point of Manufacture Testing" and "Field Acceptance Test" of the system and specific components. At a minimum it shall include the following:

7.1 Point of Manufacture Testing (PMT)

The Contractor shall detail in his proposal the procedures to be followed for the point of manufacture testing of the major equipment items. At a minimum this shall include: diesel, PV modules, PV controller, power system controller, pumps, inverter (where proposed), batteries, and ice making plant. EEA/FRDA and USAID or their authorized representative shall have the right to attend and witness component and system performance testing at the manufacturers prior to shipment. EEA/FDA and USAID representatives attending the tests shall have the right to require measures and procedures necessary to ensure that tests comply with contractors proposed testing procedure specifications (JPL, IEEE, ASME, etc.). PMT data and acceptance test certificates shall be assembled into usable formats to constitute baseline acceptance test data for the equipment. The signed (manufacturer) and countersigned (EEA and USAID and/or representative) acceptance test certificates shall be considered part and parcel of the necessary shipping documents.

7.2 Field Acceptance Testing

The Contractor proposal shall provide, in detail, performance guarantees and evaluation procedures for the system and its major components. These shall

include at a minimum the following:

- o A PV array performance guarantee expressed, in part, as a curve guaranteeing the average daily output of the PV array as a function of the average daily insolation.
- o Diesel operating efficiency as a function of load over a sustained running time.
- o Battery "round-trip" efficiency as a function of temperature and state of charge.
- o Control system full operational performance.
- o System performance (ice production) by both diesel and PV/battery power systems.

EEA and USAID and/or their authorized representatives shall participate in a 30-day acceptance test conducted by the contractor at the site. The contractor shall submit in the proposal the guaranteed PV array output power at standard operating conditions (1000 watts/m^2, 25°C). The EEA/USAID, or its designated representative, will measure array current-voltage (I-V) curves at a number of insolation levels throughout the 30-day acceptance test period. Calibrated pyranometers, curve tracers, and temperature measurement instrumentation will be used. For each I-V curve, the maximum power point will be corrected (normalized) for temperature. All measured data must be above 95 percent of a straight line drawn from the origin to the guaranteed manufacturer output power value (Exhibit 4).

8.0 PV/DIESEL/ICE PLANT OPERATIONS AND MAINTENANCE MANUALS

The contractor shall provide manual(s) prepared to the minimum content listed below. The manual is to be used for operation, maintenance, repair and logistic support for the PV/Diesel Ice Making Plant. All manuals shall be delivered to EEA/USAID for review at least 30 days prior to the arrival of equipment at the site. All manuals shall be in English. Manual(s) will be revised as needed and a final set submitted not later than 30 days after the completion of the 30-day acceptance testing period. The minimum requirements

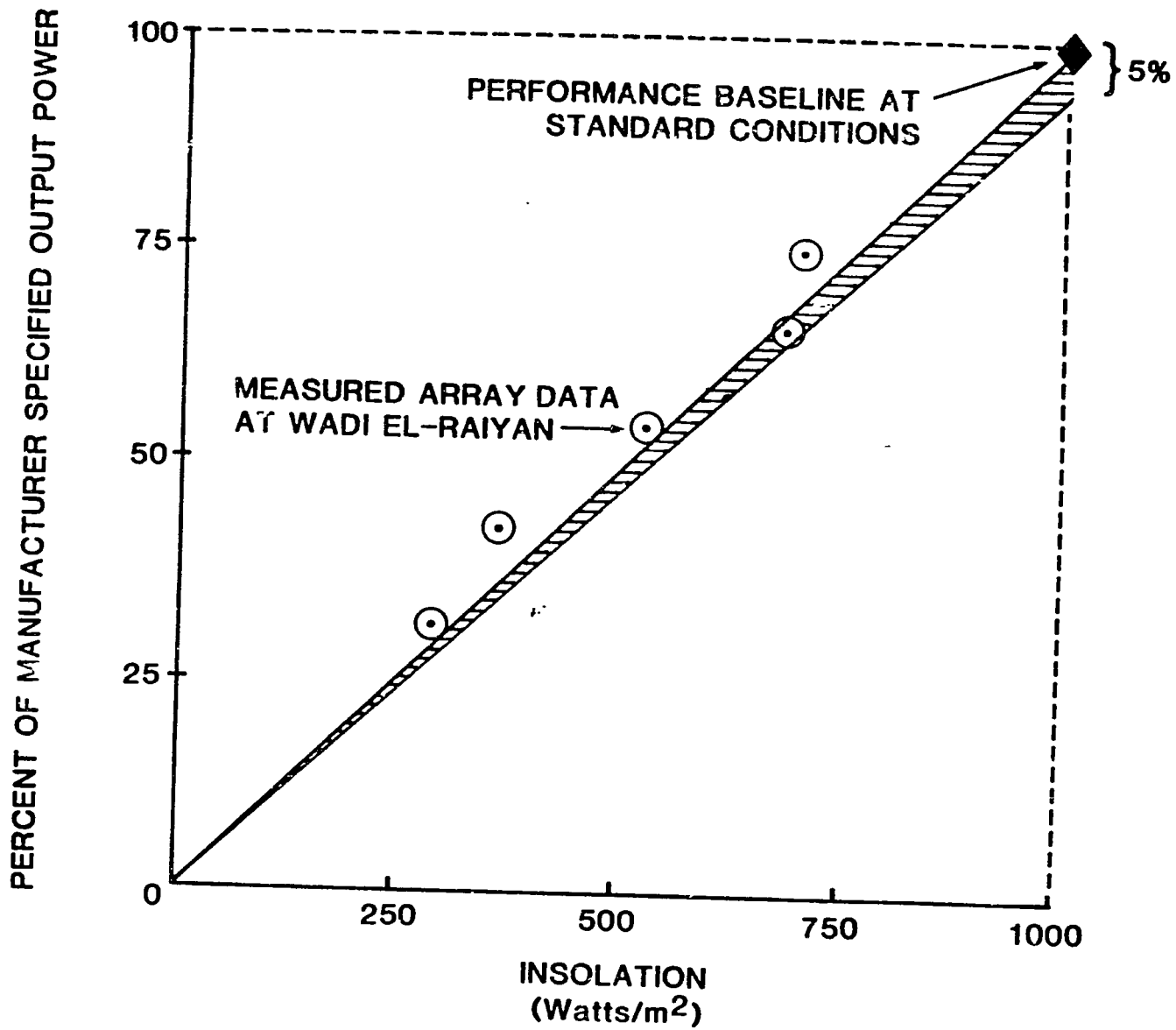

Exhibit 4.
PV ARRAY PERFORMANCE VERIFICATION

for the manual(s) shall include chapters on the following subjects:

8.1 System Description

This chapter shall include but not be limited to the following:

- a full page composite illustration of the PV/Diesel Ice Plant equipment and layout
- an illustration(s) calling out the major assemblies
- a basic description of the type of equipment and its purpose
- a function block diagram
- tables listing equipment supplies and equipment required but not supplied, if any
- tables of technical, environmental and physical characteristics, as appropriate

8.2 System Installation

This chapter shall include:

- information on unpacking and proper location of equipment
- interconnections and initial pre-operational adjustments
- details of structure, cables and foundation requirements (as applicable)
- operating ranges (voltage, current for each equipment item and system.

8.3 System Operation

This chapter shall include:

- step-by-step procedures for starting, operating and stopping the equipment
- meter readings and/or results expected from properly adjusted and operated equipment
- tables and illustrations calling out all operational controls and indicators and their functions (all references to controls and indicators throughout the manual shall follow these designations)
- means for adjusting array tilt angle

8.4 Principals (or Theory) of Operation

This chapter shall include:

- a functional description of the equipment, based on a block diagram
- for complex mechanical features, a complete explanation, using block diagrams, exploded views or cutaway drawings.
- major assemblies broken into individual circuits, accompanied by complete circuit analysis keyed to simplified schematic
- brief description of conventional circuits
- detailed descriptions of complex and novel circuits
- typical daily power, load, and state of charge curves for each component

8.5 Maintenance (Preventive/Corrective)

This chapter shall include:

- a maintenance schedule for all equipment including adjustments and procedures
- list of recommended test equipment
- lubrication data
- information that permits a technician to locate trouble and to make replacements, repairs or adjustments to the equipment
- for complex equipment or where the procedure is not obvious, an outline of disassembly and reassembly procedures (diesel)
- details of special test procedures
- completed adjustment and maintenance information for relays and other electro-mechanical devices
- Tools required for maintenance.

8.6 Parts List

The parts list shall consist of a tabulation of descriptive data on all electrical components and repairable/replaceable commercial or vendor mechanical components in the equipment. All parts shall be sufficiently described to implement reorder/replacement. The parts list shall contain at least the following information:

(a) Reference designation

(b) Name and description of part

(c) True Manufacturer's code and part number (and list of manufacturer's codes and addresses)

(d) Quantity

8.7 Drawings

In addition to drawings previously specified, the following shall be included:

(a) Schematic diagrams of individual major components, printed wiring boards and, where applicable, or the completed equipment

(b) Logic diagrams

(c) Interconnection diagrams

(d) Cabling diagrams

(e) Wiring diagrams

9.0 SPECIAL PROVISIONS

9.1 Site Access and Local Labor Provision

Employees and representatives of the Contractor and personnel conducting business with the Contractor relating to this Contract, will be granted a revocable permit to enter the Wadi El Raiyan area for the purpose of installation, operation, and/or maintenance of the facilities and equipment providing electrical energy under this Contract. Access to and movement within this area are subject to restrictions and provisions of the security instruction in effect.

It is the Contractor's responsibility to maintain satisfactory labor relations with his employees. Representatives of the Contracting Officer will not participate in labor relations matters unless disputes develop that interfere with the proper performance of the contract, at which time the representative may endeavor to assist in settling the difficulty. The contractor is encouraged to hire local labor whenever possible.

9.2 Protection of the Environment and Personnel

During all operations, all EEA and local environmental and labor requirements shall be rigorously observed. The EEA will retain the right to suspend any operation judged to present an imminent threat to the environment or personnel, or a violation of applicable labor laws and regulations or natural resources management agreements, after giving notice to the Contractor.

