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TRAINING IN WATER AND WASTEWATER INSTITUTIONAL PROGRAMS: LONG-TERM, SHORT-TERM AND STUDY TOURS

Prepared for Near East Bureau
Agency for International Development
Under OTD 160

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Chapter 1

INTRODUCTION

1.1 Purpose and Scope of Study

The Near East Bureau of the Agency for International Development requested the Water and Sanitation for Health Project (WASH) to identify and assess the organizations and institutions that offer high quality training and educational programs in the urban water supply and wastewater treatment sector to determine which organizations and institutions could provide the most effective educational services to the region.

This handbook is the result of the Bureau's request and the intended user is the project planner and/or implementer. It is hoped that the training or educational institutions identified will fulfill some of the training requirements of Near East Bureau projects. This study deals with three types of water supply and sanitation training services: short-term training (programs of less than one year); long-term training (programs of more than one year); and study tours. This handbook catalogues programs by length of the course of study, type of training offered and relation to key job functions in the sector. A chapter on study tours provides recommendations on their use as an effective training tool. A companion document has been prepared on a fourth area, training materials (see WASH Field Report No. 118).

The educational opportunities are located primarily in the United States; however, several organizations outside the U.S. (Canada, England, Italy) have also been included. A companion study is being conducted to identify Near Eastern training and educational institutions.

The list of institutions identified in this document is not exhaustive. The institutions which have been included meet the criteria that are specified in Chapter 2. However, this is not to say that all the training and educational institutions meeting our criteria were identified. It is hoped that future efforts will update the list of institutions.

1.2 Research Methodology

Time constraints dictated a research methodology that could produce a reliable study within a relatively short time. It consisted of five steps: consultation with recognized technical experts, developing criteria for selection, identifying potential institutions, surveying those institutions, and selecting those which met the criteria.

Surveying a select group of technical experts: A group of sector experts was identified which the AID and WASH professional staff felt were: a) recognized in the field for their technical competence, b) knowledgeable and experienced with training and educational programs, and c) experienced in training in developing countries. These experts were interviewed in person and by telephone to determine the criteria needed to select institutions producing effective training and education programs in the field. They were also asked to identify which institutions were currently training participants from developing countries.

Developing criteria: Selection criteria were synthesized from information obtained from both the sector experts and the AID environmental engineers from the Office of Health. WASH staff and consultants presented the final criteria to the Near East Bureau for approval prior to surveying the institutions. The criteria used for each type of program are given at the beginning of the sections listing programs and institutions.

Identifying training and education institutions: Based on survey information from selected experts and experienced AID staff, institutions and organizations were identified which offered appropriate training and education programs.

Surveying identified institutions: Individuals within the identified institutions were surveyed and interviewed by phone. Job functions for which the institutions could provide training were determined, as well as their experience with students from the Near East and faculty with experience in developing countries. The extent to which their training programs emphasized practical, hands-on skill building was also ascertained.

Developing a list of recommended institutions: The institutional data were compared with the established criteria. Those programs which met the criteria were selected.

1.3 How to Use the Handbook

The training and educational programs are listed by job function. These are defined as the functions required to plan, design, build, operate and maintain water and wastewater facilities. They are described in depth in Appendices A and B. A synopsis of the major job functions is provided at the beginning of Chapter 2 of this report.

Two types of listings are provided. In Chapter 2 each job function is given, followed by a list of organizations which offer short- and long-term programs relating to that job function. In Chapter 3 each organization is listed with a brief description of its program (length of program, overseas experience, English-as-a-second-language classes and availability of practical training opportunities) and the job functions its program is

designed to cover. In Chapter 4 study tour recommendations are discussed and organizations which provide study tours are listed.

Chapter 2

TRAINING AND EDUCATIONAL ORGANIZATIONS AND INSTITUTIONS

2.1 Definition of Long-term and Short-term Training Organizations

Long-term training institutions are defined as those organizations offering training programs in water supply and wastewater treatment that are more than 12 months in length; short term institutions offer programs such as short courses, workshops and seminars of up to 12 months in length. Long-term institutions usually offer a certificate or degree upon completion (such as a two-year, four-year or graduate degree).

2.1.1 Criteria Used

The criteria used to identify recommended training institutions were:

- Emphasis on practical training balanced with an appropriate amount of theoretical and technical content.
- Appropriate facilities: This includes the necessary practical training facilities as well as equipment, laboratories, and housing.
- Appropriate curriculum: In the case of short term training institutions, this includes skill transfer aimed at training needs which are immediately applicable to working conditions and problems in home countries. In the case of long term institutions, this includes a substantial number of credit hours devoted to finances and management in all phases of water/wastewater operations, as well as the technical competencies.
- Training staff with technical qualifications as well as work experience in third world countries.
- Experience in training foreign students living and studying away from home. In the case of long term institutions this also includes availability of special programs in English-as-a-second-language.
- Experience in working with students from Near Eastern cultures: either trainers or faculty who have worked in Near Eastern countries or who have worked successfully with students from Near Eastern countries.

2.2 Reporting Institutions Which Offer Long- and Short-Term Training

The following is a list of the institutions that offer training and education programs which would satisfy learning needs for particular job functions. A job functions summary is provided (Chart #1) as an overview of all relevant training/educational categories which apply to both water supply and wastewater treatment. The specific components in this chart are again recapitulated with the corresponding training institution in the first column as the reader looks to find appropriate training institutions. More detailed listings of the specific job functions contained in that category are listed in Appendices A and B of this report and should be referred to when one is especially interested in a particular category. If an organization is listed, it is being recommended as a provider of effective training for that functional job category. As such, it has programs dealing specifically with nc fewer than three-quarters of the detailed job functions that are outlined in detail in Appendices A or B.

Columns two and three of the list identify the organizations that have met the criteria and offer training and education programs that could fit the needs of the water/wastewater sector.

Chapter 3 contains an alphabetical listing of all the institutions and organizations that were listed and recommended as meeting the criteria and offering effective programs. In this list each organization is named, with its address and the name of a contact person with whom one could communicate further. There is also more specific information in these areas:

- job functions for which training is offered;
- overseas experience that the institution has had;
- types of hands-on facilities that are used in its educational programs;
- availability of English-as-a-second-language (ESL) courses;
- availability of short-term or long-term courses, length of courses, degrees or certificates available.

JOB FUNCTIONS SUMMARY: WATER SECTOR

	A. Technical	B. Economic/ Finance	C. Social	D. Management
I. Planning	Conduct engineering (including environmental assessments) studies to develop alternative plans, develop criteria for comparisons, make recommendations for decision-making.	Prepare analyses, annual operating budgets, etc. for comparisons and decision-making; prepare plans for funding, revenue collection, and cash flow operating plans.	Conduct social feasibility surveys, develop social criteria, make recommendations and participate in decision-making.	Coordinate and plan for all financial, technical, and social planning activities; conduct manpower planning activities, handle day-to-day management of resources required for planning activities and manage decision-making.
II. Design	Develop flow diagram for water supply schemes -- select appropriate process units, design process units, and evaluate designs.	Estimate construction and operation and maintenance costs of water supply designs, develop strategies for securing funding, design appropriate financial systems -- cash flow and revenue collection systems.		Coordinate and direct all design activities, project time frames for construction and implementation, recruit and select design staff, manage day-to-day activities.
III. Construction	Develop construction plan and construction schedule, determine resource requirements, implement day-to-day construction activities, and make certain construction follows and meets specifications.	Manage day-to-day financial aspects of construction, maintain construction costs within budget and maintain accounting systems for construction phase.		Coordinate and direct all construction activities, maintain construction schedule within time frame, recruit and select construction staff, handle day-to-day management of resources, and communicate with officials and funding agencies.
IV. Operations & Maintenance	For each process perform normal and abnormal operation procedures, preventive and corrective maintenance procedures, and laboratory and system control procedures.	Prepare annual budgets, recommend financing for improvements and expansion and manage day-to-day financial activities.		Recruit O&M staff, manage resources, prepare periodic reports, manage all O&M day-to-day activities, project future needs and maintain operation ability of plant.

WATER SECTOR TRAINING: RECOMMENDED INSTITUTIONS

JOB FUNCTIONS	SHORT-TERM INSTITUTIONS	LONG-TERM INSTITUTIONS
I. Water System: Planning		
A. Technical: Conduct engineering studies (including environmental assessments) to develop criteria for comparisons, make recommendations for decision-making.	International Center for Advanced Technical and Vocational Training British Water International Philadelphia Suburban Corporation Middlesex Polytechnic	Arizona State University University of Cincinnati Clemson University Drexel University East Tennessee State University Ferris State College University of Florida University of Maryland University of North Carolina Northeastern University University of Oklahoma University of Pittsburgh Rensselaer Polytechnical Institute University of Texas Tufts University Vanderbilt University Western Carolina University University of Wisconsin Southern Illinois University

WATER SECTOR TRAINING: RECOMMENDED INSTITUTIONS

JOB FUNCTIONS	SHORT-TERM INSTITUTIONS	LONG-TERM INSTITUTIONS
I. Planning (continued)		
B. Economic/Finance: Prepare analyses, annual operating budgets, etc. for comparisons and decision-making; prepare plans for funding revenue collection, and cash flow operating plans.	Middlesex Polytechnic Philadelphia Suburban Corporation British Water International International Center for Advanced Technical and Vocational Training	Drexel University East Tennessee State University Ferris State College University of Florida University of Maryland University of North Carolina University of Oklahoma University of Pittsburgh Tufts University University of Texas University of California - L.A. University of Iowa Michigan State University Pennsylvania State University University of Wisconsin Western Carolina University Clemson University

JOB FUNCTIONS	SHORT-TERM INSTITUTIONS	LONG-TERM INSTITUTIONS
I. Planning (continued)		
C. Social: Conduct social feasibility surveys, develop social criteria, make recommendations and participate in decision-making.	Philadelphia Suburban Corp. British Water International International Center for Advanced Technical and Vocational Training University of Connecticut	Southern Illinois University Vanderbilt University Northeastern University Arizona State University Drexel University East Tennessee State University Ferris State College University of Florida University of Maryland University of North Carolina University of Oklahoma University of Pittsburgh Tufts University University of Texas University of California Michigan State University University of Wisconsin Western Carolina University Clemson University Southern Illinois University

WATER SECTOR TRAINING: RECOMMENDED INSTITUTIONS

JOB FUNCTIONS	SHORT-TERM INSTITUTIONS	LONG-TERM INSTITUTIONS
I. Planning (continued)		
D. Management: Coordinate and plan for all financial, technical, and social planning activities; conduct manpower planning activities, handle day-to-day management of resources required for planning activities and manage decision-making.	University of Connecticut International Center for Advanced Technical and Vocational Training British Water International Philadelphia Suburban Corp. Middlesex Polytechnic	University of Cincinnati Rensselaer Polytechnical Institute Vanderbilt University Arizona State University East Tennessee State University Ferris State College University of Florida University of Maryland University of North Carolina University of Pittsburgh Tufts University University of Texas University of California - L.A. Michigan State University Western Carolina University Clemson University

JOB FUNCTIONS	SHORT-TERM INSTITUTIONS	LONG-TERM INSTITUTIONS
II. Water System: Design		
A. Technical: Develop flow diagram for water system schemes, select appropriate process units, design process units, and evaluate designs.	Utah Technical College Green River Community College Charles County Community College Environmental Resources Training Center Northern Laboratories Philadelphia Suburban Corporation British Water International Middlesex Polytechnic	Worcester Polytechnic Institute Valparaiso University Northeastern University Drexel University University of Oklahoma University of Wisconsin University of Iowa Pennsylvania State University Clemson University Michigan State University University of California - L.A. University of Texas Tufts University University of Pittsburgh University of North Carolina University of Maryland University of Florida Arizona State University Vanderbilt University Rensselaer Polytechnical Institute University of Cincinnati

WATER SECTOR TRAINING: RECOMMENDED INSTITUTIONS

JOB FUNCTIONS	SHORT-TERM INSTITUTIONS	LONG-TERM INSTITUTIONS
II. Design (continued)		
B. Financial: Estimate construction and operation and maintenance costs of water systems designs, develop strategies for securing funding, design appropriate financial systems -- cash flow and revenue collection systems.	University of Connecticut British Water International Philadelphia Suburban Corp.	Worcester Polytechnic Institute University of Wisconsin University of Iowa Michigan State University University of California - L.A. University of Texas University of Pittsburgh University of North Carolina University of Maryland University of Florida Vanderbilt University University of Cincinnati

JOB FUNCTIONS	SHORT-TERM INSTITUTIONS	LONG-TERM INSTITUTIONS
II. Design (continued)		
C. Management: Coordinate and direct all design activities, project time frames for construction and implementation, recruit and select design staff, manage day-to-day activities.	University of Connecticut International Center for Advanced Technical and Vocational Training British Water International Philadelphia Suburban Corp.	Tufts University University of Oklahoma Worcester Polytechnic Institute University of Wisconsin Michigan State University University of California - L.A. University of Texas University of Pittsburgh University of North Carolina University of Cincinnati

WATER SECTOR TRAINING: RECOMMENDED INSTITUTIONS

JOB FUNCTIONS	SHORT-TERM INSTITUTIONS	LONG-TERM INSTITUTIONS
III. Water Systems: Construction		
A. Technical: Develop construction plan and construction schedule, determine resource requirements, implement day-to-day construction activities, and make certain construction follows and meets specifications.	Philadelphia Suburban Corp. Middlesex Polytechnic Northern Laboratories	University of Florida University of Maryland University of Iowa Northeastern University Drexel University Pennsylvania State University Clemson University Arizona State University Rensselaer Polytechnical Institute University of Oklahoma Worcester Polytechnic Institute University of Wisconsin University of Texas University of Pittsburgh University of Cincinnati