9.3 Public Release Information

There shall be no public release of information or photographs concerning the aspects of this Contract or other documents resulting from this Contract without prior written approval of the EEA.

9.4 Pre-Award Survey

The EEA/USAID may make a pre-award survey to the facilities of any apparently successful bidder to determine whether or not such bidder is adequately qualified to perform the requirements of any Contract that may be awarded on the basis of this specification. Investigation may be conducted to determine that the Contractor does regularly engage in the performance of work of the type covered by the specification and has a satisfactory record of performance in this field. The bidder is required to submit information, as well as any other related material, requested by EEA/USAID audit agencies during the course of the preaward survey.

9.5 Minimum Proposal Requirements

The contractor is required to submit as part of the proposal the following:

- Organization Chart. Show the organization for accomplishing and managing the project. Explain briefly the responsibilities of each element shown on the organizational chart. Identify key personnel by name in each element and submit their curriculum vitae (resumes). Show the lines of authority within the organization. If important portions of the project are to be subcontracted (e.g., design of the system), identify the subcontracted function, the subcontractor(s),

the subcontractor's key personnel, and which elements of the organization will manage the subcontract(s).

- o Key Personnel and Resumes. Provide resumes of key personnel, including those of the subcontractor(s). Be explicit in identifying past training and experience of each individual which qualifies him/her for the position to be held in the organization.
- o Staffing Plan. Indicate the type and approximate number of skilled personnel required in each element of the organization chart. State whether or not the required personnel are available within the organization. If not, comment on the availability of needed skilled personnel within the labor force and outline a schedule and plan for recruitement and/or training.
- o Related Experience. For each of the categories of experience below, list and describe projects or contracts which have provided your firm or that of your proposed subcontractor with related, qualifying experience. The descriptions should include: (1) dates during which the work was accomplished; (2) the scope and price of the total project or contract; (3) statement of what portion of the total project or contract was accomplished by your firm, i.e., an explicit desciption of the responsibilities or role of your firm; (4) financing arrangements; (5) references; (6) approximate payment for your service; (7) number of similar projects, location and contact person.
  - Construction Projects. List and discuss projects or contracts providing experience in the construction of facilities, particularly those using PV/Diesel hybrid systems.
  - Operation and Maintenance of PV/Diesel/Ice-making Systems. List and discuss projects or contracts providing experience in the operation and/or maintenance of PV/Deisel and ice-making systems.

For each of the items listed, state which of the following functions were the responsibility of your firm; (a) start-up of facilities; (b) operation of facilities; (c) routine maintenance; (d) periodic overhaul of facilities. Also, state what type of facilities were included; (e) PV systems; (f) controls; (g) electrical switchgear and protection equipment; (h) other. If "other" is listed, please identify or explain.

9.6 Post-Award Site Visit

Upon contract award, winning contractor personnel are expected to inspect the Wadi Raiyan site to satisfy themselves as to all general and local conditions that may affect the design and installation of the PV/Diesel/Ice-making system. EEA/USAID, and/or authorized representative personnel will be available at that time for detailed discussions prior to initiation by the contractor of detailed system design.

9.7 Summary of Deliverables

(1) Contract Documentation Schedule

	ACTIVITY	WEEKS AFTER CONTRACT AWARD*
(a)	Project Schedule.....	2
(b)	EEA/USAID Approval of Project Schedule.....	5
(c)	Detailed Design Complete.....	9
(d)	EEA/USAID Design Review Complete (Authorization to proceed).....	13
(e)	Written Results of Component/Subsystem In-Factory Testing.....	Within 2 weeks of test completion
(f)	System Operations and Maintenance Manuals.....	Within 4 weeks of system acceptance
(g)	Unscheduled Maintenance Reports.....	As required to document unscheduled maintenance throughout the 2-year support period

(2) Contract Hardware Installation Schedule

(a) Site Preparation Complete, Hardware Delivered to Site..... Day 0 (D)

(b) Construction Completed, PV/Diesel Interconnected with the Ice-maker..... D + 60 days

(c) System Acceptance Test Complete..... D + 90 days

(d) Final System Drawings and System Operations and Maintenance Manual Submitted..... D + 120 days

* In this schedule, one week is allowed for transmittal and receipt of documents mailed from either the United States or Cairo.

APPENDIX A

Solar, Ambient and Water Temperature Data

APPENDIX A

Insolation (Source: Published research by Dr. Mossallan Shaltout of the Egyptian Meteorological Authority)

Horizontal Global Average Daily Insolation

EL FAIYUM EGYPT LAT=29

	SOLAR (kWh/day)	TEMP °C	REFLEC*
JAN	3.8	15.2	.20
FEB	4.9	16.2	.20
MAR	6.0	18.6	.20
APR	7.4	22.2	.20
MAY	7.6	26.1	.20
JUN	8.1	28.7	.20
JUL	8.1	30.2	.20
AUG	7.5	29.8	.20
SEP	6.7	27.4	.20
OCT	5.2	25.4	.20
NOV	4.0	21.2	.20
DEC	3.4	16.3	.20

* Estimated for sand

Ambient Temperature (Source: El Giza + 2 degrees Centigrade)

MONTH	MAX	MIN	MEAN
JAN	22.2	8.1	15.2
FEB	23.7	8.6	16.2
MAR	26.4	10.7	18.6
APR	30.7	13.7	22.2
MAY	34.7	17.6	26.1
JUN	36.8	20.6	28.7
JUL	37.8	22.5	30.2
AUG	37	22.5	29.8
SEP	34.4	20.4	27.4
OCT	32.6	18.1	25.4
NOV	28.2	14.2	21.2
DEC	22.6	10.1	16.3

Water Temperature (Source: Rafik Georgy, based on FRDA data)

8 - 28 Degrees Centigrade

APPENDIX B

Selected pages from

Inorganic Pollutants In El-Faiyum
Aquatic Environment

Reference: Supreme Council of Universities
Foreign Relations Co-ordination Unit
Report No. 2: Aug. 1, 1984 - Nov. 30, 1984
Report No. 3: Dec. 1, 1984 - Feb. 28, 1985
Report No. 4: Mar. 1, 1985 - April 30, 1985

Principal Investigator:
Dr. Mahmoud Abbas Saleh
Professor of Chemistry
Faculty of Agriculture
Cairo University

GRANT
FRCU 842020

INVESTIGATION OF INORGANIC POLLUTANTS IN EL FAIYUM AQUATIC ENVIRONMENT

Principal Investigator
Dr. Mahmoud Abbas Saleh
Professor of Chemistry
Faculty of Agriculture, Cairo University

Report No. 2.

August 1st to November 30, 1984

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RESULTS

This section presents results of the detailed chemical and biological studies of samples and specimens which were collected during the first expedition. It also presents results which were either obtained by direct measurments in the field or by visual observation and photography. General features and discription of studied area were shown in details in our first report.

Chemical Results:

Inorganic pollutants in water and selected food chain were determined stations locations of the Wadi El-Raiyan and water springs are shown in Figure 1. The concentration of some important non metallic pollutants and some physical measurments are shown in Table 1 and table 2 respectively. Concentration of heavy metals in water samples of Wadi El-Raiyan drainage canals and soil samples are shown in Tables 3, 4 ,5 respectively. Concentration of heavy metals in biological samples is hsown in Tables 6-10.

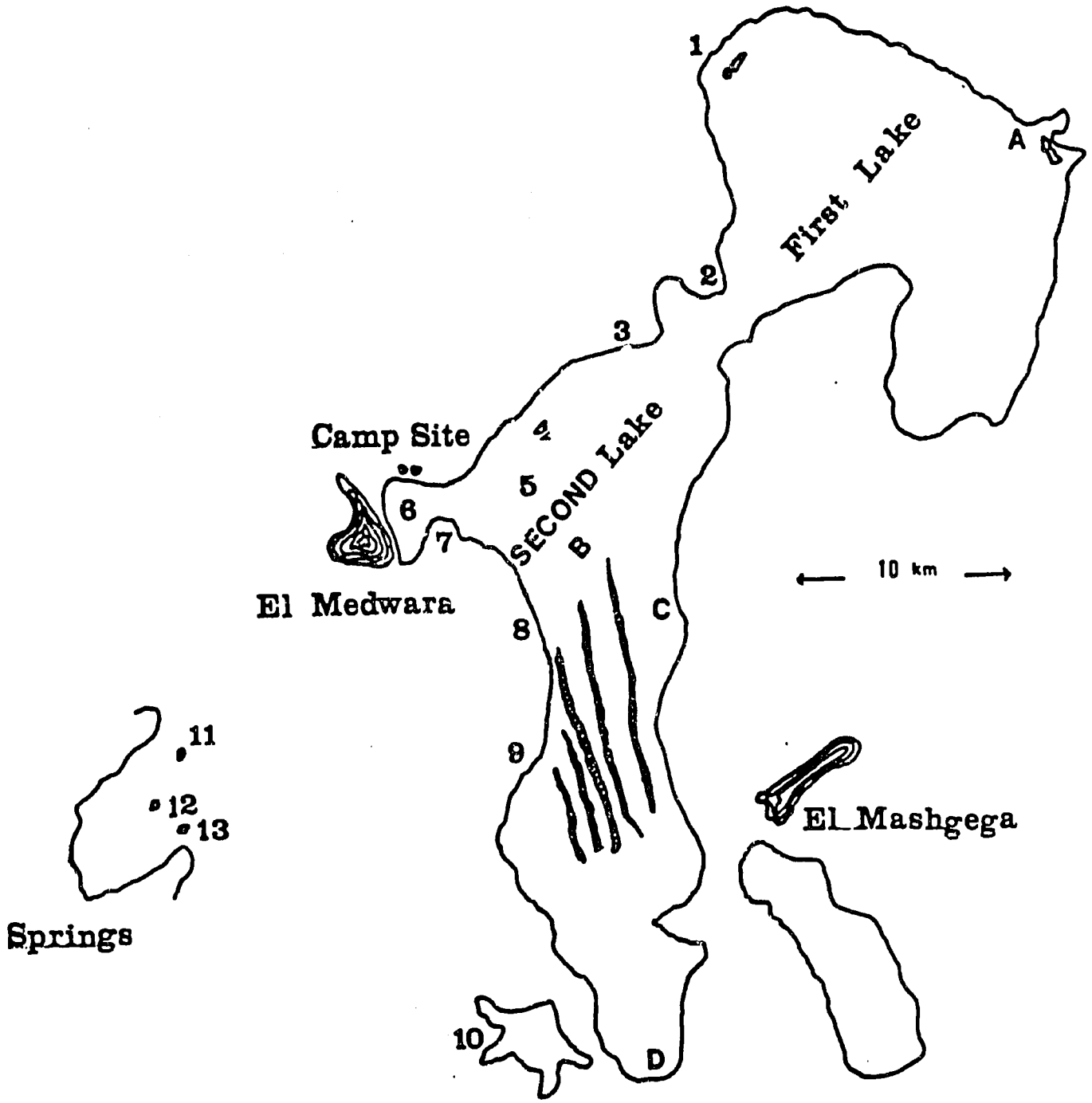

Figure 1. Map of the Selected Stations of Wadi El-Raiyan Lakes and Water Springs.

Table 1. Concentration of Nonmetallic Inorganic Ions in Water (mg/L = ppm)

Station/Depth	Sulfate SO_4^{2-}	Sulfite SO_3^-	Bisulfide HS^-	Nitrate NO_3^-	Nitrite NO_2^-	Ammonium NH_4^+	Amonia NH_3	Chloride Cl^-	Bromide Br^-	Iodide I^-	Thiocyanate SCN^-	Oxygen O_2
1 Surface	520	0.000	0.010	105	0.016	0.030	0.022	534	0.006	0.9	0.008	10.8
2 Surface	750	0.002	0.040	160	0.002	0.050	0.040	663	0.005	1.0	0.003	10.8
3 Surface	1155	0.002	0.010	118	0.011	0.080	0.050	881	0.006	1.3	0.007	10.0
4 Surface	570	0.000	0.000	137	0.004	0.050	0.040	1346	0.006	1.1	0.006	9.4
10m	702	0.000	0.000	147	0.002	0.050	0.040	1336	0.006	1.2	0.005	8.5
5 Surface	1045	0.000	0.010	137	0.005	0.050	0.040	1425	0.010	0.8	0.006	9.0
5m	630	0.000	0.010	147	0.009	0.025	0.020	1445	0.010	1.3	0.009	8.8
10m	682	0.000	0.010	143	0.009	0.025	0.020	1326	0.006	1.6	0.004	8.2
6 Surface	425	0.000	0.010	109	0.012	0.050	0.040	147	0.006	0.8	0.007	9.4
2.5m	300	0.015	0.015	81	0.012	0.120	0.100	1366	0.006	0.8	0.003	9.2
7 Surface	1156	0.008	0.010	10	0.002	0.050	0.040	1425	0.008	0.8	0.004	8.0
8 Surface	830	0.020	0.015	127	0.002	0.060	0.048	1445	0.020	0.9	0.006	8.5
9 Surface	820	0.025	0.008	105	0.005	0.100	0.080	1336	0.023	1.3	0.006	9.0
10 (Seepage)	945	0.000	0.010	118	0.010	0.000	0.000	8405	0.026	1.6	0.004	7.4
Average value	781	0.005	0.011	117	0.007	0.053	0.042	1128	0.012	1.1	0.005	9.07
11 Origin	417	0.005	0.030	4	0.005	0.075	0.060	2257	0.006	1.3	0.006	11.8
12 Origin	520	0.000	0.200	11	0.004	0.600	0.470	2316	0.008	1.1	0.000	4.8
13 Origin	410	0.005	0.060	2	0.000	0.120	0.100	1772	0.002	0.8	0.000	9.0
Pool	440	0.008	0.020	3	0.000	0.100	0.080	1881	0.003	0.7	0.000	10.8
Average value	447	0.004	0.077	5	0.002	0.224	0.177	2056	0.005	0.9	0.001	9.1

* Phosphate concentration in all stations was less than 0.1 ppm , None of the cyanide or arsenite were detected.
* The results are the average of three measurements.

Table 2. Physical Properties of Water Sample of Wadi El-Paiyan.

Station/Depth		pH July	pH Nov.	Salinity July	Salinity Nov.	Electric conductivity July	Electric conductivity Nov.	Hardness July	Hardness Nov.	T.S.S (mg/L) July	T.S.S (mg/L) Nov.
1	Surface	7.5	8.5	1.4	1.0	33	20	18	18	1690	1024
2	Surface	7.5	8.0	1.4	1.2	32	20	17.6	19	1636	1024
3	Surface	7.2	8.0	1.4	1.3	30	21	26.8	19	1536	1075
4	Surface	7.0	8.2	3.2	2.8	71	42	36.1	28	3635	2150
	10m	7.5	8.5	3.2	3.0	72	42	35.0	29	3686	2150
5	Surface	7.3	8.0	3.2	3.2	72	52	34.8	32	3686	2662
	10m	7.8	8.5	3.0	3.2	72	50	37.1	31	3686	2560
6	Surface	7.2	8.0	3.4	3.5	73	52	39.4	27	3738	2662
	2.5m	7.2	8.2	3.1	3.3	74	52	39.0	34	3788	2662
7	Surface	7.5	8.2	3.0	3.2	70	51	36.1	29	3584	2611
8	Surface	7.2	8.2	3.0	3.6	46	55	34.0	30	2355	2816
9	Surface	7.2	8.2	3.3	3.5	68	45	43.0	38	3481	2304
10	Surface	6.0	8.5	33.3	26.0	760	370	270.0	100	38912	18944
	Average	7.4	8.2	2.8	2.8	60	43	33	28	3072	2201
11	Origin	7.5	7.5	4.3	4.0	98	72	67	62	5018	3686
12	Origin	8.5	7.2	4.3	4.5	99	62	60	51	5069	3174
13	Origin	7.8	7.5	3.6	4.6	99	55	58	43	5069	2816
	Pool	7.8	8.0	4.7	3.8	100	52	55	43	5120	2662
	Average	7.9	7.6	4.2	4.2	99	60	60	50	5069	3072

Water temperature was 25-28°C during July and 12-20°C during November.

Table 3. Concentration of Heavy Metals in Water Samples of Wadi El-Raiyan µg/L (ppb).

Station/Depth		Copper Cu	Iorn Fe	Lead Pb	Manganese Mn	Mercury Hg	Selenium Se	Zinc Zn
1	Surface	1.3	70	31.5	13.2	50	8.8	4.3
2	Surface	8.5	190	28.0	4.5	50	8.8	22.0
3	Surface	8.5	350	50.0	14.2	90	8.8	25.0
4	Surface	3.3	340	47.5	21.5	97	8.8	14.3
	10m	4.0	350	50.0	20.1	90	8.8	15.0
5	Surface	4.8	58	38.0	4.5	30	20.0	4.0
	5m	6.0	100	57.5	13.3	10	18.5	27.5
	10m	5.5	670	37.5	5.3	55	20.0	6.3
6	Surface	10.0	310	28.0	7.3	50	19.0	7.4
	2.5m	2.5	35	32.5	1.5	10	20.0	7.5
7	Surface	10.0	332	48.7	25.7	55	9.0	28.7
8	Surface	8.0	207	55.0	14.5	55	0.25	18.5
9	Surface	2.0	555	72.5	19.8	40	12.5	26.5
10	Surface	9.0	362	131.2	20.7	69	20.0	11.7
	Average	6.0	281	50.6	13.3	54	13.0	15.6
11	Origin	7.8	213	87.5	15.8	10	12.5	32.0
12	Origin	10.0	1337	31.3	65.0	5	16.3	35.0
13	Origin	4.5	68	48.8	6.8	3	12.5	2.5
	Pool	3.3	1020	70.0	55.0	4	7.0	7.3
	Average	6.4	660	59.4	35.6	5.5	12.0	19.2

Table 4. Concentration of Heavy Metals in El-Faiyum Drainage Canals, µg/L (ppb)

	Station	Copper Cu	Iorn Fe	Lead Pb	Manganese Mn	Mercury Hg	Selenium Se	Zinc Zn
1	مصرف الخميسين - أبوكساه	7.8	981	24.0	46.6	5.0	10.6	35.0
2	مصرف شعلان - شعلان	19.7	1768	51.8	259.0	45.0	7.5	67.5
3	مصرف الفرق الرئيسي عزبة أبو طالب	8.9	422	31.6	43.1	85.2	9.5	23.6
4	مصرف الفرق عزبة الاصفاف	18.5	231	27.5	52.4	39.6	2.7	7.8
5	مصرف المنهمس - عزبة الباسل	22.7	714	35.1	175.8	50.6	2.6	27.9
6	مصرف الكمال - هوارة المقطع	19.7	1412	33.3	168.5	68.5	4.4	69.3
7	مصرف الكمال - اللاهون	18.8	1105	52.6	378.0	49.5	8.2	58.8
Average		16.7	947	36.5	160.4	49.0	6.5	41.4

Table 5. Concentration of Heavy Metals in Wadi El-Raiyan Soil mg/ kg (ppm).

Sample	Copper Cu	Iorn Fe	Lead Pb	Manganese Mn	Zinc Zn
1	0.14	24.2	2.5	0.32	1.36
2	0.12	10.1	3.9	0.15	1.13
3	0.24	18.1	13.9	0.25	1.19
4	1.29	33.5	0.7	0.70	2.39
5	0.10	21.2	2.6	0.95	0.75
6	0.09	11.0	0.9	0.24	1.19
7	0.05	14.4	0.6	0.24	0.78
8	0.05	9.1	1.7	0.18	0.69
9	0.15	20.2	1.4	0.39	0.75
10	0.04	10.0	0.6	0.19	0.47
11	0.04	14.3	0.7	0.25	0.63
12	0.09	29.0	1.4	0.37	0.67
Average	0.20	17.9	2.6	0.35	1.0

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Table 6. Concentration of Heavy Metals in Selected Plants of Wadi El-Raiyan, µg/g dry weight (ppm).