WATER SECTOR TRAINING: RECOMMENDED INSTITUTIONS

JOB FUNCTIONS	SHORT-TERM INSTITUTIONS	LONG-TERM INSTITUTIONS
III. Construction (continued)		
B. Financial: Manage day-to-day financial aspects of construction, maintain construction costs within budget and maintain accounting systems for construction phase.	Philadelphia Suburban Corp. Middlesex Polytechnic University of Connecticut	University of Floridá University of Maryland Northeastern University Drexel University Pennsylvania State University Clemson University Arizona State University Rensselaer Polytechnical Institute University of Oklahoma Worcester Polytechnic Institute University of Wisconsin University of Texas University of Pittsburgh University of Cincinatti

JOB FUNCTIONS	SHORT-TERM INSTITUTIONS	LONG-TERM INSTITUTIONS
III. Construction (continued)		
C. Management: Coordinate and direct all construction activities, maintain construction schedule within time frame, recruit and select construction staff, handle day-to-day management of resources, and communicate with officials and funding agencies.	Middlesex Polytechnic Philadelphia Suburban Corp. University of Connecticut	University of Florida University of Maryland Northeastern University Drexel University Pennsylvania State University Arizona State University Rensselaer Polytechnical Institute University of Oklahoma Worcester Polytechnic Institute University of Wisconsin University of Texas University of Pittsburgh University of Cincinnati

JOB FUNCTIONS	SHORT-TERM INSTITUTIONS	LONG-TERM INSTITUTIONS
IV. Operation and Maintenance		
A. Technical: For each process perform normal and abnormal operation procedures, preventive and corrective maintenance procedures, and laboratory and system control procedures.	Northern Laboratories Ulster County Community College Technology Management Services, Inc. Southern Maine Technical Vocational Institute Operations Management International Ministry of Environment - Canada Linn-Benton Community College Kirkwood Community College Environmental Resources Training Center Charles County Community College Green River Community College Utah Technical College Philadelphia Suburban Corporation Middlesex Polytechnic British Water International	Pennsylvania State University Utah Technical College Green River Community College Charles County Community College Environmental Resources Training Center Kirkwood Community College Linn-Benton Community College Ulster County Community College

JOB FUNCTIONS	SHORT-TERM INSTITUTIONS	LONG-TERM INSTITUTIONS
IV. Operation and Maintenance (continued)		
B. Financial: Prepare annual budgets, recommend financing for improvements and expansion, manage day-to-day financial activities.	University of Connecticut Middlesex Polytechnic Philadelphia Suburban Corporation Utah Technical College Green River Community College Charles County Community College Environmental Resources Training Center Kirkwood Community College Linn-Benton Community College Operations Management International Southern Maine Vocational Technical Institute Technology Management Services, Inc. Ulster County Community College British Water International	Utah Technical College Green River Community College Charles County Community College Environmental Resources Training Center Kirkwood Community College Linn-Benton Community College Ulster County Community College

JOB FUNCTIONS	SHORT-TERM INSTITUTIONS	LONG-TERM INSTITUTIONS
IV. Operation and Maintenance (continued)		
C. Management: Recruit O&M staff, manage resources, prepare periodic reports, manage all O&M day-to-day activities, project future needs and maintain operation ability of plant.	Philadelphia Suburban Corp. Middlesex Polytechnic Utah Technical College Green River Community College Charles County Community College Environmental Resources Training Center Kirkwood Community College Linn-Benton Community College Operations Management International Southern Maine Vocational Technical Institute Technology Management Services Inc. Ulster County Community College University of Connecticut British Water International Industrial Training Service Ltd.	University of Pittsburgh Utah Technical College Green River Community College Charles County Community College Environmental Resources Training Center Kirkwood Community College Linn-Benton Community College Ulster County Community College

JOB FUNCTIONS SUMMARY: WASTEWATER SECTOR

	A. Technical	B. Economic/ Finance	C. Social	D. Management
I. Planning	Conduct engineering (including environmental assessments) studies to develop alternative plans, develop criteria for comparisons, make recommendations for decision-making.	Prepare analyses, annual operating budgets, etc. for comparisons and decision-making; prepare plans for funding, revenue collection, and cash flow operating plans.	Conduct social feasibility surveys, develop social criteria, make recommendations and participate in decision-making.	Coordinate and plan for all financial, technical, and social planning activities; conduct manpower planning activities, handle day-to-day management of resources required for planning activities and manage decision-making.
II. Design	Develop flow diagram for water supply schemes -- select appropriate process units, design process units, and evaluate designs.	Estimate construction and operation and maintenance costs for wastewater collection, treatment and disposal systems, develop strategies for securing funding, design appropriate financial systems -- cash flow and revenue collection systems.		Coordinate and direct all design activities, project time frames for construction and implementation, recruit and select design staff, manage day-to-day activities.
III. Construction	Develop construction plan and construction schedule, determine resource requirements, implement day-to-day construction activities, and make certain construction follows and meets specifications.	Manage day-to-day financial aspects of construction, maintain construction costs within budget and maintain accounting systems for construction phase.		Coordinate and direct all construction activities, maintain construction schedule within time frame, recruit and select construction staff, handle day-to-day management of resources, and communicate with officials and funding agencies.
IV. Operations & Maintenance	For each process perform normal and abnormal operation procedures, preventive and corrective maintenance procedures, and laboratory and system control procedures.	Prepare annual budgets, recommend financing for improvements and expansion and manage day-to-day financial activities.		Recruit O&M staff, manage resources, prepare periodic reports, manage all O&M day-to-day activities, project future needs and maintain operation ability of plant.

WASTEWATER SECTOR TRAINING: RECOMMENDED INSTITUTIONS

JOB FUNCTIONS	SHORT-TERM INSTITUTIONS	LONG-TERM INSTITUTIONS
I. Wastewater System: Planning		
A. Technical: Conduct engineering studies (including environmental assessments) to develop alternative wastewater management plans, develop criteria for comparisons, make recommendations for decision-making.	Philadelphia Suburban Corp. Northern Laboratories Inc. Middlesex Polytechnic	Arizona State University University of Cincinnati Clemson University Drexel University East Tennessee State University Ferris State College University of Florida University of Maryland University of North Carolina Northeastern University University of Oklahoma University of Pittsburgh Rensselaer Polytechnical Institute University of Texas Tufts University Vanderbilt University Western Carolina University University of Wisconsin

WASTEWATER SECTOR TRAINING: RECOMMENDED INSTITUTIONS

JOB FUNCTIONS	SHORT-TERM INSTITUTIONS	LONG-TERM INSTITUTIONS
I. Planning (continued)		
B. Economic/Finance: Prepare analyses, annual operating budgets, etc. for comparisons and decision-making; prepare plans for funding, revenue collection, and cash flow operating plans.	Philadelphia Suburban Corp. Middlesex Polytechnic	Drexel University East Tennessee State University Ferris State College University of Florida University of Maryland University of North Carolina University of Oklahoma University of Pittsburgh Tufts University University of Texas University of California - L.A. University of Iowa Michigan State University Pennsylvania State University University of Wisconsin Western Carolina University Clemson University

WASTEWATER SECTOR TRAINING: RECOMMENDED INSTITUTIONS

JOB FUNCTIONS	SHORT-TERM INSTITUTIONS	LONG-TERM INSTITUTIONS
I. Planning (continued)		
C. Social: Conduct social feasibility surveys, develop social criteria, make recommendations and participate in decision-making.	Philadelphia Suburban Corp. University of Connecticut	Southern Illinois University Vanderbilt University Northeastern University Arizona State University Drexel University East Tennessee State University Ferris State College University of Florida University of Maryland University of North Carolina University of Oklahoma University of Pittsburgh Tufts University University of Texas University of California Michigan State University University of Wisconsin Western Carolina University Clemson University Southern Illinois University

WASTEWATER SECTOR TRAINING: RECOMMENDED INSTITUTIONS

JOB FUNCTIONS	SHORT-TERM INSTITUTIONS	LONG-TERM INSTITUTIONS
I. Planning (continued)		
D. Management: Coordinate and plan for all financial, technical, and social planning activities, handle day-to-day management of resources required for planning activities and manage decision-making.	Philadelphia Suburban Corp. Middlesex Polytechnic University of Connecticut	University of Cincinnati Rensselaer Polytechnical Institute Vanderbilt University Arizona State University East Tennessee State University Ferris State College University of Florida University of Maryland University of North Carolina University of Pittsburgh Tufts University University of Texas University of California - L.A. Michigan State University Western Carolina University Clemson University

JOB FUNCTIONS	SHORT-TERM INSTITUTIONS	LONG-TERM INSTITUTIONS
II. Wastewater System Design		
A. Technical: Develop flow diagrams for wastewater systems, select appropriate process units, design process units, and evaluate designs.	Charles County Community College Green River Community College Northern Laboratories Utah Technical College Philadelphia Suburban Corp. Environmental Resources Training Center	Worcester Polytechnic Institute Valparaiso University Northeastern University Drexel University University of Oklahoma University of Wisconsin University of Iowa Pennsylvania State University Clemson University Michigan State University University of California - L.A. University of Texas Tufts University University of Pittsburgh University of North Carolina University of Maryland University of Florida Arizona State University Vanderbilt University Rensselaer Polytechnical Institute University of Cincinnati

WASTEWATER SECTOR TRAINING: RECOMMENDED INSTITUTIONS

JOB FUNCTIONS	SHORT-TERM INSTITUTIONS	LONG-TERM INSTITUTIONS
II. Design (continued)		
B. Financial: Estimate construction and operation and maintenance costs of wastewater collection, treatment and disposal systems, develop strategies for securing funding, design appropriate financial systems -- cash flow and revenue collection systems.	Philadelphia Suburban Corp. University of Connecticut	Worcester Polytechnic Institute University of Wisconsin University of Iowa Michigan State University University of California - L.A. University of Texas University of Pittsburgh University of North Carolina University of Maryland University of Florida Vanderbilt University University of Cincinnati

JOB FUNCTIONS	SHORT-TERM INSTITUTIONS	LONG-TERM INSTITUTIONS
II. Design (continued)		
C. Management: Coordinate and direct all design activities, project time frames for construction and implementation, recruit and select design staff, manage day-to-day activities.	Philadelphia Suburban Corp. University of Connecticut	Tufts University University of Oklahoma Worcester Polytechnic Institute University of Wisconsin Michigan State University University of California - L.A. University of Texas University of Pittsburgh University of North Carolina University of Cincinnati

WASTEWATER SECTOR TRAINING: RECOMMENDED INSTITUTIONS

JOB FUNCTIONS	SHORT-TERM INSTITUTIONS	LONG-TERM INSTITUTIONS
III. Wastewater System: Construction		
A. Technical: Develop construction plan and construction schedule, determine resource requirements, implement day-to-day construction activities, and make certain construction follows and meets specifications.	Middlesex Polytechnic Northern Laboratories Philadelphia Suburban Corp.	University of Florida University of Maryland University of Iowa Northeastern University Drexel University Pennsylvania State University Clemson University Arizona State University Rensselaer Polytechnical Institute University of Oklahoma Worcester Polytechnic Institute University of Wisconsin University of Texas University of Pittsburgh University of Cincinnati

JOB FUNCTIONS	SHORT-TERM INSTITUTIONS	LONG-TERM INSTITUTIONS
III. Construction (continued)		
B. Financial: Manage day-to-day financial aspects of construction, maintain construction costs within budget and maintain accounting systems for construction phase.	University of Connecticut Middlesex Polytechnic Northern Laboratories Philadelphia Suburban Corp.	University of Florida University of Maryland Northeastern University Drexel University Pennsylvania State University Clemson University Arizona State University Rensselaer Polytechnical Institute University of Oklahoma Worcester Polytechnic Institute University of Wisconsin University of Texas University of Pittsburgh University of Cincinnati

WASTEWATER SECTOR TRAINING: RECOMMENDED INSTITUTIONS

JOB FUNCTIONS	SHORT-TERM INSTITUTIONS	LONG-TERM INSTITUTIONS
III. Construction (continued)		
C. Management: Coordinate and direct all construction activities, maintain construction schedule within time frame, recruit and select construction staff, handle day-to-day management of resources, and communicate with officials and funding agencies.	Philadelphia Suburban Corp. Middlesex Polytechnic University of Connecticut	University of Florida University of Maryland Northeastern University Drexel University Pennsylvania State University Arizona State University Rensselaer Polytechnical Institute University of Oklahoma Worcester Polytechnic Institute University of Wisconsin University of Texas University of Pittsburgh University of Cincinnati

JOB FUNCTIONS	SHORT-TERM INSTITUTIONS	LONG-TERM INSTITUTIONS
IV. Wastewater System: Operation and Maintenance		
A. Technical: For each process perform normal and abnormal operation procedures, preventive and corrective maintenance procedures, and laboratory and system control procedures.	Northern Laboratories Ulster County Community College Technology Management Services Inc. Southern Maine Technical Vocational Institute Operations Management International Ministry of Environment - Canada Linn-Benton Community College Kirkwood Community College Environmental Resources Training Center Charles County Community College Green River Community College Utah Technical College Philadelphia Suburban Corporation Middlesex Polytechnic	Pennsylvania State University Utah Technical College Green River Community College Charles County Community College Environmental Resources Training Center Kirkwood Community College Linn-Benton Community College Ulster County Community College

WASTEWATER SECTOR TRAINING: RECOMMENDED INSTITUTIONS

JOB FUNCTIONS	SHORT-TERM INSTITUTIONS	LONG-TERM INSTITUTIONS
IV. Operation and Maintenance (continued)		
B. Financial: Prepare annual budgets, recommend financing for improvements and expansion, manage day-to-day financial activities.	University of Connecticut Middlesex Polytechnic Philadelphia Suburban Corp. Utah Technical College Green River Community College Charles County Community College Environmental Resources Training Center Kirkwood Community College Linn-Benton Community College Operations Management International Southern Maine Vocational Technical Institute Technology Management Services, Inc. Ulster County Community College	Utah Technical College Green River Community College Charles County Community College Environmental Resources Training Center Kirkwood Community College Linn-Benton Community College Ulster County Community College

JOB FUNCTIONS	SHORT-TERM INSTITUTIONS	LONG-TERM INSTITUTIONS
IV. Operation and Maintenance (continued)		
C. Management: Recruit O&M staff, manage resources, prepare periodic reports, manage all O&M day-to-day activities, project future needs and maintain operational ability of plant.	Philadelphia Suburban Corp. Middlesex Polytechnic Utah Technical College Green River Community College Charles County Community College Environmental Resources Training Center Kirkwood Community College Linn-Benton Community College Operations Management International Southern Maine Vocational Technical Institute Technology Management Services, Inc. Ulster County Community College University of Connecticut Industrial Training Services Ltd.	University of Pittsburgh Purdue University Utah Technical College Green River Community College Charles County Community College Environmental Resources Training Center Kirkwood Community College Linn-Benton Community College Ulster County Community College

Chapter 3

DESCRIPTION OF TRAINING INSTITUTIONS

3.1 Chapter Contents and Use

This chapter provides a brief description of each training institution by listing its experience, programs available, contact person and address. Only long-term training institutions were questioned about English-as-a-second-language (ESL) classes. Therefore, in the short-term training institutions listings, an ESL category will not appear. If the reader has identified the type of training needed and the institutions of interest in Chapter 2, s/he may use this chapter for the necessary follow-up and for obtaining the details for requesting further information directly from the preferred institution. All institutions are listed alphabetically (for universities, the word which identifies the university, usually its location, is the key word; e.g., University of California at Los Angeles is listed under the "C" listings and not the "U" listings).