Species/Location	Copper Cu	Lead Pb	Mercury Hg	Selemium Se	Zinc Zn
Phragmites anstralis					
1	3	59			14
2	4	50			16
3	4	60			17
8	1	75			9
Tamarix sp.					
2	1	48			31
7	0	48	105	6	13
Juncus rigidus					
2	4	49			2
Najas armata					
	3	84			5

Table 7. Concentration of Heavy Metals in Selected Algae, Planktons and Insects of Wadi El-Raiyan µg/g dry weight (ppm)

Species/Location	Copper Cu	Lead Pb	Mercury Hg	Selenium Se	Zinc Zn
Algae					
11	8	64			32
12	6	87			39
13	2	117	64	45	54
Planktons					
2	2	59	75	40	0.0
5	1	200			0.0
Insects					
Ants	100	1054			0.0
Crickets	16	106	1256	330	0.0

Table 8. Concentration of Heavy Metals in Fishs µg/g dry weight (ppm).

Species/Location, part	Copper Cu	Lead Pb	Mercury Hg	Selenium Se	Zinc Zn
Tilapia zilli.					
drainge canal St. 2					
whole body	13	55	68	86	149
intestine	3	54			63
fins and tail	0	179			453
draing canal St. 3					
whole body	13	67			84
intestine	6	57			86
fins and tail	0	921			0
draing canal St. 4					
whole body	2	63			59
intestine	6	69			58
fins and tail	3	956			415
draing canal st. 6					
whole body	6	66			191
intestine	7	200			170
fins and tails	3	1100			200
Wadi El-Raiyan Lakes					
St.6					
whole body	3	60	60	43	1
intestine	2	65			50
fins and tail	6	300			3
St.3					
whole body	1	86			49
intestine	11	82			40

Table 9. Concentration of Heavy Metals in Birds of Wadi El-Raiyan µg/g dry weight (ppm).

Species/Part	Copper Cu	Lead Pb	Mercury Hg	Selenium Se	Zinc Zn
Egretta garzetta					
Whole body	17	323	101	76	96
brain	1	5000			0
feathers	16	791			23
liver	20	66			60
kidney	17	550			254
Vanellus spinosus					
whole body	7	114			80
feathers	148	2100			93
kidney	7	246			145
Acrocephalus stentoreus					
whole body	5	310			57

Table 10. Concentration of Heavy Metals in Mammals µg/g dry weight (ppm).

Species/part	Copper Cu	Lead Pb	Mercury Hg	Selenium Se	Zinc Zn
Gerbillus gerbillus					
whole body	8	60	88	52	44
liver	0	1630			360
Kidney	1	3700			3000
heart	59	2941			476
Canis aureus					
feces	18	100			126

It appeares from Tables 1 - 4 that water salinity and the amounts of total soluble salts (TSS) increased from the water inputs and moving toward the second lake reaching values of 34 part per thousand (‰) in some of the seepage area with a 38.9 g/L of soluble salts, this value is extremely high but it is not considered as a part of the lake. Salinity of the drainage canals and at the Wadi El-Raiyan tunnel was about 0.5 ‰. Water pH was very much the same throughout the lakes being slightly basic and ranging from 7.0 to 7.8 during July and from 8.0 to 8.5 during November. Water hardness also increased from the water inputs and movings toward the second lake. Water temperatue was 25 -28°C during July and 12-20°C during November . Dissolving oxygen in water was 7.4 mg/L in the seepage areas which is characterestic with very high salinity and 10.8 mg/L in the first lake with a low salinity. Heavy metals concentrations in water was relatively low and below the recommended levels for general uses and also below the permissible values for public water supplies as shown in Figure 2 and Table 11. Lead concentration ranged from 28 to 72 microgram/liter (ppb) with an average of 50 ppb. Zinc from 4 to 29 ppb with an average of 16 ppb, copper from 1 to 10 ppb with an average of 6 ppb, selenium from 0.25 to120 ppb with an average of 54 ppb, iron concentration ranged from 35to 670 ppb with an average of 280 ppb, manganese ranged from 1.5 to 25 ppb with an average of 13 ppb. No arsenic was found in any of the examined stations. Heavy metals concentrations in El-Faiyum drainage canals were

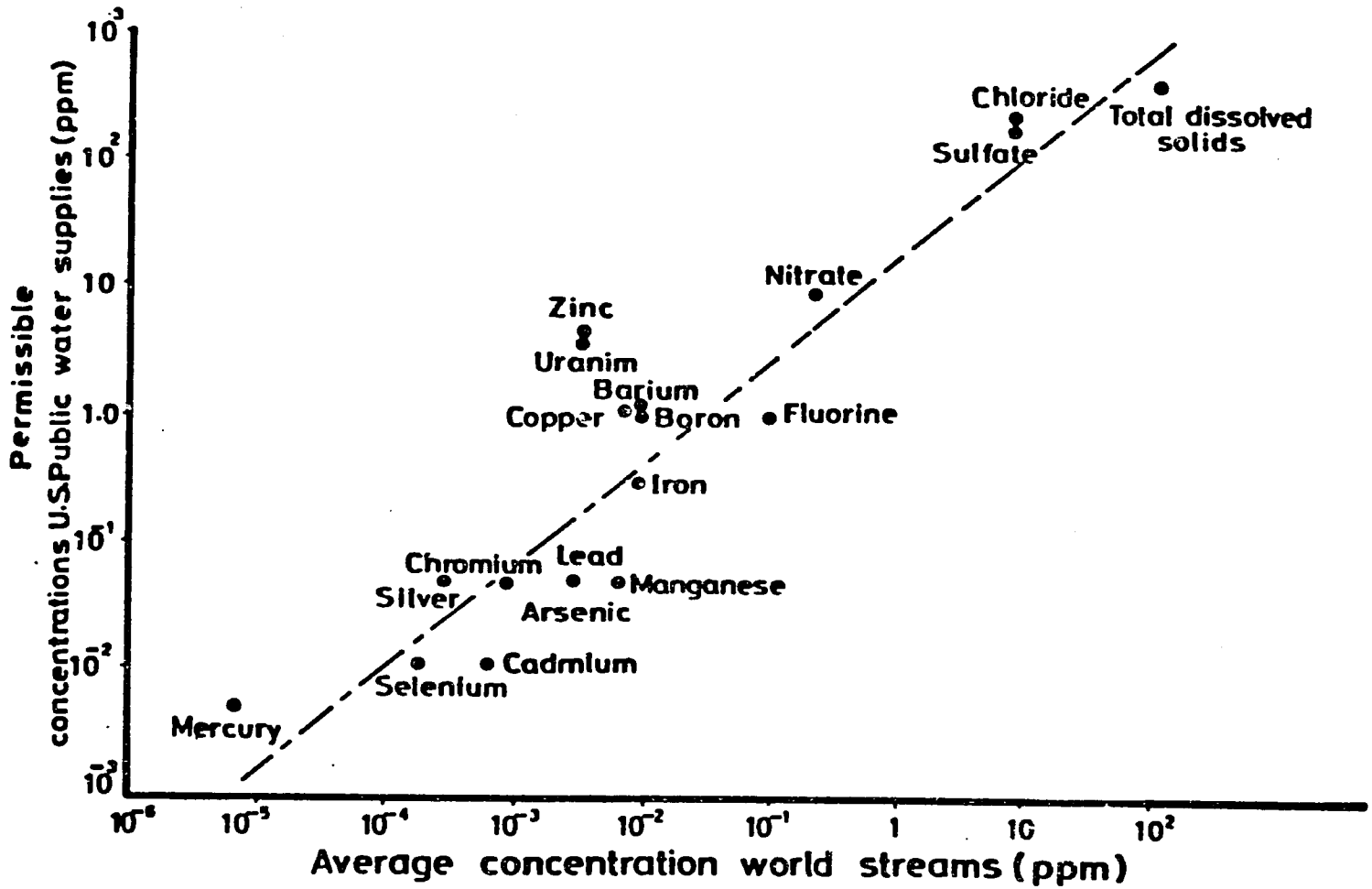

Fig.2 : Correlation between trace element concentrations in streams and permissible concentrations in water supplies.

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Table 11. Parameters and Criteria For Domestic Water Supplies

Quality Parameter	Undesirable effect	Minimum desirable level	Maximum Permissible level
Substances causing discolouration	discoloration	5 units	50 units
Substances causing odour	odours	unobjectionable	unobjection-able
Substances causing taste	Taste	unobjectionable	unobjection-able
Suspended matter	Turbidity	5 units	25 units
Total solids	Taste, gastrointestinal irritation	500 mg/l	1500mg/l
pH value	Taste, corrosion	7.0-8.5	6.5-9.2
Anionic detergents	Taste and foaming	0.2mg/l	1.0mg/l
Mineral oils	Taste and odour after chlorination	0.01mg/l	0.3 mg/l
Phenolic compounds	Taste and odour after chlorination	0.001mg/l	0.002mg/l
Total hardness (as CaCO3)	Excessive scale formation	100mg/l	500mg/l
Calcium(as Ca)	Excessive scale formation	75 mg/l	200 mg/l
Chloride (as Cl)	Taste, corrosion in hot water system	200 mg/l	600 mg/l
Copper (as Cu)	Taste and corrosion	0.05mg/l	1.5mg/l
Iron (as Fe)	Taste, Turbidity, growth of iron bacteria	0.1mg/l	1.0mg/l
Magnesium (as Mg)	Hardness, taste and gastr intestinal irritation in the presence of sulphate	30mg/l	150gm/l
Manganese (as Mn)	Taste, turbidity dis-colouration	0.05mg/l	0.5mg/l
Sulphate	Gastrointestinal irritation when magnesium or sodium are present.		

Table 11. Continued

Quality Parameter	Undesirable effect	Minimum desirable level	Maximum permiessible level
Zinc (as Zn)	Tasteturbidity and sand like deposits	5.0mg/l	15mg/l
Nitrates(as N)		absent	15gm/l
Fhlorides		0.6-0.9mg/l	0.8-1.7mg/l
Arsenic	Toxic		0.05mg/l
Cadmium	Toxic		0.01mg/l
Cyanide	Toxic		0.05mg/l
Lead	Toxic		0.1mg/l
Mercury	Toxic		0.001mg/l
Selenium	Toxic		0.01mg/l
Organic chemicals	Taste	0.04mg/l	0.15mg/l
a-carbon chloro-form extract(CCE)			
b-Methylene blue active substances			
Pesticides			
Aldrin			0.017mg/l
Chlordane			0.003mg/l
DDT			0.042mg/l
Dieldrin			0.007mg/l
Endrin			0.001mg/l
Heptachlor			0.018mg/l
Lindane			0.056mg/l
Toxophane			0.005mg/l
Radioactivly			
Gross beta		100 Pc/l	100 Pc/l
Radium 226		1 Pc/l	3 Pc/l
Strontium 90		2 Pc/l	10 Pc/l

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similar to those found in the Wadi El-Raiyan lakes except zinc which was two to three times higher, copper was 5 times higher, iron was 4 times higher and manganese was 7 times higher. Ammonium ion and free ammonia concentration in water was only determined during the second field expedition and was found to be in the range of 0.02 to 0.12 ppm. Dissolved oxygen and ammonium concentration in water are suitable for fish production and may be classified as salmonied water. Inorganic anions concentrations of nitrites, sulfite, sulfide, phosphate and thiocyanate were very low, halides concentration was moderatly high, however, sulfate ion concentration was very high as shown in Table 1.

Oxygen concentration in water varied significantly when it was monitored every two hours for 24 hours in one of the station, the concentration of oxygen was minimum of 5 ppm at dawn and maximum of 12 ppm at sunset. Oxygen concentration, salinity, pH and temperature for every 2 hours period are shown in Figure 3.

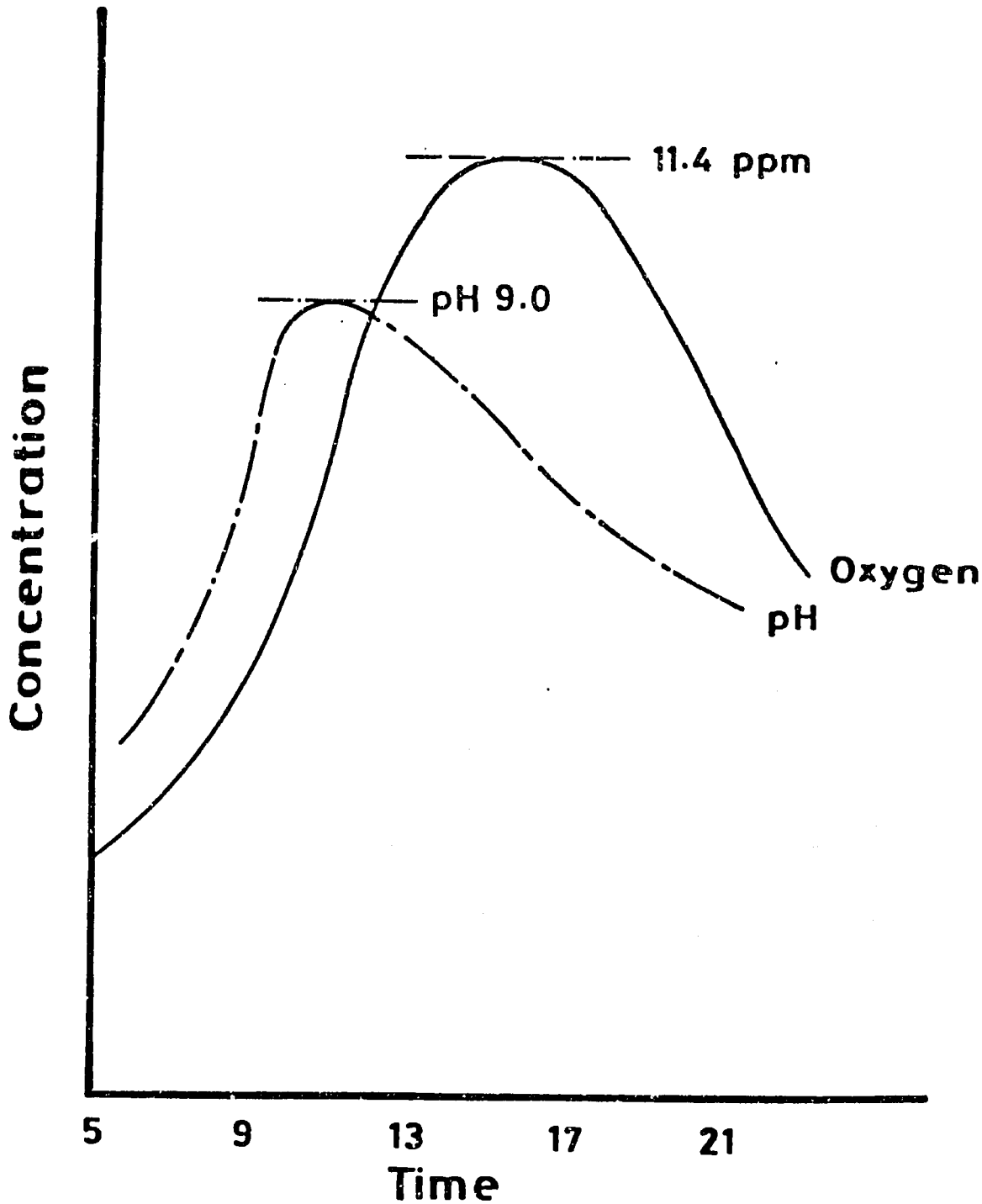

FIGURE 3. OXYGEN CYCLE

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INVESTIGATION OF INORGANIC POLLUTANTS IN EL FAIYUM AQUATIC ENVIRONMENT

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Report No. 3

December 1st 1984, to February 28, 1985

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RESULTS

This section presents results of the detailed chemical and biological studies of samples and specimens which were collected during the second expedition. It also presents results which were either obtained by direct measurments in the field or by visual observation and photography.General features and discription of studied area were shown in details in our first and second reports.

Chemical Results:

Stations locations of the Wadi-El-Raiyan and water springs are shown in Figure 1. The concentration of some important non metallic pollutants and some physical measurments are shown in Table 1 and table 2 respectively. Concentrations of heavy metals in water samples of Wadi El-Raiyan, are shown in Tables 3. Concentration of heavy metals in biological samples is shown in Tables 5 - 7 .

It appears from Tables 1-3 that water salinity, hardness and amounts of total soluble salts (TSS) followed the same pattern previously shown in our first and second reports, but these values were lower for the second lake and the seepage areas than what was recorded during the field expeditions of July and Novembers, possibly due to dilution. Water pH was very much the same throughout the lakes,being slightly basic and

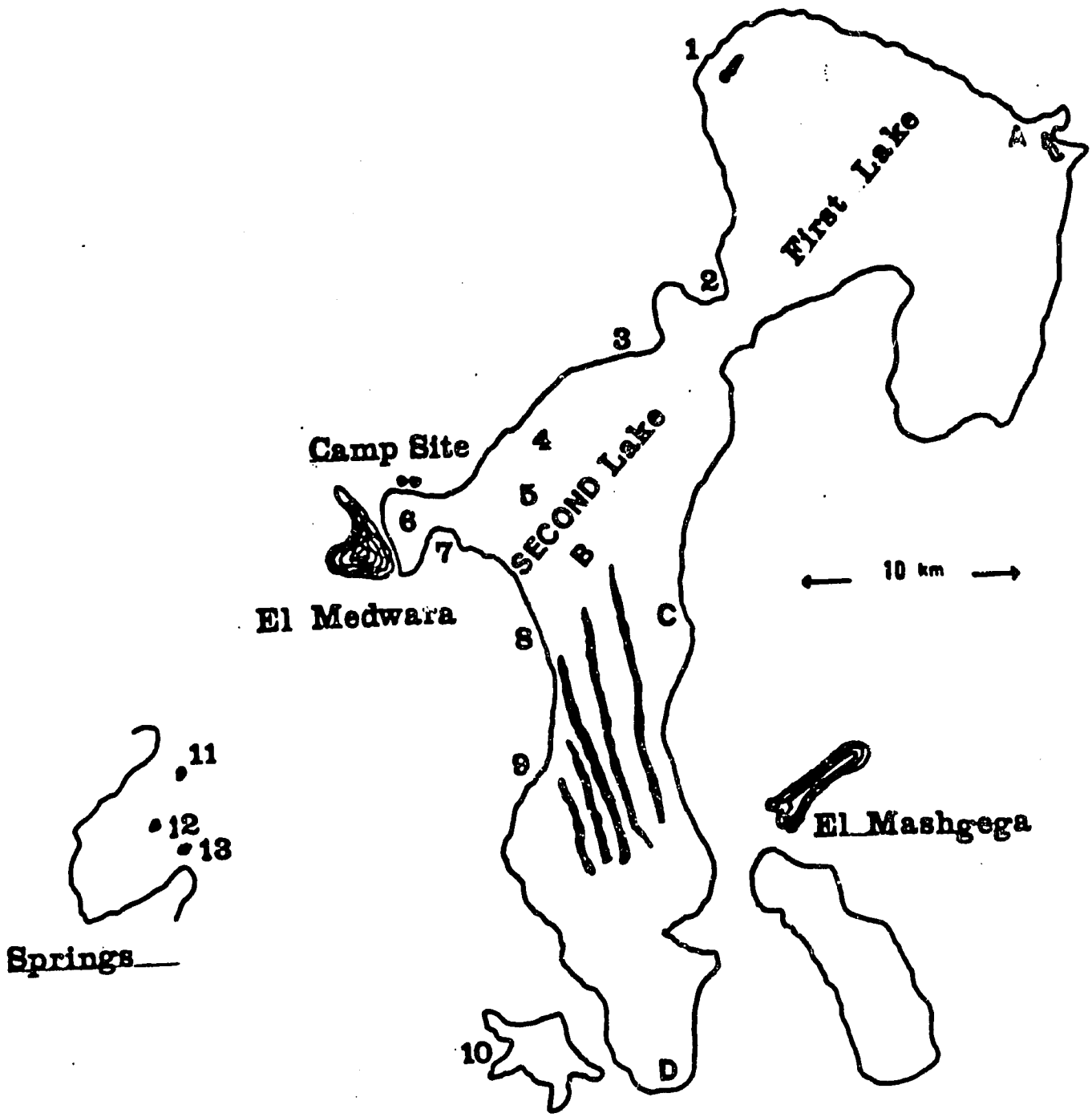

Figure 1. Map of the Selected Stations of Wadi El-Raiyan Lakes and Water Springs.