Arizona State University
Dept. of Civil Engineering
G 120 D
Tempe, Arizona 85287
(602) 965-3296
Contact: Dr. John Klock

Overseas Experience: Foreign students comprise 15-20% of civil engineering programs; most come from Asia and Iran. Professors have worked overseas with Public Health Services in Central and South America.

Hands-On Approach: Laboratory work and possible development of cooperative education program with industry for on-the-job training.

ESL Classes: Available

Long-Term Offerings: Masters degree only. Water: Planning (technical, social, management); Design (technical, financial, management). Wastewater: Planning (technical, social, management); Design (technical); Construction (technical, financial, management).

British Water International (B.W.I.)
James House
27 London Road
Newbury, Berkshire RG13 1JL U.K.
(635) 30777 Telex: 848925 NATWAT G
Contact: R.P.J. Turrell, Executive Director

Overseas Experience: All classes are designed for personnel from developing countries. The training staff have all worked overseas extensively.

Hands-On Approach: Broad laboratory training in pumps, pipes, and other systems hardware. Course includes an internship with industries. B.W.I. is beginning to organize courses in wastewater systems.

Short-Term: Six to twelve weeks. Water: Planning (technical, economic/finance, social, management); Design (technical, financial, management); O&M (technical, financial, management).

University of California
at Los Angeles
3677 Geology Building
Los Angeles, California 90024
(213) 825-2636
Contact: Dr. Richard Perrine

Overseas Experience: 40% of the students in environmental engineering are foreign, coming mostly from Asia, Israel, and Iran. Professors have worked on urban projects in Saudi Arabia. Some of the professors are from China and Taiwan.

Hands-On Approach: Applied research and mandatory internship for doctoral program. Program has water quality and problem-solving focus.

ESL Classes: Available

Long-Term Offering: B.S., M.S., Ph.D. Water: Planning (economic/finance, management); Design (technical, financial, management).

Charles County Community College
Water Quality Training Center
P. O. Box 910
La Plata, Maryland 20646
(301) 934-2251, Ext. 339
Contact: J. Bair

Overseas Experience: Presently preparing to train the first group of Egyptians in water/wastewater operation and maintenance this fall.

Hands-On Approach: Does laboratory training in operation and maintenance of pumps, motors, etc. On-the-job training is possible under supervision of professionals in local treatment plants.

ESL Classes: Not available.

Short-Term: Given on demand (in subjects listed under long-term).

Long-Term Offerings: One and two year programs available. Water: Design (technical); O&M (technical, financial, management). Wastewater: Design (technical); O&M (technical, financial, management).

University of Cincinnati
Dept. of Environmental Engineering
Cincinnati, Ohio 45221
(513) 475-3648
Contact: Dr. James MacDonough

Overseas Experience: Foreign students comprise 10-15% of the students in civil engineering, most coming from India, Nigeria and China. Some of the civil engineering professors are from Lebanon, Nepal, and China; others have either taught or worked in India, Egypt or Afghanistan.

Hands-On Approach: Mandatory undergraduate participation in cooperative education program, working at the Environmental Protection Agency (EPA) facilities on campus, and assisting in the laboratory.

ESL Classes: Available

Long-Term Offerings: Water/wastewater programs offer B.S. and M.S. Water: Planning (management); Design (technical, financial, management); construction (technical, financial, management). Wastewater: Planning (technical, management); Design (technical, financial, management); Construction (technical, financial, management).

Clemson University
Dept. of Environmental Systems
Engineering
Clemson, South Carolina 29631
(803) 656-3276
Contact: Dr. Thomas M. Keinath

Overseas Experience: Foreign students comprise 10-15% of the students in environmental engineering coming from Europe, Asia and Latin America. Two professors have taught short courses in China; others have done workshops in Europe.

Hands-On Approach: Field trips, thesis/research, emphasis on laboratory work.

ESL Classes: Some ESL classes are available; however the university prefers that students have a TOEFL score of 600.

Long-Term Offerings: Water/Wastewater programs offer M.S., M.E., and Ph.D. Water: Planning (technical, social, management); Design (technical); Construction (technical, financial). Wastewater: Planning (technical, economic/finance, social, management); Design (technical); Construction (technical, financial).

University of Connecticut
Director of International Health
Education
P. O. Box 329
Hartford, Connecticut 96141
(203) 241-4930/1
Contact: Theresa DeRosa

Overseas Experience: Courses in training and project management designed for managers from developing countries. After six months, in-country follow-up by program staff to assist the participants.

Hands-On Approach: Development of a home-country project, field trips and problem-solving exercises.

Short-term: Given on demand. Water: Planning (social, management); Design (financial, management); Construction (financial, management; O&M (financial, management). Wastewater: Planning (social, management); Design (financial, management); Construction (financial, management); O&M (financial, management).

Drexel University
32nd and Chestnut Streets
Philadelphia, Pennsylvania 19104
(215) 895-2265
Contact: Herbert Allen, Ph.D.

Overseas Experience: Foreign students comprise 5% of the student body. 10-15% of the civil engineering professors are from overseas, mainly Lebanon and India.

Hands-On Approach: Mandatory participation in cooperative education program for on-the-job training.

ESL Classes: Not available

Long-Term Offerings: Water/wastewater program offers B.S., M.S., and Ph.D. Given on demand. Water: Planning (social, management); Design (financial, management); Construction (financial, management); O&M (financial, management). Wastewater: Planning (social, management); Design (financial, management); Construction (financial, management); O&M (financial, management).

East Tennessee State University
P. O. Box 22960A
Johnson City, Tennessee 37614
(615) 929-4268
Contact: Monroe Morgan

Overseas Experience: 5-10% of students are foreign, coming from Ethiopia, Sudan and Kenya. The professors have had no overseas experience other than their contact with the foreign students.

Hands-On Approach: Field trips, cooperative education program and special inter-session training for foreign students.

ESL Classes: Available

Long-Term Offerings: Water/wastewater program offers B.S. and M.S. degrees. Water: Planning (technical, economic/finance, social, management). Wastewater: Planning (technical, economic/financial, social, management).

Environmental Resources Training Center (E.R.T.C.)
Southern Illinois University
Edwardsville, Illinois 62025
(618) 692-2030
Contact: Tom Wooter

Overseas Experience: Program has hosted Asians on study tours.

Hands-On Approach: 50% of courses are hands-on; 50% are lectures/demonstrations. Program has on-site pilot facilities for water/wastewater practical training. Laboratory training in operation and maintenance of pumps, motors, etc.

Short-Term: Given on demand. Water: Design (technical); O&M (technical, financial, management). Wastewater: Design (technical); O&M (technical, financial, management).

Long-Term Offerings: One year certificate for operators available. Water: O&M (technical, financial, management).

Ferris State College
School of Allied Health
Big Rapid, Michigan 49307
(616) 796-0461
Contact: Michael Ells

Overseas Experience: 5-15% of program students are foreign born, coming from Asia, Central and South America, Saudi Arabia, Kuwait and Iran. Professors have no overseas experience other than their contact with the foreign students.

Hands-On Approach: Laboratory work, field study and a ten-week internship with various industries and government agencies.

ESL Classes: Classes are available. In addition, students participate in a re-entry seminar before returning home.

Long-Term Offerings: Water/wastewater program offers a B.S. degree. Water: Planning (technical, economic/finance, social, management). Wastewater: Planning (technical, economic/finance, social, management).

University of Florida
217 A.P. Black Hall
Gainesville, Florida 32611
(904) 392-0841
Contact: Dr. Warren Viessmann, Jr.

Overseas Experience: Foreign students comprise 10-20% of program, coming from Asia, Latin American and Afghanistan. Professors have consulted in Latin America and China. One professor was educated in Algeria.

Hands-On Approach: Program includes the possibility of credited internships with industry, heavy laboratory emphasis, and association with Florida's regional operator's course for hands-on training in operation and maintenance.

ESL Classes: Available

Long-Term Offerings: Water/wastewater program offers B.S., M.S., and Ph.D. Water: Planning (technical, economic/finance, social, management); Design (technical, financial); Construction (technical, financial, management); Wastewater: Planning (technical, economic/finance, social, management); Design (technical, financial); Construction (technical, financial, management).

Green River Community College
12401 SE 320th Street
Auburn, Washington 98002
(206) 833-9111
Contact: Fred Delvecchio

Overseas Experience: Program has hosted foreign personnel on study tours.

Hands-On Approach: Pilot facilities for water/wastewater practical training. Does laboratory training in operation and maintenance of pumps, motors, etc.

ESL Classes: Not available

Short-Term: Given on demand. Water: Design (technical; O&M (technical, financial, management). Wastewater: Design (technical); O&M (technical, financial, management).

Long-Term Offerings: One and two year programs available. Water: O&M (technical, financial, management). Wastewater: O&M (technical, financial, management).

Industrial Training Service Ltd.
43 Market Place
Wetherby
West Yorkshire LS22 4LN, U.S.
(0937) 63531 Telex: IG 888941 Industrain
Contact: J.B. Senior, Overseas Manager

Overseas Experience: Course in training management and/or general management for staff from developing countries.

Hands-On Approach: One week of on-the-job training; field visits with various organizations.

Short-Term: Course length: Thirteen weeks. Water: O&M (management). Wastewater: O&M (management).

International Center for Advanced
Technical and Vocational Training
201, Via Ventimiglia
10127 Turin, Italy
(11) 633733 Telex: CENTRN-I 221449
Contact: Dario Guido

Overseas Experience: Center tailors courses to the needs of developing countries. Permanent courses in training of trainers and open courses in management and planning of energy and water resources. Staff is international.

Hands-On Approach: Development of home country project and three weeks of study visits.

Short-Term: Course length: Seven to twelve weeks. Water: Planning (technical, economic/finance, social, management); Design (management).

University of Iowa
Civil and Environmental Engineering
College of Engineering
Iowa City, Iowa 52242
(319) 353-3388
Contact: Dr. Richard Dague

Overseas Experience: 25-30% of the students in the program are foreign, coming from Taiwan, South America and Iran. Professors have consulted in Jamaica, South America and Europe.

Hands-On Approach: Strong laboratory emphasis, with labs located in the University's water plant and the city's wastewater treatment plant. Extra lab work can be given to foreign students to build their skills.

ESL Classes: Available.

Long-Term Offerings: Water/wastewater programs offer M.S. and Ph.D. Water: Planning (economic/finance); Design (technical, financial); Construction (technical). Wastewater: Planning (economic/finance); Design (technical, financial); Construction (technical).

Kirkwood Community College
6301 Kirkwood Blvd., S.W.
Cedar Rapids, Iowa 52404
(319) 398-5678
Contact: Douglas Feil

Overseas Experience: One student each from Brazil and Nigeria has been in the program.

Hands-On Approach: Operation and maintenance training is done partially in on-campus wastewater pilot plant. Laboratory training in operation and maintenance of pumps, motors, etc. Complete laboratory for training in water/wastewater treatment process.

ESL Classes: Not available

Short-Term: Given on demand. Water: O&M (technical, financial, management). Wastewater: O&M (technical, financial, management).

Long-Term Offerings: One year program. Water: O&M (technical, financial, management). Wastewater: O&M (technical, financial, management).

Linn-Benton Community College
6500 SW Pacific Blvd.
Albany, Oregon 97321
(503) 928-2361
Contact: John Carnegie

Overseas Experience: There have been students from India in the program. Professors have worked in Saudi Arabia, Switzerland and Sri Lanka.

Hands-On Approach: Programs are skill-oriented, with 20% of the course hands-on.

ESL Classes: Not available

Short-Term: Training done on demand. Water: O&M (technical, financial, management). Wastewater: O&M (technical, financial, management).