ranging from 7.8 to 8.8. Water temperature was 8-15°C . Dissolving oxygen in water was 6.2 mg/L in the seepage areas which is characterestic with very high salinity and 11.2mg/L in the first lake with a low salinity. Heavy metals concen trations in water was relatively lower than what recorded in the second report, and below the recommended levels for general uses and also below the permissible values for public water supplies. Lead concentration ranged from 4 to 53 microgram/Liter (ppb) with an average of 26 ppb. Zinc from 7 to 389 ppb with an average of 133 ppb, copper from 1 to 16 ppb with an average of 8 ppb, selenuim from 0.00 to 12 ppb with an average of 5 ppb, iron concentration ranged from 14 to 630 ppb with an average of 195 ppb, manganese ranged from 0.0 to 6 ppb with an average of 2 ppb. No arsenic was found in any of the examined stations, ammonium ion and free ammonia concentration in water was detrmined in the field and was found to be in the range of 0.00 to 0.05 ppm. Dissolved oxygen and ammonium concentration in water are suitable for fish production and may be classified as salmonied water. Inorganic anions concentrations of nitrites, sulfide, phosphate and thiocyanate were very low, halides concentration was moderatly high, however, sulfate ion concentration was very high as shown in Table 1.

Relatively high concentration of cyanide (13 ppb) was detected in the first lake only and near fishing activities which might be a result of illegal uses of cyanide for fishing.

Table 1 . Concentration of Nonmetallic Inorganic Ions in Water (mg/L = ppm)*

Station/Depth	Sulfate SO_4^{2-}	Sulfite SO_3^{2-}	Bisulfide HS^-	Nitrate NO_3^-	Nitrite NO_2^-	Ammonium NH_4^+	Ammonia NH_3	Chloride Cl^-	Bromide Br^-	Iodide I^-	Thiocyanate SCN^-	Oxygen O_2	Phosphate PO_4^{3-}
1 Surface	565	0.05	0.010	88	0.016	0.030	0.00	495	0.004	1.08	0.007	11.3	0.315
2 Surface	580	0.002	0.040	98	0.002	0.050	0.00	514	0.003	1.32	0.003	11.0	0.367
3 Surface	560	0.002	0.010	94	0.012	0.080	0.00	641	0.004	1.27	0.004	11.4	0.300
4 Surface	785	0.000	0.000	83	0.004	0.050	0.040	1387	0.005	1.48	0.005	10.2	0.315
10 m	740	0.05	0.010	81	0.002	0.050	0.040	1406	0.004	1.45	0.006	8.4	0.250
5 Surface	670	0.000	0.000	82	0.005	0.050	0.040	1387	0.005	1.43	0.004	8.8	0.315
5 m	645	0.000	0.000	83	0.009	0.040	0.030	1387	0.004	1.39	0.004	8.2	0.245
10 m	820	0.000	0.010	84	0.009	0.030	0.020	1387	0.004	1.60	0.004	8.0	0.297
6 Surface	605	0.000	0.000	72	0.012	0.050	0.040	1367	0.006	0.92	0.005	9.3	0.245
2.5 m	515	0.000	0.000	74	0.012	0.005	0.004	1387	0.007	0.92	0.005	9.0	0.280
7 Surface	1285	0.000	0.000	81	0.002	0.050	0.040	1435	0.007	0.83	0.006	8.5	0.245
8 Surface	720	0.020	0.015	72	0.012	0.060	0.040	1446	0.018	1.27	0.006	9.8	0.210
9 Surface	865	0.025	0.000	77	0.012	0.005	0.080	1387	0.021	1.43	0.005	9.5	0.158
10 (Seepage)	1020	0.000	0.000	92	0.010	0.000	0.000	10870	0.022	1.64	0.006	6.2	0.087
A	280	2.000	0.000	96	0.005	0.000	0.000	0.612	0.003	0.84	0.004	11.7	0.380
B	635	1.000	0.010	88.5	——	0.030	0.020	1.308	0.003	1.50	0.005		0.262
C	670	0.000	0.000	73	0.010	0.080	0.060	1.351	0.008	0.63	0.006	11.9	0.193
D	830	——	0.000	79.5	——	0.600	0.470	1.397	0.005	1.08	0.006	14.5	0.315
Average Value	915.92	0.220	0.006	113.32	0.009	0.070	0.050	1199	0.005	1.5	0.005	11.9	
11 Origin	490	0.000	0.000	5.2	0.012	0.000	0.000	2079	0.004	0.42	0.001	9.5	0.028
12 Origin	525	0.000	0.02	8.5	0.004	0.04	0.03	2029	0.003	0.53	0.001	8.5	0.063
13 Origin	410	0.000	0.01	3.2	0.012	0.15	0.120	1902	0.003	0.80	0.000	7.9	0.063
Pool	535	0.000	0.000	2.8	0.000	0.10	0.080	1505	0.003	0.64	0.002	12.6	0.077
Average value	505	0.000	0.02	4.9	0.012	0.096	0.076	1878	0.003	0.59	0.001	7.1	

* The results are the average of three measurments, None of the cyanide or arsenite ions were detected except a relatively high concentration (13 PPb)of cyanide was detected in the first lake near fishing area.

Table 2. Physical Properties of Water Sample of Wadi El-Raiyan.

Station/Depth		pH	Salinity gm/L	Electric conductivity	Hardness
1	Surface	7.8	1.03		15
2	Surface	8.2	1.01		18
3	Surface	8.4	1.36		17
4	Surface	8.2	1.98	365	30
	5 m	8.5	2.17	427	31
5	Surface		2.00	391	33
	5 m		2.04	406	32
	10 m		2.04	406	34
6.	Surface	8.0	2.30	461	32
	2.5 m	8.5	2.05	398	36
7	Surface	8.5	2.01	341	32
8.	Surface		2.26	461	28
9	Surface		2.40	484	41
10	Surface	8.8	17.08	---	100
	A	7.9	1.90	392	16
	B	8.2	1.98	397	27
	C	8.4	2.03	412	30
	D	8.5	2.08	412	26
11	Origin		3.00	604	60
12	Origin	7.3	3.44	689	54
13	Origin		3.03	607	52
	Pool	8.3	2.99	599	45

Table 3. Concentration of Heavy Metals in Water Samples of Wadi El-Raiyan ug/L (ppb).

Station/Depth		Copper Cu	Iorn Fe	Lead Pb	Manganese Mn	Mercury Hg	Selenium Se	Zinc Zn
1	Surface	2.8	27	19	3.0	6.6	5.8	14
2	Surface	4.0	14	14	2.5	0.3	0.9	31
3	Surface	5.1	22	19	3.7	2.2	1.5	0.0
4	Surface	10.0	148	8	1.4	2.6	0.9	207
	10 m	6.0	105	4	1.1	2.0	0.2	76
5	Surface	9.0	108	30	1.2	5.9	0.2	129
	5 m	6.5	64	27	0.4	3.6	10.6	11
	10m	6.0	90	25	1.2	2.8	12.6	7
6	Surface	9.3	106	30	0.0	4.5	10.8	9
	2.5 m	14.0	585	28	2.7	3.6	11.0	210
7	Surface	16.0	268	53	3.6	4.0	10	216
8	Surface	7.3	99	28	2.2	4.5	8.6	26
9	Surface	12.0	209	10.0	1.6	0.2	1.4	295
10	Surface	1.7	630	10.0	6.5	2.8	8.4	107
	Average	7.83	176.1	21.7	2.22	3.2	5.9	95.5
	A	1.3	36	7	0.4	3.2	0.9	24
	B	1.1	280	42	1.8	5.6	0.0	185
	C	11.0	617	43	0.3	3.3	0.0	215
	D	11.0	218	45	1.6	4.4	4.2	315
11	Origin	6.5	126	60	0.0	3.2	10.2	75
12	Origin	6.2	92	3.0	0.5	5.2	13.8	33
13	Origin	6.0	83	19	1.7	2.2	9.2	0.0
	Pool	4.0	77	23	0.5	1	10.8	22
	Average	5.6	94.5	11.25	0.67	2.9	11	9.2

Table 4. Concentration of Heavy Metals in Selected Plants of Wadi El-Raiyan, ug/g dry weight (ppm).

Species/Location		Copper Cu	Lead Pb	Mercury Hg	Selemium Se	Iron Fe	Zinc Zn	Manganese Mn
Phragmites australis								
	5	9.8	30.0			830	14	16
	7	10.8	32.0			273	42	22
	8	12.8	47.1	78.6		330	41	51
	9	11.7	33.7	29.7		320	13	33
	13	5.2	41.0	28.3		302	21	61
Tamarix sp.								
	6	5.9	39.9	74.9	2.8	686	70	12
	7	3.5	23.0	39.5	1.0	612	64	4
	11	3.8	27.9	29.1	9.7	920	10	7
Zygophyllum album	12	3.1	30.6	4.9	29.3	1050	144	13
	6	15.8	41.6	75.7	1.90	400	477	4
Najas armata								
	A	23.1	27.5		2.90	1030	50	8

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Table 5. Concentration of Heavy Metals in Selected Planktons and Insects of Wadi El-Raiyan ug/g dry weight (ppm)

Species/Location		Copper Cu	Lead Pb	Mercury Hg	Selenium Se	Iron Fe	Zinc Zn	Manganese Mn
Plankton								
	2	14.8	637.0	75	33	6093	180	78.0
	5	00.0	284.6	283	--	20615	1690	110.0
	8	29.8	248.6			1580	537	10.3
	C	164.0	1871.0		702	7777	83	40.9
Insects								
	May Fly	37.9	186	455	353	00	35	9.2
	Crickets	49.6	163		266	473	177	19.9

Table 6. Concentration of Heavy Metals in Fishs ug/g dry weight (ppm).