University of Maryland
Dept. of Civil Engineering
College Park, Maryland 20740
(301) 454-3107
Contact: Dr. Robert Ragan

Overseas Experience: 10-30% of civil engineering students are foreign, coming from Asia, Latin America, Africa and the Middle East -- Iran, Egypt. One professor has a degree from Taiwan and some professors have consulted on appropriate technologies in developing countries.

Hands-On Approach: Four laboratory courses, field trips and design laboratory.

ESL Classes: Offered as a summer program or as a remedial program during the school year.

Long-Term Offerings: Water/wastewater program offers B.S., M.S., and Ph.D. Water: Planning (technical, economic/finance, social, management); Design (technical, finance); Construction (technical, financial, management). Wastewater: Planning (technical, economic/finance, social, management); Design (technical, financial); Construction (technical, financial, management).

Michigan State University
Dept. of Civil and Sanitary
Engineering
East Lansing, Michigan 48824
(517) 353-6487
Contact: Dr. MacKenzie L. Davis

Overseas Experience: 10-50% of civil engineering students are foreign, coming from Asia, South America, Africa and the Middle East -- Jordan, Syria. Four professors are from overseas: China, the Netherlands, Syria and Pakistan.

Hands-On Approach: One to two laboratory courses per semester are required and students may work in local plants on an individual basis.

ESL Courses: Available

Long-Term Offerings: Water/wastewater program offers B.S., M.S., and Ph.D. Water: Planning (economic/finance, social, management); Design (technical, financial, management). Wastewater: Planning (economic/finance, social, management); Design (technical, financial, management).

Middlesex Polytechnic
Queensway
Enfield, Middlesex EN3 4SF, U.K.
(1) 804-8131, Ext. 253
Contact: Dr. S.K. Dutta

Overseas Experience: All courses are designed for international participants.

Hands-On Approach: Internship in water/wastewater plants and use of water/wastewater system instruments which are appropriate in developing countries.

Short-Term: Three months or on demand. Water: Planning (technical, economic/finance, management); Design (technical); Construction (technical, financial, management); O&M (technical, finance, management). Wastewater: Planning (technical, economic/finance, management); Construction (technical, finance, management); O&M (technical, finance, management).

Ministry of Environment
Training and Certificate Section
Human Resources and Staff
Development Branch
135 St. Clair Avenue, West
Toronto, Ontario M4V 1P5 Canada
(416) 456-0266
Contact: Robert Dodderidge

Overseas Experience: 1% of the program's students have been from Ghana, Tanzania and Saudi Arabia.

Hands-On Approach: Extensive laboratory training and an internship possible in a water/wastewater treatment plant.

ESL Classes: Not available

Short-Term: Series of one week courses from basic to advanced training, which may be taken separately or together. Water: O&M (technical). Wastewater: O&M (technical).

University of North Carolina
Dept. of Environmental Science
and Engineering
Chapel Hill, North Carolina 27514
(919) 966-1171
Contact: Dr. Russel Christman

Overseas Experience: 10-15% of the program's students are from Taiwan and Brazil. Some of the professors have consulted extensively with the U.S. government worldwide.

Hands-On Approach: Projects done in on-campus water/wastewater treatment facilities.

ESL Classes: Available

Long-Term Offerings: Water/wastewater program offers M.S. and Ph.D. Water: Planning (technical, economic/finance, social, management); Design (technical, financial, management). Wastewater: Planning (technical, economic/finance, social, management); Design (technical, financial, management).

Northeastern University
360 Huntington Avenue
Boston, Massachusetts 02115
(617) 437-3993
Contact: Dr. O'Shaunessy

Overseas Experience: 40% of the students in civil engineering program are from other countries, mainly the Middle East. Many of the professors have been educated or have taught overseas.

Hands-On Approach: Emphasis on laboratory, involvement in cooperative education program, and setting up a small-scale plant as a class project.

ESL Classes: Available

Long-Term Offerings: Water/wastewater program offers B.S. and M.S. degrees. Water: Planning (technical, social); Design (technical); Construction (technical, financial, management). Wastewater: Planning (technical, social); Design (technical); Construction (technical, financial, management).

Northern Laboratories Inc. (N.L.I.)
158 Napoleon Street
Valparaiso, Indiana 46383
(219) 464-2389
Contact: A. Sami El-Naggar, President

Overseas Experience: The president of N.L.I. is an Egyptian who has worked in Cairo and Lebanon, designing and managing training plans for water/wastewater systems. He has also taught at the University of Alexandria (Egypt).

Hands-On Approach: On-the-job training, problem-solving exercises, study visits.

Short-Term: Courses given on demand. Water: Design (technical); Construction (technical); O&M (technical) Wastewater: Planning (technical); Design (technical); Construction (technical, financial); O&M (technical).

University of Oklahoma
Dept. of Civil Engineering and
Environmental Science
202 W. Boyd - Room #334
Norman, Oklahoma 73019
(405) 325-5911
Contact: Dr. Leale Streebin

Overseas Experience: 40% of the program's students are from other countries. Professors have consulted with USAID and the Pan American Health Organization in Central and South America.

Hands-On Approach: Summer institute set up to provide practical training. Students also assist professors in consulting with local plants.

ESL Classes: Available

Long-Term Offerings: Water/wastewater program offers M.S. and Ph.D. Water: Planning (technical, economic/finance, social); Design (technical, management); Construction (technical, financial, management). Wastewater: Planning (technical, economic/finance, social); Design (technical, management); Construction (technical, financial, management).

Operations Management International
900 Rockmead Drive - Suite 140
Kingwood, Texas 77339
(713) 358-9134
Contact: Chuck McElroy, Vice President

Overseas Experience: Trained operation and maintenance personnel in Korea for USAID. Also worked in Yemen, Saudi Arabia and Egypt.

Hands-On Approach: Trainees work in treatment plants under direct supervision of trainers.

Short-Term: On demand. Water: O&M (technical, financial, management). Wastewater: O&M (technical, financial, management).

Pennsylvania State University
Water Resources Engineering
Technology
Capital Campus W261
Middletown, Pennsylvania 17057
(717) 948-6133

Contact: Charles Cole

Overseas Experience: A small number of foreign students are in the graduate program; however, there are none in the Bachelor of Technology program at this time. Some of the professors are from Chile, Pakistan, India and Iran.

Hands-On Approach: There is a one semester course in operation of a water/wastewater treatment plant, in addition to field trips. Course emphasis is on applied engineering.

ESL Classes: Not available

Long-Term Offerings: Program offers a two-year B.S. which is for graduates of two-year associate program or other appropriate programs and M.S. degree. Water: Planning (economic/finance); Design (technical); Construction (technical, financial, management); O&M (technical). Wastewater: Planning (economic/finance); Design (technical); Construction (technical, financial, management); O&M (technical).

Philadelphia Suburban Corporation
(P.S.C.) Water Services
Oakhill Plaza
200 N. Warner - Suite 300
King of Prussia, Pennsylvania 19406
(215) 337-3060
Contact: Dale Kratzer

Overseas Experience: Consulted in Saudi Arabia, Syria, and Thailand on aspects of planning, design and operation/maintenance of water/wastewater systems.

Hands-On Approach: 50% of the course is hands-on: Trainees work in treatment plants, building upon previous experience to solve their own problems.

Short-Term: On demand. Water: Planning (technical, economic/finance, social, management); Design (technical, financial, management); Construction (technical, financial, management); O&M (financial, management). Wastewater: Planning (technical, economic/finance, social, management); Design (technical, financial, management); Construction (technical, financial, management); O&M (technical, financial, management).

University of Pittsburgh
939 Benedum Hall
Pittsburgh, Pennsylvania 15261
(412) 624-5363
Contact: Dr. James Miller

Overseas Experience: 50-75% of the students in the program are from other countries. Some professors are from overseas; others have taught in Europe.

Hands-On Approach: On-the-job training project, thesis focusing upon issues relevant to the home situation, extensive laboratory work.

ESL Classes: Available

Long-Term Offerings: Water/wastewater program offers M.S. and Ph.D. Water: Planning (technical, economic/finance, social, management); Design (technical, financial, management); Construction (technical, financial, management). Wastewater: Planning (technical, economic/finance, social, management); Design (technical, financial, management); Construction (technical, financial, management).

Rensselaer Polytechnical Institute
Environmental Engineering Program
Troy, New York 12181
(518) 266-6377
Contact: Dr. Bruce Naumann

Overseas Experience: Foreign students comprise 30% of graduate program, coming from Latin America, Asia and Turkey. Four professors are from overseas: Turkey, Germany, India, South Africa.

Hands-On Approach: Research project, and opportunities for students to assist professors in local consulting.

ESL Classes: Available for speaking and writing.

Long-Term Offerings: Water/wastewater program offers an M.S. degree. Water: Planning (technical, management); Design (technical); Construction (technical, financial, management). Wastewater: Planning (technical, management); Design (technical); Construction (technical, financial, management).

Southern Illinois University
School of Engineering
P. O. Box 65E
Edwardville, Illinois 62026
(618) 692-3311
Contact: Dr. George Arnold

Overseas Experience: 50% of environmental studies master-level students are foreign born. Students come from Asia, Africa, Iran and Kuwait. Professors have taught in India; one professor is from Holland.

Hands-On Approach: In-depth environmental impact studies and seminars.

ESL Classes: Available only at Carbondale, Illinois, campus.

Long-Term Offerings: Water/wastewater program offers an M.S. degree. Water: Planning (technical, social). Wastewater: Planning (social).

Southern Maine Vocational
Technical Institute
New England Regional
Wastewater Institute
2 Fort Road
South Portland, Maine 04106
(207) 767-2539
Contact: Kirk Laflin

Overseas Experience: Program hosts overseas personnel on study tours.

Hands-On Approach: Course includes an internship working in the on-campus wastewater pilot plant and laboratory training in operations and maintenance of pumps, motors, etc.

ESL Classes: Not available

Short-Term: Thirty-five hour summer short course for treatment plant managers. Water: O&M (technical, financial, management). Wastewater: O&M (technical, financial, management).

Long-Term Offerings: Nine-month operators course.

Technology Management Services, Inc. (T.S.M.I.)
6120 Paseo de Norte
Carlsbad, California 92008
(619) 438-8944
Contact: Ben Price

Overseas Experience: Have consulted for USAID in Yemen and Saudi Arabia; training at all levels in water/wastewater systems. Have written operation and maintenance manuals for systems in Guam, Trinidad and Korea.

Hands-On Approach: 70% of training is hands-on, working in T.S.M.I.'s treatment plant.

Short-Term: Given on demand. Water: O&M (technical, financial, management). Wastewater: O&M (technical, financial, management).

University of Texas
Environmental Health Engineering
Dept. of Civil Engineering
Austin, Texas 78712
(512) 471-5602
Contact: Dr. Neal Armstrong

Overseas Experience: 33% of graduate students are from other countries, including Egypt, Israel and Turkey. Some of the professors have consulted in Asia and South America.

Hands-On Approach: Laboratory emphasis, required thesis.

ESL Classes: Available

Long-Term Offerings: Water/wastewater program offers an M.S. degree. Water: Planning (technical, economic/finance, social, management); Design (technical, financial, management); Construction (technical, financial, management) Wastewater: Planning (technical, economic/finance, social, management); Design (technical, financial, management); Construction (technical, financial, management).

Tufts University
Anderson Hall
Medford, Massachusetts 02155
(617) 628-3211
Contact: Dr. Linfield Brown

Overseas Experience: 10% of students are from other countries, primarily African and Middle Eastern nations. The professors have had no overseas experience other than their exposure to the foreign students.

Hands-On Approach: 25% of the program consists of laboratory work. Internship possibilities exist within the undergraduate program.

ESL Classes: Available

Long-Term Offerings: Water/wastewater program offers B.S. and M.S. degrees. Water: Planning (technical, economic/finance, social, management); Design (technical, management). Wastewater: Planning (technical, economic/finance, social, management), Design (technical, management).

Ulster County Community College
Department of Water Quality
Stone Ridge, New York 12484
(914) 687-7621
Contact: Richard Glazer

Overseas Experience: Program has hosted overseas personnel on study tours.

Hands-On Approach: On-the-job work in treatment plant and laboratory training in the operation and maintenance of pumps, motors, etc. In 1983 Ulster's vocational course was named one of the top five in the U.S. by The National Center for Research in Vocational Education at Ohio State University.

ESL Classes: Not available

Short-Term: Given on demand. Water: O&M (technical, financial, management). Wastewater: O&M (technical, financial, management).

Long-Term Offerings: One- and two-year programs available. Water: O&M (technical, financial, management). Wastewater: O&M (technical, financial, management).

Utah Technical College
Provo Division of Continuing Education
1395 North 150th Street East
P. O. Box 1609
Provo, Utah 84603
(801) 226-5000
Contact: Debbie Horton

Overseas Experience: Program has hosted Asians on study tours.

Hands-On Approach: Field assignments and an internship working part-time in a local plant. Program staff have designed and written training and operation/maintenance manuals for U.S. water/wastewater facilities.

ESL Classes: Not available

Short-Term: Given on demand. Water: Design (technical); O&M (technical, financial, management). Wastewater: Design (technical); O&M (technical, financial, management).

Long-Term Offerings: Two year program available. Water/wastewater programs offer a B.S. Water: O&M (technical, financial, management). Wastewater: O&M (technical, financial, management).

Valparaiso University
Dept. of Civil Engineering
Valparaiso, Indiana 46383
(219) 464-5173
Contact: Dr. A. Sami El-Naggan

Overseas Experience: 25% of civil engineering students are from other countries, half coming from the Middle East. One professor is Egyptian and has consulted in the Middle East.

Hands-On Approach: One year independent research or design project required during senior year.

ESL Classes: Not available

Long-Term Offerings: Water/wastewater program offers a B.S. degree. Water: Design (technical). Wastewater: Design (technical).

Vanderbilt University
Dept. of Civil and Environmental
Engineering
Box 133 - Station B
Nashville, Tennessee 37235
(615) 322-2697
Contact: Dr. Edward Thackston

Overseas Experience: 40% of graduate students are foreign, coming primarily from Latin America and Asia. Two professors come from overseas; others have worked in Israel and India.

Hands-On-Approach: Program is 50% design practice.

ESL Classes: Courses offered as a summer program or as a remedial program during the school year.

Long-Term Offerings: Water/wastewater program offers B.S., M.S., and Ph.D. Water: Planning (technical, social, management); Design (technical). Wastewater: Planning (technical, social management).

Western Carolina University
Environmental Health Program
School of Nursing and Health Science
Cullowhee, North Carolina 28723
(704) 227-7211
Contact: Joseph Beck

Overseas Experience: 5% of program are foreign students, coming primarily from South America and Uganda. Some of the professors have worked overseas with the U.S. Public Health Service and in Liberia with the Ministry of Health.

Hands-On Approach: 50% of course is practical; students are required to do a field study problem and project to graduate. A one-quarter internship is also required.

ESL Classes: Available

Long-Term Offerings: Program offers a B.S. degree. Water: Planning (technical, economic/finance, social, management); Wastewater: Planning (technical, economic/finance, social, management).

University of Wisconsin
Dept. of Civil and Environmental Engineering
3230 Engineering Building
Madison, Wisconsin 53706
(608) 262-1776
Contact: Dr. William Boyle
Dr. Paul Berthouex

Overseas Experience: Foreign students comprise 30% of the program, coming from Turkey, Syria, Iran, Iraq and India. Some of the professors have worked with WHO and USAID in Asia and Africa. Seminars for foreign students are held on international problems.

Hands-On Approach: Summer field study required; mandatory thesis/research; use of Madison's wastewater treatment plant as a laboratory.

ESL Classes: Available

Long-Term Offerings: Program offers B.S., M.S., and Ph.D. Water: Planning (technical, financial, social); Design (technical, financial, management); Construction (technical, financial, management). Wastewater: Planning (technical, financial, social); Design (technical, financial, management); Construction (technical, financial, management).

Worcester Polytechnic Institute
Dept. of Civil Engineering
Worcester, Massachusetts 01609
(617) 793-5309
Contact: Dr. K. Keshavan

Overseas Experience: Foreign students comprise 5% of the student body, coming mainly from South America and the Middle East. Half of the professors are from overseas: India, Hungary, Turkey, and the Middle East. Some of the professors have worked with UNESCO.

Hands-On Approach: Two required projects; extensive laboratory work also required.

ESL Classes: Available, in addition to special writing classes.

Long-Term Offerings: Program offers a B.S. degree. Water: Design (technical, financial). Wastewater: Design (technical, financial).

Chapter 4

STUDY TOURS

4.1 Definitions and Overview

Study Tours as defined in this handbook are an organized series of activities, such as visits, that are intended to provide learning opportunities for trainees within a particular topic or area. In the water supply and wastewater treatment sector study tours frequently consist of a series of visits to water and wastewater utilities, educational institutions active in the sector, and/or municipalities which have responsibilities for managing community facilities. Sometimes students attend conferences or short workshops as a part of the scheduled activities. In most cases, study tours are from 2 to 5 weeks in duration; however, they may occasionally run 8 to 10 weeks.

Our research has indicated that study tours are a popular educational and training method in the international water and wastewater sector. They have excellent potential as tools for learning; unfortunately, they frequently do not live up to their potential. In this chapter, recommendations are made on how to maximize the effectiveness of study tours. Particular pitfalls are pointed out as well. In Section 4.3 of this chapter, utilities which offer study tours are listed.

4.2 Recommendations on How to Effectively Use Study Tours as a Learning Experience

The following several pages contain recommendations on how to effectively plan and use study tours as an educational experience.

4.2.1 Recommendation #1: Determine If Study Tours Are the Most Appropriate Educational Methodology for Your Needs.

Discussion:

Study tours can be a very practical way to increase knowledge, observe alternative approaches, and compare how things can be or are being done in other parts of the world. The interchange between participants and staff at the site can be quite helpful. However, study tours cannot meet all needs. Before deciding if a study tour is appropriate, it may be useful to consult the following lists of what study tours can and cannot do.

Study tours can:

- o increase technical knowledge in specific areas
- o expand knowledge base for more effective problem-solving
- o provide specific "how-to's" in designated areas
- o improve capacity to identify advantages/disadvantages of various technologies
- o provide increased information for comparison and selection of designated system designs and technologies
- o provide limited skill-building (depending on how actively involved the participants are)
- o establish contacts in participants' areas of specialty which can be accessed in the future

Study tours cannot provide:

- o skill-building at high levels (usually not oriented toward skill practice, although could be so designed)
- o specific technical knowledge over a large number of designated areas (usually limited in scope)
- o start-up knowledge (basics) in general water and wastewater areas (most study tour designs assume some knowledge and experience in the field)
- o greatly increased knowledge of theory behind water and wastewater technologies (theory is limited)
- o in-depth analytical skills in a variety of water/wastewater technologies

4.2.2 Recommendation #2: Assign Responsibility Carefully for Putting a Study Tour Together.

Discussion:

Designing, planning and conducting effective study tours is certainly no easy job. It requires someone with familiarity with the water and sanitation sector and a high degree of knowledge and experience about training; i.e., how people learn. This person must be experienced in conducting study tours, knowing what works and what does not.

The designer must also be able to devote considerable time to the activities required to organize and conduct a worthwhile tour. Study tours that are hastily put together or planned by persons without the special expertise listed above are seldom worth the resources they consume. A contractor should be selected to plan, organize and conduct a study tour if the tour is not part of a larger project where paid staff are available.

4.2.3 Recommendation #3: Select Participants for Study Tours with Care.

Discussion:

The appropriate participants for study tours are the individuals who are or will be performing the functions being studied. Research indicated that a good many study tour participants were not the ones who would actually be doing the work. Study tours are often viewed as highly desirable by potential participants. They are short enough, exciting and appealing enough to be seen as a "plum" by both participants and project managers. Research indicated that tours were often used as rewards for top officials, who were appointed (or appointed themselves) as participants rather than the staff who should have attended. In the politics of development work, it is often not easy to say "no" to important people who wish to participate in study tours. However, it is fairly ineffective to send the wrong persons on study tours; they probably learn little and will not be able to apply it upon returning home. The key questions to ask are "how will the candidates use the knowledge and skills learned on the job, and will the candidates be able to pass on the knowledge gained to others?"

4.2.4 Recommendation #4: Plan and Design a Study Tour Systematically.

Discussion:

A study tour is an educational experience and deserves the same degree of attention as the classroom, workshop or seminar. Educational experiences that lead to learning do not happen by chance. They must be carefully thought out and planned. The following steps are important design and planning points:

A. Set specific learning objectives. One of the first things to do in planning and organizing study tours is to think through and identify specifically what the participants should learn. The entire plan can then be woven around the learning objectives.

The participants themselves should be significant authors and contributors to identifying these learning goals. However, there are others with whom the participants work whose input is also important. The bosses or managers of the participants should be involved in determining what is to be gained from the study tour. It is also a good idea to involve colleagues and peers of the selected participants in the process of setting objectives. The more involvement and investment the work group has in one of its members going on a study tour, the easier it may be to bring back and implement new ideas.

Learning objectives should be as specific as possible. Objectives that are too broad or vague do not provide enough guidance to either the learner or the organizer, making it difficult to arrange useful activities. For example, an objective such as "to learn more about wastewater treatment plants," is too general to assist in the determination of where to go and what to see. But, "to compare and list the advantages and disadvantages of three types of wastewater treatment systems," will enable the planners to arrange useful activities.

B. Key learning principles at work during study tours. People learn in lots of different ways; however, there are several essential things to remember while planning a study tour:

1. Learning by doing is the most powerful form of learning. It is absolutely essential in areas where the development of specific skills is needed. If the objective is to learn how to implement new maintenance procedures for pumps, the participant may need to actually do it rather than to have it described to him or even watch others do it.

2. Interaction among participants and the staff of the facility is important. Dialogue and access to the expertise at the facility is key. Large groups of participants can easily dilute this important process. Five to eight participants usually permits effective interaction. Ten participants may be all right, but groups over ten are too large.

3. Information overload can easily occur during a study tour. An individual's ability to assimilate information and retain it for future use is limited. Activities should be designed and scheduled with this in mind. Time should be set for reflection, note-taking, and organization of information.

4. Fatigue inhibits learning. Study tours usually require the participant to travel long distances, moving from location to location frequently. In addition, participants must often communicate in a language other than their own. All these factors contribute to high levels of fatigue which in turn can lead to petty illnesses. Organizers and managers of study tours need to plan for time off and programs with a relaxed pace.

5. Provide time for discussion among participants. Time should be set aside for the participants to discuss and analyze the new information among themselves and to look at how it relates to their needs back home and how it could be effectively applied on the job.

C. Survey sites before selecting them for study tours. Sites should be selected which provide direct opportunity for meeting and achieving learning objectives. Therefore, the site must be studied in order to determine that it does in fact provide the relevant opportunities for learning.

All too often sites are selected because of prestige factors rather than learning potential. For example, sending third world participants to visit the most expensive, sophisticated, advanced water/wastewater treatment facilities may be totally inappropriate. Smaller, less sophisticated facilities may be using technologies much more similar to those of developing countries.

In selecting sites it is important to determine the time and energy that staff at the site can devote to accommodating the study tour. Sites where staff are hesitant to commit the necessary time to participants should be avoided. On the other hand, facilities that are willing to expend time and energy to make the experience successful should be compensated. Of course, compensation should depend on the duration of the visit and the staff time required to interact with the participants.

4.2.5 Recommendation #5: Make All Travel and Logistical Arrangements in Advance.

Discussion:

Travel arrangements are always complex. Making these arrangements ahead of time is the ideal; however, if the planning is done from a third world country the ideal may be difficult to attain. The main points to be made here are two: 1) It is extremely difficult and time-consuming for study tour participants to deal with their own travel tickets and reservations in the country they are visiting. Valuable learning time can be spent on the phone trying to straighten out travel plans. 2) It is also unfair to expect staff of the host institutions to solve travel problems. Re-arranging schedules and changing tickets is not their responsibility.

4.2.6 Recommendation #6: Prepare the Participant(s) for the Study Tour.

Discussion:

The participant should help plan the study tour. A written "learning plan" should be made by the participant(s) in advance which contains objectives, questions to ask or seek answers to, and preferred learning activities.

The participant should collaborate with his/her boss and peers in developing this plan. Together they should plan how the participant will share his/her tour with others upon his/her return. If the learning can be shared with the work group, others will probably feel they have benefited from the study tour even though they were unable to go themselves.

The participant should, throughout the tour, be active in meeting his/her own learning objectives. That means asking questions, making suggestions on how an activity might be helpful, or providing feedback if an activity is not useful. Sometimes participants on study tours feel that they are guests and it would be rude to ask for changes in the program, despite its irrelevant content. Participants should be prepared to help make the study tour a success. Sitting politely through the wrong seminar or irrelevant demonstration is much too passive a role for the participant.

4.2.7 Recommendation #7: Prepare the Site to be Visited.

Discussion:

The staff of study sites should be thoroughly briefed on learning objectives and given guidance on how to achieve them. The site should understand who the group members are, what their backgrounds and interests are, and what they hope to get from studying this facility or institution. It is important to be specific about what participants should do while at the site, to describe the activities that would be helpful, and to collaborate with the staff at the site to plan how these activities could be carried out.

4.2.8 Recommendation #8: Assign a Study Tour Manager/Coordinator.

A full time study tour coordinator who travels with the participants is usually the most effective way to ensure a successful group tour. This individual should be quite knowledgeable in the field of study, experienced and knowledgeable about conditions in the participants' home country, knowledgeable about the project(s) on which the participants work, and experienced at conducting study tours. This coordinator is responsible for seeing that the tour is successful and that the learning goals are achieved. S/he is responsible for managing the learning process in much the same way a teacher is responsible in the classroom. The following should be key activities of the coordinator:

A. Brief the participants on the sites to be visited. The coordinator should hold group sessions to make certain the group members or participants understand how the entire study tour agenda is arranged and why, and how the learning goals and objectives will be met by the activities. Participants should understand why they are visiting a particular site and should be given some background information.

B. Contact with the site staff upon arrival. The coordinator may want to arrange an introductory meeting between the site staff for the study tour and the participants. This meeting should reaffirm the learning objectives, review the schedule or agenda, make changes where necessary, acquaint the site staff in more detail with participant needs, and in general serve as a bridge for the participants and the staff to begin to work together.

C. Monitor the learning activities. Throughout the study tour the coordinator should monitor the activities to see that they are proceeding effectively. If they are not, the coordinator should intercede at an appropriate time to make whatever adjustments s/he deems would improve the

situation. The coordinator is responsible for maintaining the learning climate, which means taking into account all the key principles of study tour learning described in Section 4.2.4 (B) of this report.

D. Daily debriefing of participants. This report has already outlined the value of the participants being able to discuss what they are observing and doing. The coordinator should facilitate these discussions, and they should occur daily. The coordinator should encourage the participants to discuss how their learning can be applied back home and see that time is set aside for note-taking or writing in journals.