Species/Location,part	Copper Cu	Lead Pb	Mercury Hg	Selenium Se	Zinc Zn
Tilapia zilli.					
Whole body(adult)	4.2	26	16.5	55	99
intestine,Kidny,Liver	90	300	162	988	85
fins and tail	8.8	33	58	100	106
Whole body(Young)	1	10	14.5	57	49
intestine	11	105	28.2	100	40
Fins and tail	12	15	20.1	68	30

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Table 7: Concentration of Heavy Metals in Mammals ug/g dry weight (ppm).

Species/part	Copper Cu	Lead Pb	Mercury Hg	Selenium Se	Iron Fe	Zinc Zn	Manganese Mn
Jaculus jaculus							
Whole body		37	36	2.0	524	46	4.5
liver	7.0	85		12	570	353	3.0
Kidney	30.6	187		13	1941	52	540
heart	1.7	234	47	50	400	301	4.6
intestine	26.0	67		--	1612	1250	74
Hair	39.0	360		520	0.0	.71	12.5
Canis aureus							
Muscles	24.4	18	65.7	0.0	695	62	1.1
Kidney	35.4	107	9.8	0.0	367	70	5.2
heart	47.0	150	--	16.0	1042	67	10.1
teeth	16.7	148	9.8	69.0	464	171	1.8

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INVESTIGATION OF INORGANIC POLLUTANTS IN EL FAIYUM AQUATIC ENVIRONMENT

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Report No. 4

March 1st to April 30 1985

65

RESULTS

This section presents results of the detailed chemical and biological studies of samples and specimens which were collected during the third expedition. It also presents results which were either obtained by direct measurments in the field or by visual observation and photography. General features and discription of studied area were shown in details in our first and second reports.

Chemical Results:

Stations locations of the Wadi-El-Raiyan and water springs are shown in Figure 1. The concentration of some important non metallic pollutants and some physical measurments are shown in Table 1 and Table 2 respectively. Concentrations of heavy metals in water samples of Wadi El-Raiyan, are shown in Tables 3. Concentration of heavy metals in biological samples is shown in Tables 4-5.

It appears from Tables 1-3 that water salinity, hardness and amounts of total soluble salts (TSS) followed the same pattern previously shown in our first, second and third reports, but these values were lower for the second lake and the seepage areas than what was recorded during the field expeditions of July, November, and January possibly due to dilution. Water pH was very much the same throughout the lakes, being slightly basic and ranging from 7.8 to 8.8. Water

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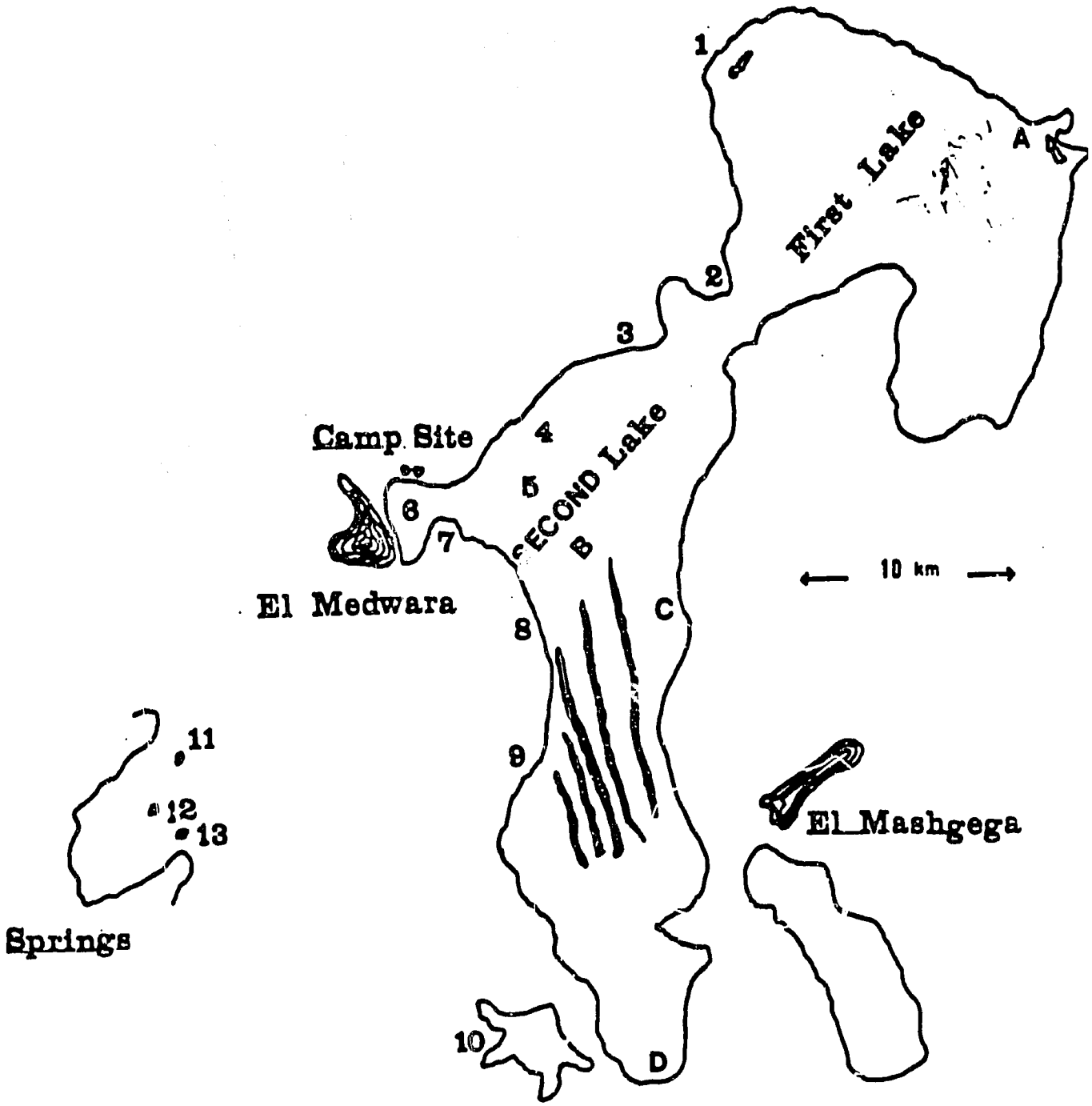

Figure 1. Map of the Selected Stations of Wadi El-Raiyan Lakes and Water Springs.

temperature was 17-25C°. Heavy metals concentrations in water was relatively lower than that recorded in the second report, and similar to what were found in the third report but below the recommended levels for general uses and also below the permissible values for public water supplies. Lead concentration ranged from 16 to 64 microgram/ Liter (ppb) with an average of 36 ppb, zinc from 6 to 80 ppb with an average of 23 ppb, copper from 7 to 34 ppb with an average of 15 ppb, selenuim from 0.00 to 13 ppb with an average of 3 ppb, mercury from 0.0 to 18 ppb with an average of 8 ppb, iron concentration ranged from 105 to 760 ppb with an average of 459 ppb, and manganese ranged from 8 to 80 ppb with an average of 20 ppb. No arsenic was found in any of the examined stations. Ammonium ion and free ammonia concentration in water were determined in the field and was found to be in the range of 0.00 to 0.15 ppm. Dissolved oxygen and ammonium concentration in water are suitable for fish production and may be classified as salmonied water. Inorganic anions concentrations of nitrite, sulfide, phosphate and thiocyanate were very low, halides concentrations were moderatly high, however, sulfate ion concentration was very high as shown in Table 1.

Table 1. Concentration of Nonmetallic Inorganic Ions in Water (mg/L = ppm)*

Station/Dept	Sulfate SO_4^{2-}	Bisulfide HS^-	Nitrate NO_3^-	Nitrite NO_2^-	Ammonium NH_4^+	Ammonia NH_3	Chloride Cl^-	Bromide Br^-	Thiocynate SCN^-	Phosphate PO_4^{3-}
1 Surface	618	0.02	87	0.005	0.8	0.62	338	0.000	0.005	0.430
2 Surface	632	0.00	84	0.005	0.05	0.04	515	0.000	0.007	0.415
3 Surface	612	0.00	84	0.002	0.1	0.08	638	0.008	0.007	0.415
4 Surface	822	0.000	78	0.000	0.05	0.04	1347	0.007	0.006	0.390
5 Surface	882	0.000	81	0.012	0.05	0.04	1311	0.000	0.005	0.380
5 m	908	0.000	74	0.005	0.1	0.08	1134	0.007	0.007	0.390
10 m	942	0.000	72	0.005	0.15	0.12	1205	0.008	0.007	0.390
6 Surface	620	0.000	74	0.002	0.05	0.04	1295	0.000	0.005	0.325
2.5 m	588	0.000	62	0.000	0.05	0.04	1205	0.006	0.004	0.340
7 Surface	1306	0.01	72	0.000	0.05	0.04	1276	0.007	0.005	0.360
8 Surface	784	0.000	65	0.002	0.05	0.04	1878	0.018	0.006	0.280
9 Surface	852	0.000	65	0.000	0.02	0.016	1205	0.021	0.006	0.290
10 (Seepage)	1428	0.000	42	0.010	0.00	0.000	12053	0.016	0.005	0.340
A Surface	322	0.000	112	0.005	0.3	0.23	177	0.000	0.003	0.445
B Surface	680	0.000	72	0.005	0.05	0.04	1205	0.006	0.005	0.340
C Surface	726	0.000	65	0.005	0.1	0.08	1559	0.007	0.005	0.365
D Surface	912	0.000	82	0.005	0.04	0.032	1447	0.000	0.006	0.265
Average Value	728	0.000	75.1	0.004	0.121	0.092	1752	0.000	0.005	0.354
11 Origin	208	0.025	0.7	0.000	0.06	0.048	1914	0.008	0.000	0.035
12 Origin	224	0.20	6.5	0.010	0.05	0.04	1772	0.006	0.000	0.055
13 Origin	196	0.020	0.8	0.000	0.0	0.0	1453	0.000	0.000	0.060
Pool	466	0.015	0.12	0.000	0.0	0.0	1453	0.006	0.000	0.045
Average value	273	0.020	8.3	0.002	0.027	0.022	1648	0.066	0.000	0.0487

* The results are the average of three measurments, None of the cyanide or arsenite ions were detected.