4.2.9 Recommendation #9: Account for Reentry to the Workplace.

The only real measure of the success of an educational or training event is the degree to which it enables changes to be made in the workplace. New knowledge and skills from the study tour must be integrated into on-going operations in the workplace. This is almost never easy. Participants will be better able to apply their learning if they plan how they will do that. At the end of the study tour it is a good idea to have the group members spend an entire day planning their reentry. This planning for reentry should address the following questions:

- How will important information about the trip be shared with colleagues and peers to help them learn rather than feel envious that tour participants received a special opportunity which they did not?
- What specifically should be reported to superiors and how should this be done?
- How does one make certain superiors do not feel threatened by expertise gained from the study tour?
- What strategies can be developed to integrate new knowledge into the workplace? Consider who might be affected, what assistance might be needed to incorporate changes, and where sources of help may exist in the work setting.

4.3 Types of Activities Possible in Designing Study Tours

There are a number of activities that can be arranged for study tours. Among these are:

- visiting utilities, touring the facility, question and answer session with experts

- problem-solving discussions with experts from utilities
- interviewing treatment plant operators or other appropriate experts
- working alongside or with (shadowing) a particular expert who is performing specific functions or tasks in which the participant is interested
- visiting educational institutions to study water/wastewater training methods
- observing classes in particular water/wastewater subjects
- interviewing students and instructors from water/wastewater field
- problem-solving discussions with instructors and professors
- observing training laboratories and how they work
- participating as a student in previously organized short courses, workshops, etc.
- visiting consulting firms, exploring design issues with experts
- problem-solving discussions with various experts in consulting firms
- visiting EPA research labs that are actively engaged in conducting research in environmental engineering
- visiting universities that are doing research in areas that are particularly relevant to the participant
- visiting the main office of utilities to observe how they organize themselves, systems for revenue collection, financial systems and general management systems
- shadowing a manager or financial expert from the main office.

There are, of course, many more activities that could be arranged for participants. The key is to design the process and direct the activity toward the achievement of specific learning goals.

4.4 Utilities for Study Tours

The utilities listed on the following pages have expressed interest in receiving overseas visitors for short periods of time. They are aware that being listed here commits them to no obligation and realize that final details such as number of participants, time, objectives of the tour, and costs will be worked out at some future time.

The utilities are organized into the following groups:

I. Water Utilities

A. Plants with average daily flow of over 100 million gallons (p. 69-70).

B. Plants with average daily flow of 50 - 100 million gallons (p. 71).

C. Plants with average daily flow of 10 - 50 million gallons (p. 72-73).

D. Plants with average daily flow under 10 million gallons (p. 74-75).

II. Wastewater Utilities

A. Advanced Wastewater Treatment Plants. Those which use sophisticated, advanced processes for treatment and are usually highly automated (p. 76-78).

B. Plants which use activated sludge for the major treatment process (p. 79-83).

C. Plants which use trickling filters for a major treatment process (p. 84-85).

D. Plants which use stabilization ponds for a major treatment process (p. 86-87).

E. Plants which use primary treatment mainly to process wastewater (p. 88).

I. Water Utilities

A. Average flow of over 100 million gallons per day (m.g.d.)

Denver Water Department
1600 W. 12th Ave.
Denver, Colorado 80254
(303) 623-2500
Contact: Ed Ruetz

Average Flow:	Four plants -- 120-400 m.g.d.
Design Flow:	Four plants -- 625 m.g.d.
Processes Used:	Three plants use modern rapid dual media filters. One plant uses the older technology of slow sand filters.
Source:	Mountain runoff which is stored in series of reservoirs
Overseas Experience:	Visitors from England and India

Miami-Dade Water and
Sewer Authority
P. O. Box 330316
Miami, Florida 33233-0316
(305) 655-7471
Contact: Judy Rubenstein

Average Flow:	Three plants -- 240 m.g.d.
Design Flow:	Three plants -- 320 m.g.d.
Processes used:	Rapid sand filters with iron removal and lime softening
Source:	Shallow underground wells
Overseas Experience:	Visitors from England, Korea, the Caribbean, and Republic of South Africa

Philadelphia Water Utility
3900 Richmond Street
Philadelphia, Pennsylvania 19137
(215) 686-9700, Ext. 27225
Contact: Tom Kulesza

Average Flow:	Three plants -- 72,120, and 250 m.g.d.
Design Flow:	Three plants -- 90,150, and 300 m.g.d.
Processes Used:	Single media rapid sand filters, fluoride addition
Source:	Surface river water
Overseas Experience:	Visitors from Europe

I. Water Utilities

B. Average flow of 50 - 100 million gallons per day (m.g.d.)

Des Moines Water Works
1003 Locust St.
Des Moines, Iowa 50307
(515) 283-8750
Contact: Dr. L. D. McMullen

Average Flow: 38-60 m.g.d.

Design Flow: 100 m.g.d.

Processes used: Filtering is done in specialized two story tank for space conservation. Lime softening and fluoride added. Utility has two interesting programs, control of pipe corrosion and unaccounted for water.

Source: Two surface river sources and large ground pipe infiltration gallery

Overseas Experience: Visitors from England

Fairfax County Water Authority
P. O. Box 1500
Merrifield, Virginia 22116
(703) 698-5600
Contact: James Warfield

Average Flow: 70 m.g.d.

Design Flow: 162 m.g.d.

Processes Used: Conventional filtering systems used as well as advanced treatment process.

Source: Surface river and dammed reservoir. Electricity is generated by the dam to operate the water treatment plant.

Overseas Experience: Visitors from over 50 countries. Plant is one of the most advanced in U.S.

I. Water Utilities

C. Average flow of 10 - 50 million gallons per day (m.g.d.)

El Paso Water Utilities
P. O. Box 511
El Paso, Texas 79961
(915) 533-9701
Contact: John Hickerson
General Manager

Average Flow:	40 m.g.d.
Design Flow:	50 m.g.d.
Processes Used:	Rapid sand filter, water softening
Source:	Ground water
Overseas Experience:	Visitors from South and Central America, India, and Near East countries

Salt Lake City Public Utilities Department
1530 S.W. Temple
Salt Lake City, Utah 84115
(801) 535-7880
Contact: Leroy Hooton

Average Flow:	Three plants -- 25,40,15 m.g.d.
Design Flow:	Three plants -- 30,42,20 m.g.d.
Processes Used:	Rapid sand dual media filters
Source:	Surface water -- river, ground water -- deep wells, springs, and artesian basin
Overseas Experience:	Visitors from Ethiopia

Philadelphia Suburban Corporation
Water Services
Oakhill Plaza
200 N. Warner, Suite 300
King of Prussia, Pennsylvania 19406
(215) 337-3060
Contact: Dale Kratzer

Average Flow:	Three plants -- 30,20,10 m.g.d.
Design Flow:	Three plants -- 40,30,15 m.g.d.
Processes Used:	Rapid dual media sand filters in plants. One plant processes groundwater by using aeration, and microorganism and algae removal.
Source:	Surface water/groundwater
Overseas Experience:	Visitors from Europe

City of San Angelo Water
Utility
P. O. Box 1751
122 W. First St.
San Angelo, Texas 76902
(915) 658-1010
Contact: Cloice Whitley

Average Flow:	12 m.g.d.
Design Flow:	22 m.g.d.
Processes used:	Mixed media and rapid sand filters
Source:	Surface water
Overseas Experience:	Has not hosted foreign personnel previously

I. Water Utilities

D. Average flow under 10 million gallons per day (m.g.d.)

Ames Iowa Water and Wastewater Plant
Municipal Building
Ames, Iowa 50010
(515) 232-5148
Contact: Harris Skeidel
Director of Water
and Pollution Control

Average Flow:	6 m.g.d.
Design Flow:	9 m.g.d.
Processes Used:	Aeration, lime softening and rapid sand filtration
Source:	Ground well water
Overseas Experience:	Visitors from Africa and Asia for U.S. Public Health Service

Water Filtration Plant
397 Lowell St.
Andover, Mass. 01810
(617) 475-6980
Contact: Robert E. McQuade
Director of Public Works

Average Flow:	5-9 m.g.d.
Design Flow:	12 m.g.d.
Processes Used:	Dual media filtration, fluoride addition
Source:	Reservoir surface water
Overseas Experience:	Visitors from all over the world

Florida Keys Aquaduct Authority
P. O. Box 1239
Key West, Florida 33040
(305) 294-2454
Contact: Katherine O'Vide

This plant in Key West is a back-up system for a 130 mile aquaduct from Florida City. Florida City provides water to the Florida Keys from a ground water source on the mainland.

Average Flow:	2.9 m.g.d.
Design Flow:	3 m.g.d.
Processes Used:	Reverse osmosis
Source:	Sea water
Overseas Experience:	Visitors from Saudi Arabia, Libya, and England

II. Wastewater Utilities

A. Advanced Wastewater Treatment Plants

Metropolitan Sanitation District
of Greater Chicago
100 E. Erie St.
Chicago, Illinois 60611
(312) 751-5585
Contact: Barbara Rumsey

Average Flow:	Seven plants -- 1.4 billion gallons per day
Design Flow:	Seven plants -- 2 billion gallons per day
Processes Used:	All use activated sludge and some plants use tertiary/advanced treatment processes.
Sludge Handling:	Sludge is air vacuumed, or centrifuge dried and used for land reclamation.
Source:	55% residential, 45% industrial
Overseas Experience:	Visitors from all over the world

San Jose-Santa Clara Water
Pollution Control Plant
700 Los Esteros Rd.
San Jose, California 95134
(408) 946-0680
Contact: Mark Niver

Average Flow:	115 m.g.d.
Design Flow:	143 m.g.d.
Processes Used:	Activated sludge, nitrification, tertiary/advanced treatment process
Sludge Handling:	Solar dried for landfill
Source:	65% residential; 35% industrial with summer increase of 65% industrial due to food processing industry
Overseas Experience:	Visitors from Japan, Australia and Europe

Upper Occoquan Sewer Authority
P. O. Box 918
Centreville, Virginia 22020
(703) 830-2200
Contact: Peter Paulin

Average Flow:	8.5 m.g.d.
Design Flow:	15 m.g.d.
Processes Used:	Conventional activated sludge with series of advanced processes using chemical clarification, ballast ponds, mixed media filters and ion exchange
Sludge Handling:	Organic sludge is composted for landscaping and chemical sludge is landfilled.
Source:	96% residential, 4% industrial
Overseas Experience:	Visitors from 59 different countries

II. Wastewater Utilities

B. Activated Sludge as major treatment process

Town Branch Treatment Plant
Division of Sanitary Sewers
Lexington - Fayette Urban
County Government
1401 Old Frankfurt Pike
Lexington, Kentucky 40504
(606) 233-1911
Contact: Jim Campbell

Average Flow:	Two plants -- 15,10 m.g.d.
Design Flow:	Two plants -- 18,16 m.g.d.
Processes Used:	Activated sludge, methane gas from anaerobic digestion is collected and used to run the plant.
Sludge Handling:	Vacuum dried for landfill
Source:	100% residential
Overseas Experience:	Foreign students on tours

Miami-Dade Water and Sewer Authority
P. O. Box 330316
Miami, Florida 33233-0316
(305) 665-7471
Contact: Judy Rubenstein

Average Flow:	Three plants -- 60,110,45 m.g.d.
Design Flow:	Three plants -- 80,121,50 m.g.d.
Processes Used:	Activated sludge using pure oxygen
Sludge Handling:	Effluent is either charged into the sea or pumped into deep disposal wells. Sludge is air dried and used directly for landscaping.
Source:	90% residential, 10% industrial
Overseas Experience:	Visitors from England, Korea, the Caribbean and Republic of South Africa

Milwaukee Metropolitan Sewerage District
735 N. Water St.
Milwaukee, Wisconsin 53202
(414) 225-2064
Contact: Dr. Steve Graef

Average Flow:	Two plants -- 140,75 m.g.d.
Design Flow:	Two plants -- 200,120 m.g.d.
Processes Used:	Activated sludge
Sludge Handling:	Air dried and applied on agricultural land or anaerobically digested and sold nationally as a soil amendment
Source:	65% residential; 35% commercial and industrial
Overseas Experience:	Visitors from Jordan and Mexico

Philadelphia Water Utility
3900 Richmond St.
Philadelphia, Pennsylvania 19137
(215) 686-9700, Ext. 82201
Contact: Bill Wankoff

Average Flow:	Three plants -- 180,160,80 m.g.d.
Design Flow:	Three plants -- 210,210,100 m.g.d.
Processes Used:	One plant has activated sludge using rotating biological contacters; the other two use oxygenated activated sludge.
Sludge Handling:	Composted and sold or used for land reclamation. Liquid sludge is used for strip mining land reclamation.
Source:	Various percentages of residential and industrial sources
Overseas Experience:	Visitors from various other countries

City of Phoenix Water and Wastewater Department
125 E. Washington St.
Phoenix, Arizona 85004
(602) 262-6627
Contact: Max Palmer or
Bill Korbitz

Average Flow:	Two plants -- 110 m.g.d.
Design Flow:	Two plants -- 120 m.g.d.
Processes used:	Activated sludge
Sludge Handling:	Incineration
Source:	70% residential; 30% industrial
Overseas Experience:	Has not hosted overseas personnel in the last 1½ years

City of San Angelo Water Utility
P. O. Box 1751
122 W. First St.
San Angelo, Texas 76902
(915) 658-1010
Contact: Cloice Whitley

Average Flow:	8 m.g.d.
Design Flow:	13 m.g.d.
Processes Used:	Activated sludge
Sludge Handling:	Used directly for irrigation water
Source:	80% residential; 20% industrial
Overseas Experience:	Has not hosted overseas personnel before

Pima County Wastewater Management
131 W. Congress - 3rd Floor
Tucson, Arizona 85701
(602) 792-8095
Contact: George A. Brinsko
Director of Wastewater
Management

Average Flow:	Two plants -- 44 m.g.d.
Design Flow:	Two plants -- 55 m.g.d.
Processes Used:	One plant -- activated sludge; one plant -- biofilters; several small plants which use stabilization ponds or package plants which are self-operative and need very little maintenance
Sludge Handling:	Air dried for landfill or ground injection into agricultural lands
Source:	Residential, commercial, and industry which does some pre-treatment of industry's wastewater
Overseas Experience:	Has not hosted overseas personnel previously

II. Wastewater Utilities

C. Trickling Filters as a major treatment process

Ames Iowa Water and Wastewater Plant
Municipal Building
Ames, Iowa 50010
(515) 232-5148
Contact: Harris Seidel, Director
of Water and Pollution
Control

Average Flow:	6 m.g.d.
Design Flow:	6 m.g.d.
Processes Used:	Trickling filters
Sludge Handling:	Digested and spread on land
Source:	Various; residential and industrial
Overseas Experience:	Visitors from Africa and Asia

City Sewerage Plant
208 S. 500 East
St. George, Utah 84770
(801) 673-3621/3130
Contact: James E. Wade

Average Flow:	2.5 m.g.d.
Design Flow:	4 m.g.d.
Processes Used:	Trickling filter
Sludge Handling:	Dried and distributed to community as soil amendment
Source:	99% residential; 1% industrial
Overseas Experience:	Has not hosted overseas personnel before

Joint Municipal Authority of
the Wyomissing Valley
701 Old Wyomissing Rd.
Reading, Pennsylvania 19611
(215) 376-1756
Contact: Ralph Johnson

Average Flow:	2.5 m.g.d.
Design Flow:	4 m.g.d.
Processes Used:	Trickling filter and activated sludge
Sludge Handling:	Anaerobically digested, liquid disposal onto crop land or belt pressed into solid for landfill disposal
Source:	51% residential; 49% commercial and industrial
Overseas Experience:	Visitors from various countries sponsored by the World Bank

II. Wastewater Utilities

D. Stabilization Ponds as a major treatment process

City of Portales Wastewater Treatment Plant
101 W. 1st St.
Portales, New Mexico 88130
(505) 356-3049/8291
Contact: Hillary Biges

Average Flow:	1-1.5 m.g.d.
Design Flow:	2.5 m.g.d.
Processes Used:	Stabilization pond
Sludge Handling:	Sludge is removed from system once every ten years
Source:	85% residential; 15% industrial
Overseas Experience:	Has not hosted overseas personnel before

El Paso Water Utilities
P. O. Box 511
El Paso, Texas 79961
(915) 533-9701
Contact: John Hickerson

Average Flow:	Three plants -- 24,19,6 m.g.d.
Design Flow:	Three plants -- 25,20,6 m.g.d.
Processes Used:	Stabilization ponds, trickling filter, and activated sludge
Sludge Handling:	Centrifuged or air dried, then composted and sold as soil amendment
Source:	Various; residential and industrial
Overseas Experience:	Visitors from South and Central America, India and Near East countries

II. Wastewater Utilities

E. Primary treatment as a major treatment process

Metropolitan St. Louis
Sewer District
2000 Hampton Ave.
St. Louis, Missouri 63139
(314) 768-6236
Contact: Nancy Burnell

Average Flow:	Three plants -- 300 m.g.d.
Design Flow:	Three plants -- 535 m.g.d.
Processes Used:	Primary -- screening and settling; some secondary treatment process also. Effluent is charged into Mississippi River.
Sludge Handling:	90% incinerated; 10% landfill
Source:	80% residential; 20% industrial
Overseas Experience:	Visitors from Russia and China

Chapter 5

ISSUES AND RECOMMENDATIONS

5.1 Key Issues from This Study

The planning and research that has gone into this study and the information these efforts have produced raise some interesting issues about training and education in the international water/wastewater sector. Following are brief descriptions, discussion, and recommendations on these issues.

Issue: There is a need for more educational institutions which provide practical and theoretical training and education in water/wastewater.

Discussion and Recommendations:

Effective technology transfer requires both knowledge and skills for persons holding jobs in water/wastewater projects in the developing world. The acquisition of knowledge without operational skills is not sufficient. The real need is for both. However, the number of colleges and universities surveyed that actually had a practical, hands-on approach to teaching water/wastewater technologies was quite limited. Recommendation: Third world institutions needing education and training for staff, especially long-term, should be diligent in locating educational institutions that do indeed emphasize practical hands-on training rather than the more theoretical, classroom-based approach. This need should be communicated to educational institutions.

Issue: There is a need for more on-going short-term courses.

Discussion and Recommendations:

There do not appear to be many on-going short-term courses in which a third world student might participate. Many organizations will offer these courses on demand but relaying this information to potential consumers in developing countries requires a brokering role on the part of development assistance organizations. This role needs to be more aggressively taken. This is significant when one realizes that it is not usually possible to enroll only one or two students in a workshop on, for example, financial management

for wastewater utilities. One must recruit enough students to make an on-demand workshop worthwhile for the institution. Recommendation: There is a need to organize a system for short-term basic training which is offered on a periodic basis for water and wastewater trainees from developing countries.

Issue: Study tours require care in organization and planning or they can easily be a waste of time and resources.

Discussion and Recommendations:

Research indicated that while study tours are a popular form of education and training -- having, in fact, potential for being quite useful -- they are often poorly done and less useful then they should be. Chapter 4 provides some in-depth guidelines for making study tours more effective and useful. The conclusion that one might reach about study tours is that to be effective, study tours require a good deal of organization and management. Recommendation: Unless the expertise, resources, and commitment are available to ensure they are done properly, study tours should not be used as a serious educational tool.

Issue: Of the many educational institutions listing programs in water and wastewater, few are geared to meet the needs of the international student.

Discussion and Recommendations:

In order to provide genuinely useful water/wastewater training and education for trainees from development projects in this sector, the criteria in Chapter 1 should be met. These criteria represent the best recommendations of recognized sector experts; and while the criteria address high standards of excellence, they are not unrealistic in light of the special needs of water/wastewater development education. Recommendation: To obtain the best training possible (which is sensitive to the needs of the international student), it is suggested that great care be exercised in selecting a training or educational institution. Finally, it is also noted that if the current situation is to improve, development agencies must be prepared to devote resources to promote, develop and assist educational and training programs.

Appendix A

JOB FUNCTIONS: WATER

In the area of water, all the activities required to plan, design, construct, and operate water systems, including sources, treatment and distribution were analyzed. A list of job functions necessary to carry out these activities was developed. The job functions are organized under these major headings:

I. Planning for Water Systems

II. Design of a Water System

III. Construction of Facilities

IV. Operation and Maintenance

Each of the four major headings is organized into four groupings as follows:

A. Technical Activities

B. Financial and Economic Activities

C. Management Activities

D. Social Considerations

In other words, the technical job functions required to plan for a water system, the financial and economic activities necessary during the planning stage, the management functions required to effectively carry out the planning phase, and the social considerations needed while planning would all be listed for planning, design, construction, and operation and maintenance.

Following is this list of job functions.

I. WATER SYSTEM PLANNING

A. Technical

1. Conduct engineering and environmental assessment studies/surveys which would include:

   - o geographical details
   - o population statistics and water consumption and demand (current and projected)
   - o land use (current and projected)
   - o water source quality and quantity
   - o existing water supply, treatment, and distribution systems
   - o effects of water systems on aspects of public health
   - o available energy and other resources

2. Identify and develop alternative water management plans which would include describing the options technically, describing their likely impact, identifying advantages and disadvantages of the option for the following system components:

   - o source development
   - o treatment
   - o distribution

3. Develop criteria for comparison and selection of alternative water management plans taking the following into account:

   - o economics
   - o reliability
   - o public health

- o institutional and social needs
- o human resource needs

4. Make recommendations for most viable alternative and assist in the decision-making process.

I. Planning (continued)

B. Economics/Finance

1. Prepare economic comparisons of alternative systems being considered.

2. Prepare cost analysis for design and construction activities for each alternative system being considered.

3. Prepare annual operating budgets for each alternative system being considered.

4. Participate in decision-making on which system to implement.

5. Prepare plans for obtaining funding, including financial projections for 5 and 10 years.

6. Prepare cash flow operating plan.

7. Develop alternative strategies for revenue collection, identifying advantages/disadvantages of each.

I. Planning (continued)

C. Social

1. Conduct social feasibility surveys and studies which include:

- o existing water supply and distribution systems
- o public's perception of their present system
- o public's understanding of relationship between water supply and health
- o effect of new system on local social patterns and daily life

- o potential for local contribution to capital and/or recurrent costs of the new system

2. Develop social criteria for water management systems such as:

   - o maintaining cultural/aesthetic values
   - o public perception of need
   - o public ability and willingness to use the system
   - o impact of new facility(ies) on community
   - o labor qualifications and availability for staffing

3. Integrate social planning with technical planning to make certain social criteria are considered in developing alternate plans.

4. Make recommendations for best water system alternative and assist in the decision-making.

I. Planning (continued)

D. Management

1. Coordinate and direct all technical, social and financial planning activities.

2. Ensure all activities meet existing environmental requirements and technical standards.

3. Work with other ministries and officials to see that water management plans integrate appropriately with related areas such as transportation, agriculture, food production, community health, etc.

4. Coordinate water planning efforts with national water resources and development goals.

5. Determine staffing needs; design manpower development and training systems; and recruit and select staff required to perform necessary work.

6. Manage day-to-day planning activities, staff and budget.

7. Coordinate with higher officials on major aspects of planning for water systems.

8. Identify funding sources where external funding is required, keep potential donor agencies informed about planning process.

II. WATER SYSTEM DESIGN

A. Technical

1. Source Development:

   a. Develop site layouts and design criteria for selected source development scheme. The following source development schemes would be considered:

      - o surface reservoir
      - o river intake
      - o well or well-field
      - o other

   b. Identify geologic and soil characteristics including soil borings, groundwater monitoring, etc.

   c. Develop preliminary and final designs for structures and mechanical, electrical and other support systems.

   d. Evaluate source development design to assure compliance with technical standards and regulatory requirements.

2. Treatment: Develop a flow diagram, identifying process unit names and sequence, of a community water treatment scheme to include water treatment using one or more of the following processes:

   - o aeration
   - o disinfection
   - o filtration
   - o fluoridation

- o iron and manganese removal
- o coagulation/flocculation
- o residue processing and disposal
- o softening
- o special processes (demineralization, desalinization, reverse osmosis units)
- o taste and odor control

3. Select process units which will provide cost effective water treatment.

4. Perform site surveys and geotechnical investigations to establish structural design criteria.

5. Design water treatment plant to include identification of support systems to be used for executing the designated process units for:

   - o electrical/mechanical equipment
   - o structural and architectural design
   - o engines
   - o plumbing
   - o measuring systems
   - o control systems
   - o chemical feeders
   - o rolling stock
   - o heating/ventilation/air conditioning

6. Evaluate the design for a treatment plant which will provide water treatment and determine whether the designed plant would meet design and regulatory requirements.

7. Distribution

a. Perform detailed typographic and utility surveys to identify optimal routings for transmission and distribution piping.

b. Perform subsurface exploration to establish pipeline structural design criteria.

c. Design transmission and distribution piping systems considering initial and future water demands, including fire flow demands.

II. Design (continued)

B. Financial

1. Estimate the construction, annual operation and maintenance, and amortization cost of the water supply, treatment and distribution facilities shown in design.

2. Implement strategies for obtaining funding, and make financial projections for 5 and 10 years.

3. Design financial accounting system for water treatment system (i.e., accounts payable, accounts receivable, payroll records, tax records, etc.).

4. Design cash flow and revenue collection system for water supply treatment and distribution system.

II. Design (continued)

C. Management

1. Coordinate and direct all financial design activities.

2. Coordinate and direct all technical design activities.

3. Project time frame for construction and implementation of water treatment system.

4. Recruit and select staff required to perform necessary work activities during design stage (i.e., civil engineers, water and sanitation engineers, financial planners, etc.).

5. Design appropriate staffing systems complete with management/supervisory reporting structures for water treatment system.

6. Manage day-to-day resources needed to perform design activities.

7. Communicate with higher officials on aspects of designing water system.

8. Coordinate donor agencies.

III. WATER SYSTEM CONSTRUCTION

A. Technical (construction supervision)

1. Make recommendations on how construction will be accomplished (i.e., what stages will be done in-house and what will be contracted out).

2. Plan and develop a schedule for constructing the system, listing all construction phases (i.e., excavation, movement of materials, laying foundations, etc.).

3. Determine resources -- manpower, equipment, materials, finance, supplies -- required for construction.

4. Obtain above mentioned resources needed for construction.

5. If contractors are to be used:

   - o Prepare specifications and contract of work for construction of water treatment system
   - o Advertise for proposals for construction
   - o Evaluate proposals for construction
   - o Award contracts for construction
   - o Oversee and inspect contractor(s) who are constructing water system

6. Implement day-to-day construction activities required for completion.

7. Supervise day-to-day labor force.

8. Solve day-to-day construction problems, maintaining completion schedule.

9. Make certain construction follows and meets design specifications.

III. Construction (continued)

B. Financial

1. Inform funding agencies regularly of financial status of construction.

2. Maintain day-to-day cash management of construction budget.

3. Maintain construction cost control within budget.

4. Maintain financial accounting system for construction budget (i.e., accounts payable, accounts receivable, payroll records, tax records, etc.).

III. Construction (continued)

C. Management

1. Coordinate and direct all financial construction activities.

2. Coordinate and direct all technical construction activities.

3. Maintain construction schedule within time frame.

4. Recruit and select staff required to perform necessary work activities during construction (i.e., bricklayers, pipe fitters, foreman, etc.).