Table 2. Physical Properties of Water Sample of Wadi El-Raiyan.

Station/Depth		pH	Salinity gm/L	Electric conductivity	Hardness
I	Surface	8.88	1.17	243	15
2	Surface	8.86	1.13	243	18
3	Surface	8.50	1.74	355	17
4	Surface	8.50	2.25	462	30
	5 m	8.50	2.28	446	31
5	Surface	8.59	2.22	449	33
	5 m	8.50	2.18	461	32
	10 m	8.56	2.27	502	34
6	Surface	8.50	2.44	500	32
	2.5 m	8.50	2.46	496	36
7	Surface	8.55	2.70	499	32
8	Surface	8.17	2.72	485	28
9	Surface	8.55	2.24	485	41
10	Surface	8.80	17.65	1844	100
A	Surface	7.20	0.69	139	16
B	Surface	8.59	2.27	451	27
C	Surface	8.60	2.05	414	30
D	Surface	8.50	2.31	476	26
11	Origin	7.48	3.25	647	60
12	Origin	7.78	3.02	614	54
13	Origin	7.56	2.71	528	52
	Pool	8.28	2.62	539	45

Table 3. Concentration of Heavy Metals in Water Samples of Wadi El-Raiyan ug/L (ppb).

	Station/Depth	Copper Cu	Iorn Fe	Lead Pb	Nanganese Mn	Mercury Hg	Selenium Se	Zinc Zn
I	Surface	10	580	20.5	17	2.2	1.4	6
2	Surface	7.5	105	14.5	8	1.2	6.4	13
3	Surface	14.5	510	36.5	15	0.0	6.4	20
4	Surface	14.5	390	39.5	20	13	6.4	23
	10 m	11.5	245	53	9	11	0.0	13
5	Surface	10	460	20.5	16.5	18	4.6	10
	5 m	21.5	690	57.5	16.5	3	0.4	33.5
	10m	12.5	520	47.5	13	14	2.8	26
6	Surface	34	695	53	24.5	17	0.4	30
	2.5 m	12.9	320	59.5	25.5	6.6	0.0	18.5
7	Surface	21	760	51	25.5	14.2	3.2	18
8	Surface	12	555	62.5	16	6.4	5.4	18.4
9	Surface	--	--	--	--	--	--	--
10	Surface	18	224	14.5	38	9.8	4.8	13.5
A	Surface	1.3	36	14.5	4	15	3	13
B	Surface	9.4	455	53.5	19.6	11	9.4	19
C	Surface	12.5	390	46	18.5	1.4	0.0	13
D	Surface	19.5	560	64.5	18	8	3	34
	Average	15.3	461	39.9	17.6	8.8	3.5	18.9
11	origin	11	60	48.5	28.5	11	0.5	20
12	Origin	16.5	475	45	25.5	21	0.0	73.5
13	Origin	5	30	22	22	14.6	2.8	2.5
	Pool	11.6	930	66.5	24.4	15	5.5	22.5
	Average	11.02	264.1	45.5	25.1	15.4	2.2	24

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Table 4. Concentration of Heavy Metals in Selected Plants and Birds of Wadi El-Raiyan, ug/g dry weight (ppm).

Species/Location	Copper Cu	Lead Pb	Mercury Hg	Selemium Se	Zinc Zn	Manganese Mn
Phragmites australis	6.3	9.7	21.3	10.6	12.7	39
Tamarix sp.	11.4	9.4	56.1	18.7	22.0	42
Motacilla alba	23.4	20.4	126.7	6.4	19.6	28
meat	30.5	21.5	149.2	9.8	44.5	84
kidney	25.6	29.7	44.6	19.3	18.7	47
liver	11.7	5.3	12.4	11.4	26.6	3.9
heart	155.5	50.5	94.7	198.9	71.8	23.7
fealthers	20.6	6.7	59.9	19.9	73.2	7.5
bones	45.7	37.1	113.4	54.8	55.6	32.1
Bubulcus ibis	7.7	59.3	106.8	19.6	26.6	8.0
whale booly	6.4	39.1	27.6	55.1	64.0	11.9
meat	9.4	36.6	92.3	20.3	53.7	16.5
feathers	26.1	27.5	22.4	3.8	16.0	6.2
benes	158.9	179.5	846.15	20.0	123.0	0.00
	9.4	65.5	196.6	30.6	80.8	13.4

Table 5. Concentration of Heavy Metals in Fishs ug/g dry weight (ppm).

Species/Location, part	Copper Cu	Lead Pb	Mercury Hg	Selenium Se	Zinc Zn
Tilapia zilli.					
Whole body (one year old)	2.5	15.9	19.1	20.0	60
intestine,kidny,Liver	20.2	25.8	103.4	36.2	68
fins and tail	27.0	26.1	117.2	39.0	108
whole body(two years old)	4.1	12.7	18.9	25.6	43
intestine	191.4	28.9	56.0	56.0	63
Fins and tail	26.9	22.9	88.6	41.8	97
whale body(three years old)	6.8	20.0	58.3	18.3	26.6
Intestine, Kindny.Liver	15.3	19.3	75.2	15.2	52.3
Fins and tail	9.0	34.1	119.2	19.2	57.7
whole body	11.7	15.8	20.8	14.7	22.7
Intestine,kidny,liver	12.11	23.2	32.0	18.0	61.1
Fins and tail	4.4	29.9	48.0	20.0	72.8

APPENDIX C

Instrumentation Requirements
and Specifications

SPECIFICATIONS FOR A FIELD TEST INSTRUMENTATION SYSTEM

The Renewable Energy Field Test instrumentation system will be used to monitor IPH, PV and wind energy system installations at urban and remote desert locations in Egypt. These energy systems include main power sources (solar collectors, PV arrays and wind turbines) as well as ancillary subsystems depending on specific field test applications. These subsystems include ice-making equipment, desalination systems, a variety of load characteristics ranging from small DC loads to grid-connected applications and back-up power systems (diesel engines and batteries).

The instrumentation system must be a stand-alone system. Failure of the instrumentation system must not affect the performance of the field test system that is being monitored. The instrumentation system must have an on-site data storage system that is non-volatile and capable of easy physical removal and transport to another location for data removal and long-term storage. One form of the non-volatile storage system must be a microchip/ EPROM or CMOSRAM - Type system that can be "milked" on site easily and without danger of a loss of data.

The instrumentation system must be a microcomputer based data logger with programmable input channels and output formats both analog and digital. The user must have control over sampling frequency and output period for each channel. The capability to multiplex some of the channels is also required. Primary design objectives for the instrumentation system should be reliability, simplicity, small size, low power and the ability to operate in environmental extremes as specified (especially high temperature, sand/dust and tropical/sea coast). The unit must be capable of stand-alone battery operation for a period of at least one month, preferably for two months.

The following minimum specifications are required for the instrumentation system. If an exception must be taken to one or more of these requirements,

the exception shall be noted and a clear explanation given as to why the bidder believes that the exception should be acceptable to the purchaser.

Physical Specifications

- o Small, stand-alone, self-contained system in an environmental enclosure
- o Desired weight: less than 10 pounds
- o Desired size: less than 10 inches x 10 inches x 6 inches

System Power Requirements

- o Capable of operation using self-contained batteries
- o Capability for the use of an external power source to allow continued data collection while changing batteries is desirable.
- o Capable of transient protection from spurious electrical charges or lighnting.

Environmental Specifications

- o Ambient Temperature: -25 deg. C to +50 deg. C
- o Relative Humidity: 0 to 90 percent non-condensing
- o Impervious to a tropical, oceanside environment with occasional high airborne sand/dust and/or sulphur levels

Analog Inputs

Number of Channels: At least 12 channels

Voltage Measurement Types: Differential or single-ended

Accuracy of Measurements: at least ± 0.5 percent

Range and Resolution: Selectable for any input channel from microvolts to several volts full scale

Sample Rates: At least once per second for each channel

Multiplex Capability: at least four channels

Pulse Inputs

Number of Pulse Counter Channels: at least 4 channels

Analog and Digital Control Outputs: a total of three resettable channels each is desired with a range of 0 to ± 5 volts with a 0.5 volt resolution

Multiplex Capability: at least three channels

Output Signal Interface

Memory: Capable of storing at least 3000 data points per day for a period of one month (two months desirable)

Display: A visual display of stored data is required on-site for data verification before data removal

Peripheral Interface: Downloading of data at the site should be by physical removal of the data storage device or simple, reliable data downloading to a non-volatile storage device. Storage data files shall be IBM-PC compatible on floppy disc either directly from the data logger or through a simple, fast, reformatting technique.

FIELD TEST PERFORMANCE MONITORING DATA REQUIREMENTS

Field Test #6 (PV ice-making)

Parameter	Channel Type	Output Interval
* Array Power (kW)	P	10 min.
Array Voltage (volts)	A	10 min.
Array Current (Amps)	A	10 min.
PV ref. cell temp. (2 or 3) (°C)	A	10 min.
Diesel Fuel Usage (Liters)	A	Daily
* Diesel Power (kW)	P	10 min.
Diesel Number of on-off Cycles	P	Daily
Diesel Voltage (volts)	A	10 min.
Diesel Current (Amps)	A	10 min.
Battery Charge and Discharge Current (Amps)	A	10 min.
Battery Voltage (volts)	A	10 min.
Battery Temp. (°C)	A	10 min.
Ice Maker Water Flow (Liters)	P	10 min.
Water Inlet Temp. (°C)	A	30 min.
* Ice Maker Power (kW)	P	10 min.
Ice Maker Voltage (volts)	A	10 min.
Ice Maker Current (Amps)	A	10 min.

* Desired but not required.

Meteorological Station

Parameter	Channel Type	Output Interval
Horizontal Insolation (kW/m^2)	A	10 min.
Plane of Array Insolation (if appropriate) (kW/m^2)	A	10 min.
Ambient Temp. (°C)	A	30 min.
Humidity (%)	A	30 min.
Air Pressure ($kgrm/m^2$)	A	30 min.
Wind Speed (m/sec)	A	10 min.
Wind Direction (degrees)	A	10 min.