5. Manage resources needed to perform construction activities.

6. Communicate with higher officials on aspects of construction of the water system.

7. Coordinate funding agencies.

IV. WATER SYSTEM OPERATION AND MAINTENANCE

A. Technical

1. Perform all or part of the following operational, start up and shut down procedures for the water system:

   a. Follow operating procedures for each process and support system for the water supply, treatment and distribution facilities:

      - o Recognize indicators of normal and abnormal conditions
      - o Identify causes of abnormal conditions using proper troubleshooting techniques
      - o Perform necessary corrective actions
      - o Record reasons for taking corrective actions, including the consequences of not taking action
      - o Perform necessary calculations
      - o Record necessary information
      - o Use necessary tools/test equipment/reference manuals
      - o Conform to safety procedures
      - o Identify safety hazards
      - o Explain interaction with other support systems/equipment and the total water system
      - o Relate necessary information to others

2. Perform the following preventive maintenance procedures:

   - o Follow actions in accordance with schedule
   - o Recognize when corrective maintenance is indicated
   - o Identify and locate each part of the system requiring preventive maintenance
   - o Perform preventive maintenance actions

- o Record reasons for taking these actions, including the consequences of not taking action
- o Record necessary information
- o Use necessary tools/test equipment/reference manuals
- o Conform to safety procedures
- o Identify safety hazards
- o Explain interaction with other support systems/equipment and the total treatment process
- o Relate necessary information to others

3. Perform the following corrective maintenance procedures:

- o Locate causes of malfunction using proper troubleshooting techniques
- o Perform corrective maintenance actions
- o Record reasons for taking these actions, including the consequences of not taking action
- o Record necessary information
- o Use necessary tools/test equipment/reference manuals
- o Conform to safety procedures
- o Identify safety hazards
- o Relate necessary information to others

IV. Operations and Maintenance (continued)

B. Financial

1. Perform the following normal financial operations for plant operation and maintenance:

- o prepare annual budgets
- o recommend financing for capital improvements and expansion
- o maintain normal financial day-to-day cash management
- o maintain financial accounting system for water treatment plant(s) (i.e., accounts payable, accounts receivable, payroll records, tax records, etc.)

IV. Operations and Maintenance (continued)

C. Management

1. Recruit and select staff required to operate and maintain water treatment system.

2. Manage human resources (i.e., orienting new employees, disciplining and motivating employees, encouraging professional development among staff, etc.).

3. Organize and implement a human resources development system that will allow for training of staff.

4. Maintain stock of supplies and materials necessary for operation of water treatment system.

5. Prepare periodic reports for appropriate government and/or private organizations.

6. Maintain daily operational controls.

7. Communicate effectively with community (i.e., responding to complaints, explaining operations to citizens, promoting treatment plant image).

8. Respond to/work with appropriate ministry officials.

9. Project future needs and plan for future expansion of system.

10. Maintain treatment plant (i.e., check physical plant for worn parts, replace worn parts, recommend capital improvements, etc.).

Appendix B

JOB FUNCTIONS: WASTEWATER

In the area of wastewater, all the activities required to plan, design, construct, and operate collection, wastewater treatment and disposal facilities were analyzed. A list of job functions necessary to carry out these activities was developed. The job functions are organized under these major headings:

I. Planning for Wastewater Systems

II. Design of a Wastewater System

III. Construction of Facilities

IV. Operation and Maintenance

Each of the four major headings is organized into these four groupings:

A. Technical Activities

B. Financial and Economic Activities

C. Management Activities

D. Social Considerations

In other words, the technical job functions required to plan for a wastewater system, the financial and economic activities necessary during the planning stage, the management functions required to effectively carry out the planning phase, and the social activities needed while planning would all be listed for planning, design, construction, and operation and maintenance.

Following is this list of job functions.

I. WASTEWATER SYSTEM PLANNING

A. Technical

1. Conduct engineering and environmental assessment studies/surveys which would include:

   - o geographical details
   - o population statistics and wastewater flow and pollutant loads (current & projected)
   - o land use (current & projected)
   - o potable water supply(ies)
   - o characteristics of wastewater flows and pollution loads (residential, commercial and industrial)
   - o current wastewater collection, treatment, and disposal systems
   - o effects of wastewater on water quality and on public health
   - o available energy resources

2. Develop alternative wastewater management plans and describe the technical options, their likely impact, and identify advantages and disadvantages of the options for the following system components:

   - o collection
   - o treatment
   - o disposal

3. Identify appropriate alternative wastewater management plans such as but not limited to:

   - o no action
   - o partial collection
   - o complete collection
   - o primary treatment
   - o secondary treatment
   - o advanced treatment
   - o land application

4. Develop criteria for comparison of alternative wastewater management plans in areas such as:

   - o economics

- o feasibility/implementability
- o reliability
- o human resource needs
- o public health
- o institutional/social

5. Make recommendations for most viable alternative and assist in the decision-making process.

I. Planning (continued)

B. Economic/Finance

1. Prepare economic comparisons of alternative systems.

2. Prepare cost analysis for design and construction activities for each alternative system.

3. Prepare annual operating budgets for each alternative system.

4. Participate in decision-making on which system to implement.

5. Prepare plans for obtaining funding, including financial projections for five and ten years.

6. Prepare cash flow operating plan.

7. Develop alternative strategies for revenue collection, identifying advantages and disadvantages of each.

I. Planning (continued)

C. Social

1. Conduct social feasibility survey and studies which include:

- o public's perception of their existing system
- o public's understanding of relationship between sanitation and health

- o effect of new system on social patterns and daily life
- o potential for local contribution to capital and/or recurrent costs of new system

2. Develop social criteria for wastewater management systems such as:

   - o maintaining cultural/aesthetic values
   - o public perception of need
   - o public ability and willingness to use the system
   - o impact of new facility(ies) (construction and social effects) on community
   - o labor (qualifications and availability for staffing)

3. Integrate social planning with technical planning to make certain social criteria are considered in developing alternative plans.

4. Make recommendations for best wastewater system alternative and assist in the decision-making.

I. Planning (continued)

D. Management

1. Coordinate and direct all financial planning activities.

2. Coordinate and direct all technical planning activities.

3. Coordinate and direct all social planning activities.

4. Make certain all activities comply with existing environmental laws and regulations and technical standards.

5. Work with other ministries and officials to see that wastewater management plans are integrated appropriately with related areas such as transportation, agriculture, food production, community health, etc.

6. Coordinate wastewater planning efforts with national development goals.

7. Conduct manpower planning studies and design manpower development and training systems for staffing required for system design, construction management, and operation and maintenance of proposed wastewater systems.

8. Recruit and select staff required to perform necessary activities.

9. Manage day-to-day staff and budget resources needed for planning.

10. Communicate with high officials on planning for wastewater systems.

11. Identify funding sources. Where external funding is required, keep potential donor agencies informed about planning process.

II. WASTEWATER DESIGN

A. Technical

1. Collection:

   a. Perform detailed topographic and utility surveys to identify optimal routings for collector and interceptor sewers.

   b. Perform subsurface explorations to establish pipeline structural design criteria.

   c. Perform economic comparisons of pumping vs. gravity-flow schemes.

   d. Design collector and interceptor piping and pumping facilities, considering initial and future wastewater flows, including industrial flows and infiltration and inflow.

2. Treatment and Disposal:

   Develop a flow diagram (identifying the sequence of the process units and their names, the direction of the wastestream and sidestreams, and recycling arrangements) of a primary, secondary, and/or advanced wastewater treatment scheme for a community, to include wastewater treatment and disposal systems using one or more of the following process units:

a. Preliminary and Primary Treatment Systems:

- o prechlorination
- o screening and comminution
- o grit removal
- o flow measurement
- o primary sedimentation
- o disinfection

b. Secondary and Advanced Treatment Systems:

- o trickling filtration
- o activated sludge
- o aeration
- o final clarification
- o sand filtration
- o coagulation and precipitation
- o stabilization ponds
- o nitrification
- o denitrification
- o activated carbon absorption
- o disinfestation
- o microscreening
- o disposal to a watercourse
- o disposal by land application

c. Residual Solids

- o thickening
- o primary digestion
- o secondary digestion
- o sludge conditioning
- o sludge dewatering
- o heat treatment
- o incineration
- o composting
- o landfill disposal
- o land application

3. Select process units which will provide cost effective primary, secondary, and/or advanced treatment for wastestream.

4. Prepare preliminary and final designs for a treatment plant which will provide primary, secondary and/or advanced treatment for wastestream. The designs will incorporate the following:

   - o electrical/mechanical equipment
   - o standby systems
   - o plumbing, heating and ventilation systems
   - o instrumentation and control systems
   - o structural and architectural design

5. Evaluate the design for a treatment plant which will provide primary, secondary, and/or advanced wastewater treatment and determine whether the design plant would meet design and regulatory requirements.

II. Design (continued)

B. Financial

1. Estimate the construction, annual operation and maintenance and amortization costs of a primary, secondary, and/or advanced treatment plant shown in design.

2. Implement strategies for obtaining funding, including financial projections for five and ten years.

3. Design financial accounting system for wastewater treatment system (i.e., accounts payable, accounts receivable, payroll records, tax records, etc.).

4. Design cash flow and revenue collection system for wastewater collection, treatment, and disposal system.

II. Design (continued)

C. Management

1. Coordinate and direct all financial design activities.

2. Coordinate and direct all technical design activities.

3. Project time frame for construction and implementation of wastewater treatment system.

4. Recruit and select staff to work during design stage (i.e., civil engineers, water and sanitation engineers, financial planners, etc.)

5. Design appropriate staffing systems complete with management/supervisory reporting structures for wastewater treatment system.

6. Handle day-to-day management of the resources needed for design activities.

7. Communicate appropriately with higher officials on aspects of designing wastewater systems.

8. Communicate and coordinate with donor agencies providing funding.

III. WASTEWATER SYSTEM CONSTRUCTION

A. Technical (construction supervision)

1. Make recommendations on how construction will be accomplished (i.e., what stages will be done in-house and what will be contracted out).

2. Plan and develop a schedule for constructing the system, listing all construction phases (i.e., excavation, movement of materials, laying foundations, etc.).

3. Determine manpower, equipment, materials, finance, and supplies required for construction.

4. Obtain above mentioned resources needed for construction.

5. If contractors are to be used:

   - o Prepare specifications and contract of work for construction of wastewater treatment system
   - o Advertise for proposals for construction
   - o Evaluate proposals for construction
   - o Award contracts for construction

6. Oversee and inspect contractor(s) which is (are) constructing wastewater system.

7. Implement day-to-day construction activities required for completion.

8. Supervise day-to-day labor force.

9. Solve day-to-day construction problems, maintaining completion schedule.

10. Make certain construction follows and meets design specifications.

11. Using above basic techniques, supervise the following:

- o surveying
- o trenching
- o trench shoring
- o pipe laying
- o backfilling
- o surface restoration
- o tunneling
- o excavation
- o placing forms
- o placing reinforcing
- o pouring concrete
- o placing equipment
- o testing equipment
- o starting equipment

III. Construction (continued)

B. Financial

1. Inform funding agencies regularly of financial status of construction.

2. Manage day-to-day cash expenditures of construction budget.

3. Keep construction costs within budget.

4. Maintain accounting system for construction budget (i.e., accounts payable, accounts receivable, payroll records, tax records, etc.)

III. Construction (continued)

C. Management

1. Coordinate and direct all financial construction activities.

2. Coordinate and direct all technical construction activities.

3. Maintain construction schedule within time frame.

4. Recruit and select staff required to perform necessary work activities during construction stage (i.e., bricklayers, pipe fitters, foreman, etc.).

5. Manage day-to-day staff and budget resources needed for construction.

6. Communicate appropriately with higher officials on aspects of construction of wastewater treatment system.

7. Communicate and coordinate with funding agencies.

IV. WASTEWATER SYSTEM OPERATION AND MAINTENANCE

A. Technical

1. Perform the following for each process unit (for process units see II. A):

a. normal operation procedures:

- o master routine activities
- o demonstrate safety procedures

b. abnormal operation procedures:

- o recognize and correct abnormalities
- o demonstrate safety procedures

c. preventive maintenance procedures:

- o master routine activities
- o demonstrate safety procedures

d. corrective maintenance procedures:

- o recognize and repair malfunctions
- o demonstrate safety procedures

e. laboratory control procedures:

- o conduct sampling
- o determine appropriate analyses
- o conduct analyses
- o evaluate results of analyses
- o interpret results
- o demonstrate safety procedures

f. system interaction procedures:

- o identify function of process units
- o identify effects of wastes
- o identify purpose of process units
- o recognize and deal with potential crises

IV. Operations and Maintenance (continued)

B. Financial

1. Perform the following normal fiscal functions for plant operation and maintenance:

- o prepare annual budgets
- o recommend financing for capital improvements and expansion
- o manage normal financial day-to-day cash transactions
- o maintain financial accounting system for wastewater treatment plant(s) (i.e., accounts payable, accounts receivable, payroll records, tax records, etc.).

IV. Operations and Maintenance (continued)

C. Management

1. Recruit and select staff to operate and maintain the wastewater treatment system.

2. Manage human resources (i.e., orienting new employees, disciplining and motivating employees, encouraging professional development among staff, etc.).

3. Organize and implement a human resources development system that will allow for training of staff.

4. Maintain stock of supplies and materials necessary for operation of the wastewater system.

5. Prepare periodic reports for organization.

6. Maintain daily operational controls.

7. Communicate effectively with community (i.e., responding to complaints, explaining operations to citizens, promoting treatment plant image).

8. Respond to/work with appropriate ministry officials.

9. Project future needs and plan for future expansion of system.

10. Maintain treatment plant and collection system (i.e., check physical plant for worn parts, replace worn parts, recommend capital improvements, etc.).